The Origins of Information Science and the International Institute of Bibliography/International Federation for Information and Documentation (FID)

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This article suggests that the ideas and practices embraced by the term "documentation," introduced by Paul Otlet and his colleagues to describe the work of the International Institute of Bibliography (later FID) that they set up in Brussels in 1895, constituted a new "discursive formation," to echo Foucault. While today's special terminology of information science was not then in use, this should not obscure the fact that key concepts for information science as we now understand this field of study and research—and the technical systems and professional activities in which it is anchored—were implicit in and operationalized by what was created within the International Institute of Bibliography in 1895 and the decades that followed. The ideas and practices to be discussed would today be rubricated as information technology, information retrieval, search strategies, information centers, fee-based information services, linked data bases, database management software, scholarly communication networks, multimedia and hypertext, even the modern, diffuse notion of "information" itself. The article argues that important aspects of the origins of information science, as we now know it in the U.S. and elsewhere in the English-speaking world, were contained within or became an extension of the discursive formation that we have labeled "documentation."

Introduction

At first sight, it is curious to discuss the history of information science in terms of the creation of an international organization in Belgium in 1895, an organization with which there has been very little sustained contact in the English-speaking world. Especially is this so as we are told that the term "information science" was first used only in 1955 (Shapiro, 1995). But even a cursory examination of the history and activities of the International Institute and Office of Bibliography suggests their

fundamental importance in the development of what we now call information science.

The Office and the Institute were closely related organizations. The Office was subsidized by, and was legally responsible to, the Belgian government and functioned essentially as the administrative center for the Institute. For ease of reference here, both organizations will generally be referred to simply as the Institute or IIB. They were created to support new systems to exploit the potentialities inherent in the information technology of the time. Over a period of about 40 years, there was an interesting reciprocal interplay between actual system development, what might be described as hyperbolic extrapolation from the existing systems—the grand system vision propounded in various places by Paul Otlet (see, e.g., the papers in Rayward, 1990)—and the gradual elaboration of the fairly sophisticated theoretical framework within which the systems were originally created, reaching its fullest expression Otlet's *Traité de Documentation* (Otlet, 1934). This framework involved new ways of looking at and speaking about aspects of the world of knowledge, books, and libraries, and the social infrastructure of which they were part. This complex interrelation of systems and rationalization established what we might call, after Foucault, a new "discursive formation" (Foucault, 1972). A "discursive formation," for which, embracing Otlet's own neologism for ease of reference, the transitional term, "documentation," is useful.

This new "discursive formation" involved the promulgation of new ideas, the identification of what were regarded as new phenomena, and changes in language practices, especially the elaboration of a new terminology. It also required the creation of new formal structures of communicating individuals and the development of new tools and techniques for information handling. As it emerged, it found formal expression in a considerable volume of special publications that ranged from, and were often mixtures of, practical manuals and guides, theoreti-

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A version of some of the content of this article appeared in Rayward (1994).

cal discussions, and polemical adjurations (e.g., ''Code,'' 1910; La Fontaine and Otlet, 1895; *Manuel,* 1904–1907; Otlet, 1896, 1903, 1920, 1934; ''Rules,'' 1896). While today's special terminology of information science was not then in use, this should not obscure the fact that key concepts for information science as we now understand this field of study and research—and the technical systems and professional activities in which it is anchored— were implicit in and operationalized by what was created within the International Institute of Bibliography in 1895 and the decades that followed. That is to say important aspects of the origins information science as we now know it were contained within or became an extension of the discursive formation that we have designated ''documentation.''

In this article, then, we will examine ideas and practices developed by Paul Otlet and his colleagues in the context of their work in and through the International Institute of Bibliography. The discussion is limited to the period in which Otlet was active and the Institute enjoyed its greatest success, from 1895 until the early 1930s. The ideas and practices to be discussed would today be rubricated as information technology, information retrieval, search strategies, information centers, fee-based information services, linked data bases, database management software, scholarly communication networks, multimedia and hypertext, even the modern, diffuse notion of ''information'' itself.

Our discussion is divided into two parts. In the first, we describe the systems and organizational arrangements that were actually put in place. In the second part, we discuss some of the more speculative ideas that Otlet formulated in the course of the development of the work of the International Institute of Bibliography and of the other organizations of which it was part. In each case, we try to show how both the work and the ideas adumbrate contemporary concerns in information science and system development. Thus, we conclude, strange though it may seem, that a bibliographical venture begun in Belgium towards the end of the 19th century may well be considered to be, in retrospect, an important aspect of the historical development of information science in the United States and elsewhere in the mid-20th century.

In making a comment of this kind, two caveats are in order. First, it should be noted that what is presented here as ''documentation'' goes beyond current accepted definitions. These tend to be restricted historically to aspects of special librarianship and the handling of scientific and technical information. Otlet means something far broader by ''documentation'' and ''document'' than has been understood by those who called themselves ''documentalists'' just before and just after the Second World War (e.g., Farkas-Conn, 1990; Richards, 1988). The modern documentation movement represents an interesting process of narrowing, focusing, and institutionalizing previously quite general ideas, a process which needs considerable further study before it can properly be under-

stood. Our challenge is to come back to Otlet's original ideas so that we can examine some of their implications for the unfolding discipline or set of disciplines we now call ''information science.''

Second, we do not want to make exaggerated claims as precursors to later developments for the general ideas and attempts at system development reported here. We do not set out to show a chain of material and causal links between what is discussed and the modern developments with which they are compared—hypertext, the internet, modern information technology, and so on. We do not intend to imply some simple linear continuity between past and present. In fact, the discontinuities in this case are a particular challenge (Buckland, 1995)—otherwise why should an article of this kind be necessary now in order to recover some knowledge of fin-de-siècle and early 20th century European ''Documentation?'' We are, however, intrigued by the apparent recurrence of ideas across generations and historical periods, by the emergence at different times of a sense, intriguingly similar as well as necessarily different, of the desirability of attempting to meet certain socially constituted needs for ''information'' that are expressed in part in terms of— and attempt to exploit—existing technology and imaginative projections from it. Underlying what we present here are broad questions about the changes that have occurred in the formation and expression of the role of information in society, and the gradual development of a complex and changing information infrastructure, by means of which support has been provided for the evolving social practices associated with identifying and managing information. We explore by way of a kind of retrospective projection—or retrojection—how we can use our understanding of the current relationship between information infrastructure and knowledge work to help give meaning and structure to the past. Conversely, we explore Otlet's unique contributions to that relationship within the different context of his time in order to enhance our current understanding.[1]

Part 1: Systems and Organizational Arrangements

The Foundation of the IIB

In 1891, Paul Otlet, a young Belgian lawyer, joined the Society for Social and Political Studies that had recently been set up in Brussels. A senior colleague, distinguished in the field of international arbitration, Henri La Fontaine, directed the Society's bibliographical program. La Fontaine, whom we assume Otlet already knew, was some 15 years Otlet's senior. La Fontaine's political am-

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[1] Geof Bowker of the University of Illinois has provided me with a cogent and stimulating critique of this paper which has led me to believe that I should make a disclaimer—or clarification—of the kind given here.

bitions would give him, in 1895, a seat in the Belgian Senate which he would occupy for nearly 30 years, and his work for the international peace movement would win him the Nobel Peace Prize in 1913. Otlet assisted La Fontaine in the work of the bibliographical section of the Society and, in 1893, they renamed this the International Office of Sociological Bibliography. During these years, Otlet closely studied contemporary bibliographical tools and services, and he and La Fontaine gained considerable practical experience of problems of cooperation and standardization in the preparation of bibliographical publications (Rayward, 1975).

In thinking about what he soon concluded was the disordered state of the literature of the social sciences, and what was needed bibliographically to create in these sciences the order, rigour, and cumulativeness of the natural sciences, Otlet began to formulate some interesting ideas. It seemed to him that, divorcing a book's content from its author and his or her authorial intentions, one should be able systematically to extract from books what was their new contribution to knowledge. This information could then be cumulated on cards which could be arranged to reflect the subject relationships involved. Separate cards were an essential feature of the system technology that Otlet was envisaging. They allowed ''all the manipulations of classification and continuous interfiling.'' But something else was needed: A classification or ''very detailed synoptic outline of knowledge,'' that could be used both as a basis for arranging the cards in a catalogue and for organizing collaborative work among scholars in the compilation of the catalog (Otlet, 1892, pp. 18, 19). In 1892, when he wrote ''Something about Bibliography,'' no such classification seemed to be available.

The chance acquisition of a copy of the Melvil Dewey's Decimal Classification in 1895 changed all of this. Otlet, so the story goes, though it is probably not true, following a meeting of the British Association for the Advancement of Science and while he was on a bicycle trip around the South Coast of England, happened upon a newspaper notice of the classification (Rayward, 1975, p. 41). The detail and comprehensiveness of the classification suggested to the two friends that it could serve as a base for developing not merely a catalog of legal literature or the literature of the social sciences, but a truly universal catalog of all knowledge. In the fall of 1895, with a subvention from the prominent industrialist and social theorist, Ernest Solvay (a kind of Belgian Carnegie), and the official support of the Belgian Government (Otlet and La Fontaine were both very extremely well-connected socially and professionally, La Fontaine having only a few months previously entered the Senate), they summoned the first International Conference of Bibliography—there were to be five of these conferences before the First World War: 1895, 1897, 1900, 1908, and 1910 (Rayward, 1975, passim). The conference, acting on the suggestions contained in a discussion document prepared by the two men (La Fontaine an Otlet, 1895) resolved to

set up an International Institute of Bibliography (IIB) whose headquarters in Brussels would be known as the International Office of Bibliography (OIB) to which the Belgian government accorded a semi-official status under the aegis of the Ministry of the Interior and Public Instruction. A great catalog on cards would be assembled within the OIB by means of international cooperation through the Institute. The catalog, called the *Répertoire Bibliographique Universel* (RBU), would be arranged in a classified order by a highly elaborated version of the Dewey Decimal Classification that became known as the Classification Décimale Universelle (in English, the UDC).

The IIB/OIB became the nucleus for an extraordinary process of institutional elaboration over the next 20 years. A range of special units and collections was gradually added to it. Following a major international conference at the 1910 Brussels Worlds Fair, Otlet and La Fontaine created the Union of International Associations, which is still active. The Belgian government allowed them to bring together in a single location a number of the exhibits at the Fair as the beginnings of the collections of an International Museum. The much expanded international center that resulted, and for which the International Institute of Bibliography formed a kind of physical as well as intellectual nucleus, was called the Palais Mondial or World Palace, later the Mundaneum. In the early 1920s, it was briefly the seat of what was grandiosely labeled an International University (it was no more than an elaborate summer school). The Belgian government effectively closed the complex in 1934, though the Institute of Bibliography and the Union of International Associations, as societies of interested individuals survived, the former going through a number of organizational changes to become today's International Federation for Information and Documentation.

Databases and Collections: Bibliographic, Image, Textual, Objects

The RBU grew rapidly. By 1897, it contained 1.5 million entries. Two years later, the number was nearly 3 million, rising to 9 million by 1912, ultimately by 1930 to nearly 16 million (Otlet, 1934, p. 405). The Repertory contained two main files: An author file and a classified subject file, plus a range of subsidiary files necessary for managing the main files (Rayward, 1975, p. 118).

From the beginning, Otlet and his colleagues stressed the importance for the rapid and comprehensive development of the Universal Bibliographic Repertory of international cooperation in publishing bibliographies in a standard format, preferably on one side of a sheet and with each entry containing its UDC number. The publications could then be cut up and pasted onto cards for interfiling in the RBU. Two sets of Library of Congress cards were sent regularly to Brussels beginning in 1902. The British Museum sent its great printed catalog, the last volume of which appeared in 1899, and followed this with its printed

accession lists. Other catalogs were acquired, cut up, and added to the database along with a range of periodical bibliographies, some of which were created by associates of the IIB with the requirements of the RBU in mind. The IIB staff themselves experimented with actually publishing bibliographies on cards (they had adopted as their standard the $3'' \times 5''$ card used in the U.S.) so that entries could be incorporated directly into the RBU (e.g., Otlet and Vanderveld, 1906). Publications that conformed to the various standardized requirements that they promulgated and which were incorporated into the RBU were designated ''Contributions'' to the ''Bibliographia Universalis.'' This actually reached considerable proportions in the period before the outbreak of the First World War (Rayward, 1975, chap. 6).

The RBU was followed by other kinds of databases. First, in 1906, came a Universal Iconographic Repertory, an image database in which illustrative materials were assembled and mounted on cards or sheets of the standard size. By 1912, there were a quarter of a million items in this Repertory (Rayward, 1975, p. 154). Its purpose was to provide a pictorial dimension to the RBU.

The next step was to add a full text file to the bibliographical and pictorial files. What was at first called the Encyclopedic Repertory of Dossiers (or files), but later simply the Documentary Encyclopedia, was instituted in 1907. In it were assembled materials, such as pamphlets, brochures, even hand copied passages from books and journals ''relative to all the objects and all the facts which constitute human activity in its widest extension'' (Masure, 1913, pp. 74–75). By 1914, this unusual approach to encyclopedia contained a million items in 10,000 subject files. Much of Otlet's thinking about what one might call documentary processing centered on the need for a new kind of dynamic, multimedia encyclopedia of which the Encyclopedic Repertory of dossiers was a prototype.

Collections

In 1906, a library that integrated the collections of a number of international associations and learned societies with headquarters in Brussels was set up in the offices of the Institute. It was called the Collective Library of Learned Societies at first, later being known as the International Library. A year after it was established, 25 groups had deposited their collections in it and it continued to grow until the outbreak of the First World War.

In 1910, under the aegis of the new Union of International Associations, an International Museum was formed as part of the complex of documentary services embraced within the Palais Mondial. Otlet and La Fontaine elaborated a most ambitious program for the Museum and a number of catalogs of its collections were published. Especially important for it was the development of charts and schemas encapsulating aspects of history, geography, science, and the broad themes of internationalism to which the Palais Mondial was dedicated. An artist, Alfred

Carlier, was employed in the museum to create large educational dioramas to supplement and amplify the objects on display (Rayward, 1975, pp. 270, 295–296).

All of these databases and collections were intended to be interrelated by common, standardized methods of organization, especially their arrangement by the UDC, the Museum collections, where appropriate, as well as the Library (Otlet, 1920, p. 197).

Database Management Software: The UDC

For Otlet, the UDC was the immense ''synoptic outline of knowledge'' that need for which he had recognized as early as 1892 (Otlet, 1892, p. 19), what he later described as ''an immense map of the domains of knowledge'' (Otlet, 1918, p. 78). The UDC's function was to provide a complex code for representing extended statements of what documents were about. The codes were made up from the numbers for classes and divisions. It was thought that these codes would show ''the links, the genealogy even, of ideas and objects, their relationships of dependence and subordination, of similarity and difference.'' Otlet and La Fontaine believed, at least in the first flush of their enthusiasm for the classification, that UDC numbers constituted ''a veritable new language'' and even ''followed the laws of scientific logic'' (La Fontaine and Otlet, 1895, p. 34). It was this linguistic potential that led Otlet and his colleagues to elaborate UDC's synthetic or faceted features.

''As a classification,'' Otlet observed, ''the UDC must present a framework in which ideas can be successively subordinated to each other in different ways. . . . As a bibliographic notation, it must be a veritable pasigraphy able to interpret by numerals grouped into factors having a separate and permanent meaning, all the nuances of ideologico-bibliographical analysis'' (Otlet, 1896, p. 59). The use of the word ''pasigraphy,'' a system of knowledge representation in which the symbols used are intended to represent ideas and things directly rather than standing for words, tells us a great deal about Otlet's aspirations for the classification.

In the period after 1895, the tables of the classification were developed with the collaboration of a great many scientists and scholars throughout Europe, including several Noble prize winners. Following an important theoretical statement by Otlet, ''On the Structure of Classification Numbers'' (Otlet, 1896), the classification's ''synthetical'' features were also gradually elaborated in a series of auxiliary tables for common subdivisions, or facets, by bibliographic form, language, chronology, point of view, proper name, and place, each having its own distinctive sign or marker (Rayward, 1975, chap. V). Complex numbers were created by using special signs of association which allowed the addition to the main numbers, of other numbers derived from the auxiliary tables for the common subdivisions or from subdivisions in the main tables themselves. These features make UDC

one of the earliest and perhaps grandest of modern faceted classification systems. The first full edition of the classification was published as a huge volume of over 2,000 pages in the period 1904–1907 (*Manuel,* 1904–1907). This incorporates various developments and revisions already published in one form or another from 1899 onwards, and represents something of a bibliographical nightmare (Rayward, 1975, p. 110). This first full edition was not to be revised in any substantial way until the 1930s.

The UDC in effect was a highly complex database management system. Given the different kinds of files it was used to organize, it might even be described as what Carlson, in the context of a hypertext information storage and retrieval system calls ''an assistance processor: a retrieval mechanism (or collection of retrieval mechanisms) for effective access to and management of the database'' (Carlson, 1989, pp. 62–63).

But there were major difficulties in the application of the system, especially related to filing and to search and retrieval using compound numbers. Whereas numbers or letters automatically create a known order, an arbitrary filing order had to be established for the signs of association used for number compounding—punctuation and other symbols—and this was inevitably hard to remember. This problem was made worse by the several procedures adopted for presenting long numbers in abbreviated form. But the filing problem was also a search/retrieval problem. In theory, each of the constituent elements of compound numbers, the factors, was intended to be searchable and thus to provide multiple points of entry to the database for complex ideas or subjects. But how many entries for one long, complex number should there be? Theoretically one would expect an entry for each factor or component of the compound number. But as John Metcalfe has demonstrated, taking up a comment of Bradford's about ''a small logical defect in the structure of the Decimal Classification'' (Metcalfe, 1959, p. 33), this sort of flexibility in searching was not possible in practice, except for whole numbers reversible around the colon (:). In effect, there tended to be only an author entry and one entry in the classified file.

This problem emphasizes the limitations of the technology of card and cabinet available to Otlet and his colleagues. Nowadays, the number-compounding and synthesizing conventions of the UDC can be used in computer-based searching in such a way that they actually fulfill the functions for which they were originally devised almost a century ago (e.g., Buxton, 1990).

Information Technology and Standards: Card and Cabinet

For Otlet and his colleagues, the creation and organization of systems of access to the databases held in the IIB were dependent on a special information technology. We call this the technology of card and cabinet. It was also a technology of cutting and pasting. An aspect of Otlet's originality as a thinker, and the source of what was to develop practically and theoretically over a period of 30 years, was his realization that the standard $3'' \times 5''$ card, and later, loose sheets or leaves of standard sizes, could be put to new kinds of bibliographical uses. If cards and sheets were standardized, especially as to size and weight, then it became possible to create collaboratively continuously expanding databases in these formats. This could be done in two ways. First, substantive or bibliographic information obtained from various sources could be cut up and pasted on the cards or sheets. Second, items specially published on cards or sheets that conformed to the appropriate physical standards, could be directly incorporated into the database, thus bypassing the cutting and pasting operations. Bibliographical standards also were promulgated for preparing entries on the cards and sheets, and for entries in bibliographical and other publications intended ultimately for incorporation into the repertories.

But the cards and sheets had to be physically housed. Standard catalog and file cabinets had to be designed and manufactured to contain the databases being compiled. As the various card and paper files grew in size and were accommodated in the appropriate cabinets, divisionary cards of different heights and colors were used to indicate major file segments. Blue indicated form divisions, for example, and green, divisions according to place. Moreover the major elements of the classification numbers were recorded on lugs that were staggered along the upper edge of the divisionary cards. These features ''express externally the outline of the classification . . . and reduce search time to a minimum'' (Otlet, 1918, p. 150). To provide standardized cabinets, card stock and other special stationery necessary for its databases and for the use of its international collaborators, the International Office of Bibliography in Brussels became a bibliographical supply agency (OIB, 1897, p. 161–167; Rayward, 1974, 1975, p. 127–129).

Search Services and Strategies

An international mail search service for the Institute's databases was instituted not long after they were set up, widely advertised, and drew considerable business (Masure, 1913). Search results were copied for a fee—27 francs per 1,000 cards or 5 centimes a card in 1902 (Rayward, 1975, p. 132). Instructions for formulating searches were drawn up. The retrieval effects of search terms that were either too broad or too narrow were described and it was suggested that requests should be formulated in terms of UDC numbers. In the Tables of the Classification, ''the degree of generality and specificity of each question is exactly determined by the context.'' Use of the Tables would prompt enquirers to both bibliographic completeness as well as exactness in the use of terminology. However it was IIB policy that if a request was likely to produce more than 50 items, users would be

notified of this ''to obviate surprise'' (Communication des fiches, 1897). By 1912, requests numbered 1,700 a year and subjects ranged from the boomerang, to Bulgarian finances, to coagulation of the blood. Searches continued to be made in the files—both bibliographic and image or iconographic—until the early 1970s, when they became unavailable.

The original intention was that the database, in whole or in part, could be made available simply by copying the cards or sheets. In practice it was immensely difficult to do this in an era before photocopying or computer printouts. To respond to requests for information, the staff of the search service in Brussels had to remove cards or other documents by hand from the files, copy them by hand and re-file them by hand. This was a labor-intensive set of operations that was also liable to all sorts of errors of miscopying on the one hand and misfiling on the other. Moreover, materials sent in by collaborators from around the world had to be manually collated and filed in the databases by the OIB staff. The difficulties of reproducing and ''distributing'' major segments of the RBU are exemplified by the unsuccessful attempts in 1902 and 1903 of the pioneer sociologist and town planner, Patrick Geddes, to obtain from the IIB comprehensive bibliographies for sociology, education, ''civic and social betterment,'' and ''parks and gardening,'' and by the 1911 request, filled only partially and with great difficulty, from the National Library of Rio de Janiero, for the creation from the RBU of a general subject bibliography (Rayward, 1975, pp. 123–126). Again, modern information technology based on computing and telecommunications has very much reduced the impact of these problems in today's bibliographical and textual database services.

Information Centre/Office of Documentation and Hypertext/Hypermedia

An interesting extension of the databases and search services based on them discussed above was the creation in 1907–1908 of three special information services in the IIB that represent what one might describe as rudimentary ''manual'' hypertext/hypermedia systems. They were called the International Offices of Documentation for the Polar Regions, for Hunting and Fishing, and for Aeronautics, and each was sponsored by a number of international organizations related to its field of interest. The services required the development of a comprehensive bibliographic repertory in their specialist areas, a repertory of illustrative material, such as photographs, drawings and prints, and a comprehensive library. More interesting, central to each was the creation of a substantive repertory in which ''documentary evidence will be classified on separate sheets . . . [this repertory] will contain extracts of literary works, separate articles, cuttings from newspapers, parliamentary documents, reports, prospectuses of industrial establishments and diverse manuscripts.'' (In-

ternational Documentary Office of Fisheries, 1908; Rayward, 1975, p. 155).

A vast manual labor of indexing, transcription, and excerpting was actually begun for these Offices. Louis Masure, Secretary to the IIB, gives an account of the status of their collections as of 1912. To take just one example, the International Office for Hunting had a collection of ''books, brochures, periodicals, newspapers, documents, prints, engravings, maps, and manuscripts'' (Masure, 1913, p. 101). Laws and regulations from various countries were translated and interrelated. The periodicals received were indexed for the Office's special subject database. By 1912 for just the one subject, Hunting dogs, 63.67.1, there were about 1,000 items in a small documentary format in their own special filing cabinets. There were slightly more than 1,700 items in the large documentary format at that number, again presumably in their own special filing cabinets. Some 300 pictorial items are listed as being at that number in the iconographic file. There would also have been, in addition, a set of bibliographic cards in the classified part of the catalog at that number (these are not broken down by category in the Report) as well as books on the library shelves. The files derived from the stock and stud books, over 21,000 items, are for dogs in general at 63.67 (Masure, 1913). A special section in the International Museum was also set up to receive objects of various kinds related to hunting and fishing. One assumes that a range of charts and tables outlining the nature and extent of what was involved in the broad areas of hunting and fishing, as represented by the international associations and as discussed at the international congresses sponsored by these organizations, were drawn up for display with whatever artefacts were obtained for exhibition.

Within these Offices of Documentation each of the databases, bibliographic, image, and textual, was implicitly linked to all of the others through the use of the same database management system, UDC. A number assigned to an entry in one file automatically linked that entry to an entry bearing the same or a related number in another file. Similarly, UDC provided links to materials in the Collective Library of Learned Societies. There were implicit links to relevant objects in the International Museum. Because of both the hierarchical nature of UDC and its use of facets, it was theoretically possible in searching to switch flexibly between related subjects in a particular file or across the various files for different kinds of materials.

But in addition to the UDC and the more restricted physical guides incorporated into particular files as described above (colored cards and staggered lugs at the top of divisionary cards), Otlet suggested the need for another general navigational or mapping device to mediate movement within and between files. This device was a series of diagrams and schemas, which Otlet also called ''atlases'' in the sense of ''conceptual maps.'' These displayed in simplified, visual form, the intricate relation-

ships of the concepts embraced within various subject areas. Otlet placed great importance both for educational purposes and for clarifying and stimulating thought on the use of schemas, diagrams, charts, and tables (Rayward, 1975, p. 295–6). A number of these schemas and charts were actually drawn up to help the conceptual orientation of users and to encapsulate the relationships between the databases and collections in the Palais Mondial or Mundaneum.

The existence of all of these kinds of files, the notion of ''chunks'' that seems to be inherent in the application of the monographic principle described below, the system of nodes and links provided by the UDC, and other navigational devices such as the ''atlases'' mentioned above, suggest that these offices of documentation functioned as rudimentary, manual hypertext/hypermedia systems (Rayward, 1994).

Part 2: Some Leading Ideas

The Monographic Principle

In the course of the Institute's development, Otlet regularly justified, explained, and extrapolated from, the systems and procedures that were being implemented in it in a steady stream of publications that appeared throughout his long life (for a full bibliography, see Rayward, 1990, pp. 221–243). For Otlet, cards were a key technology. Cards were central to a special documentary function: Recording ''analytically'' single, separate pieces of information, be they bibliographical or substantive. Larger chunks of information could be recorded on separate sheets. Otlet called this identification and recording of ''bits'' of information the ''Monographic Principle.'' The use of the term, monographic, was well chosen for, from the Greek, etymologically it signifies a single or individual piece or unit of writing. The idea was to ''detach'' what the book amalgamates, to reduce all that is complex to its elements and to devote a page to each. Pages here are leaves or cards according to the format adopted.'' Otlet is here using the term ''book'' in a very general sense to mean printed text. He suggested that the ''repertories''—in modern terminology, the databases—that he and his colleagues were developing provided ''a practical means of physically dividing the book according to the intellectual division of ideas'' and obviating authorial peculiarities that obscured what was new and important in what was being presented. ''Theoretically and technically, we now have in the Repertory a new instrument for analytically or monographically recording data, ideas, information'' (Otlet, 1918, pp. 149, 150).

Consultation

Otlet also introduces a concept of ''consultation,'' a new kind of reference function that has arisen as a result of the problems posed by the increasing volume of publi-

cation and of changing scholarly practices (Otlet, 1903, p. 79). Consultation—scanning or skimming—was the rapid purposive interrogation of many sources of information for the bits that were needed. These sources inevitably contained conflicting, duplicative, or erroneous matter. One of the functions of the new systems to be introduced was to make it possible to avoid such problematic material. The issue was how to release what was valuable information from the particular bibliographic and literary forms in which it was expressed. Otlet believed that the structure of conventional documents was too constraining. He wanted to find ways of, as it were, liberating what was of value or use in the content of documents by dissection or decomposition according to the monographic principle. This could then be reintegrated or recomposed in repertories or databases in an encyclopedic dialectic of analysis and synthesis. In effect, Otlet is concerned most centrally with what might be called ''real'' or factual information retrieval, rather than retrieval from a purely bibliographic file. He justifies his concern on the grounds that it facilitates a new kind of requirement for information access that he describes in a rather throwaway term as ''consultation.''

Unfortunately the extraction and deployment of the information that was needed necessitated, as has been mentioned, laborious transcription by hand or cutting and pasting. These last processes destroyed the integrity of the original and the possibility of other kinds of analysis, manipulation, and reconstitution of the text in ways that had not yet been anticipated. Online access to machine-held files does away with all of these problems. It effectively meets the requirements that Otlet had formulated but was unable to achieve in the paper and card environment in which he functioned.

Codification and Encyclopedia

The Office of Documentation Otlet proposed was to be a new kind of organization for processing and disseminating information. As early as 1903, he suggested that such offices would ''form annexes or organizations complementary to libraries'' (Otlet, 1903, p. 84). He was critical of libraries because of the ways in which they restricted the kinds of materials they collected, resisted technical innovation, including new methods of classification and cataloging, and were conservative in their approach to information service. He came to the view that eventually reformed libraries would become Offices of Documentation—perhaps similar to what we think of as the electronic library or libraries online.

What is distinctive about the Office of Documentation described by Otlet is that its primary functions were to process information. This involved the analytical, dissecting, reordering, restructuring, synthetical tasks predicated on the application of the monographic principle. Over the years, Otlet (e.g., 1918) came back again and

again to this idea, expressing it in different ways and in different contexts.

The notion of continuously, cooperatively elaborated databases growing from the decomposed texts of ''the innumerable books on the subject matter of each discipline,'' led Otlet very early on to suggest that they could form what might be called the ''Universal Book'' for each discipline. This book, the ''Biblion,'' the Source, the permanent Encyclopedia, the Summa would link ''materials and elements scattered in all relevant publications. It will comprise inventories of facts, catalogues of ideas and the nomenclatures of systems and theories. It will condense various scientific data into tables, diagrams, maps, schemas. It will illustrate them by drawings, engravings, facsimiles and documentary photographs'' (Otlet, 1903, p. 83).

This was ''the ultimate work of documentation'' and was to be achieved by a process of ''encyclopedic codification'' that required ''condensing, generalising and synthesising'' data related to knowledge and action (Otlet, 1934, p. 409). Otlet thought of this new kind of universal encyclopedia as a great cadastral survey of learning in which all developments in knowledge could be reported and recorded day by day. It would be the culminating work of an international documentary network (Otlet, 1903, p. 83).

The importance that these two ideas attained in Otlet's thinking emerges from a report of his address in 1937 to the World Congress on Universal Documentation sponsored in Paris by the League of Nations. Here, now the grand old man of European Documentation, he shared the limelight with H. G. Wells and Watson Davis (Rayward, 1983). He is described as taking the floor at the closing session of the conference to ''indicate in a magnificent improvisation the immense intellectual evolution of Humanity.'' Having surveyed the past, ''as to the future, the work of documentation will be the work of the encyclopedia. The speaker concluded by drawing attention to the necessity of amplifying the International Network for Documentation'' (Sèance de Clôture, 1937, p. 8).

Universal Network for Documentation/an Internet

The realization of Otlet's visions depended not only on the invention of new kinds of intellectual apparatus involving technology, databases, and search engines. What was also needed was a systematic organization of documentary work at every level. The most basic level involved the cooperation of individual workers following standard practices for the creation, internal organization, publication, and processing of documents. These would facilitate the process of ''division, dissection and redistribution of items of information'' that was needed at the encyclopedic level of organization (Otlet, 1934, p. 396). Beyond the individual would be interrelated networks of libraries, archives, museums, and offices of documentation all following the same standardized methods of col-

lection development and information processing. These networks would rise through the local and national to the international levels. Ultimately, as Otlet envisioned it, this process of international organization would reach its apogee in a Universal Network for Information and Documentation that linked ''centres of production, distribution, and use regardless of subject matter or place'' (Otlet, 1934, p. 415). All around the globe, scholars and others through the Universal Network for Documentation would be drawing on, and contributing to, an ever expanding, carefully managed, encyclopedic body of knowledge universally available to all. It is hard not to see prefigured in this formulation a version of what we now know as the Internet.

Multimedia Substitutes for the Book

So far this account of Otlet's ideas has been restricted to his attempts to create working organizations and services that were limited by the card and filing cabinet-based technology of his time. But over the years, Otlet became very much aware of new possibilities for information organization and communication offered by contemporary developments in communications technology.

In 1925, Otlet and Goldschmidt, speculating about microfilm, recognized that ''broadcasting has brought about a revolution in the diffusion of the spoken word. This revolution will be improved when the spoken word and the document are brought together'' (Goldschmidt & Otlet, 1925, p. 209). This would be achieved, they observed, when microfilm displays related to particular broadcast lectures were distributed so that those listening the broadcast could view the microfilm at the same time. But it was television, then still at a highly experimental stage and to which Otlet and Goldschmidt referred somewhat cryptically, that had most to offer here. Writing nearly 10 years later in the *Traité*, Otlet was able to refer to the setting up in New York of a company that was to begin regular commercial television transmission in April 1933 (Otlet, 1934, p. 238). He noted that studios for television production and transmission would be set up in most of the major centers and that television sets, what he calls the ''reception apparatus,'' too costly to be afforded by ordinary people, would be rented out at affordable prices. Here were intoxicating prospects for documentary innovation.

The *Traité de Documentation* expresses a revolutionary vision of the future. ''One after another,'' Otlet observed, ''marvellous inventions have immensely extended the possibilities of documentation.'' Such media as ''telegraph and telephone, radio, television, cinema, records,'' as well as museum objects, all have similar aims to those of books—''information, communication''—but they achieve them differently. There was as yet, he believed, no collective name for them and so he proposed the term, ''substitutes for the book.'' He devoted a major section in the *Traité* to an examination of their current state of

technical development, their functional relationships, and their implications for documentation (Otlet, 1934, Section 243, pp. 216–247). ''The book,'' he concluded, ''is only a means to an end. Other means exist and as gradually they become more effective than the book, they are substituted for it.''

Microfilm

A special form of substitute for the book was microfilm. Otlet had become interested in the bibliographical possibilities of microfilm as early as 1905–1906. Robert Goldschmidt, a Belgian engineer and inventor whose main interests were in electricity, was his technical collaborator. Their first article appeared in 1906 (Goldschmidt and Otlet, 1906). Another anonymous article came out in 1911 (Livre microphotograhique, 1907) and a third in 1925 (Goldschmidt and Otlet, 1925). It was not until the 1920s, however, that an attempt was made to make some practical ''documentary'' use of microphotography within the International Institute of Bibliography. Microfilm was seen as providing a new communications medium for the new kinds of information sources and services that Otlet and his colleagues were devising. In 1925, 19 years after their first article on the subject, Otlet and Goldschmidt again expatiated on the advantages of cheap microfilm. They anticipated that a procedure would soon be available for microfilm copying in ''absolutely faithful natural colours.'' It would be applicable to various categories of documents—bibliographies, patents, periodicals, rare and out of print books, art works, and archives, for example. They suggested that gradually, as all of the material that had been microfilmed was brought together and coordinated through the Universal Network of Documentation that they believed must emerge, it would form ''a microphotic encyclopedia,'' the basis of new kinds of ''microphotolibraries.''

To begin to meet this objective, Otlet and his colleagues began to reproduce in microform a selection of materials—texts, images, charts, and diagrams—from the collections of the Palais Mondial or Mundaneum. *The Encyclopedia Microphotica Mundaneum* was published as a series of microfilm strips on various subjects available for purchase at a modest price. Strip number 82, for example, consisted of 49 exposures on the history of the papacy; number 257 consisted of 56 exposures on Mongolia. In addition to this more educational venture, drawing as it were on the ''encyclopedia'' encompassed in the collections of the Palais Mondial, was a weekly current awareness service. This reproduced newspaper and journal articles on various contemporary subjects. It had a regular cartoon feature that was apparently much appreciated. Georges Lorphèvre, a young man who eventually became Otlet's Secretary and later his executor, was hired part-time in the late 1920s to manage this service. It eventually had 50 subscribers (Rayward, 1975, p. 297, Rayward, 1990, pp. 208–209).

''Inventions to Be Discovered'': The Scholar's Work Station, a Memex

In the *Traité,* Otlet is led from an analysis of multi media substitutes for the book to speculate about the possibility of new of kinds of machines and procedures that could assist intellectual work (Otlet, 1934).

There ought to be a process, he thought, for printing sheets of paper in a mass without each sheet having to be handled separately in order to be put through the press. He wondered if something might be done for this purpose with x-rays applied to a heap of sheets of paper consisting of the number of copies required. He thought that cheaper photocopying paper than the silver-based kind then in use was needed, and anticipated the development of pocket-sized, hand-held photocopying machines.

Punched-card machines, what he referred to as ''selection machines or statistical machines,'' were needed that could deal with paper sheets and files. He believed that with more columns, their capacity for coding and searching could be greatly increased.

He foresaw the creation of a more rapid and economic way of inserting illustrations into printed text than was then available. This might involve creating a system of ''curved and broken lines, of polygonal and curved shapes, of elementary units of diagrams, figures and plans'' which could be put together to form whatever shapes were required (Otlet, 1934, p. 390). Otlet thought of the design process as involving the manipulation of these elements by hand in conventional cold type, but it is not too extravagant to see here the basic idea of computer-aided drawing and design for which software is now everywhere available for most personal computers.

He identified something that today we would think of as the scholar's work station. He suggested, following an 18th century model, the construction of a desk in the form of a wheel, the spokes of which would be hinged and would constitute freely movable writing surfaces. These would provide separate surfaces to hold documents related to separate current projects so that, as one task was interrupted when another was taken up, there need not be constant displacing and rearranging of materials. He also suggested that the desk should be surrounded by a great mobile filing cabinet which would always be open, at eye-level height, and within hand's reach. Mounted on a straight or circular rail, its movement controlled electrically, this is a striking physical surrogate for the files and databases now available in electronic systems.

He envisioned a variety of ''machines and auxiliary instruments of intellectual work'' that would be found on the desks of intellectual workers. There should be machines to translate speech into writing and vice versa. It should also be possible, he believed, as an application of television, to read texts held at remote locations such as books on the shelves of a library or the contents of files in filing cabinets. He was thinking of reading machines that would scan the physical items and transmit the image

to a television-like console on the user's desk, while for us this function is performed by online access to machine readable files. Similarly, he thought that it should be possible to add long distance, as it were, to existing texts held remotely and to do this in such a way that the original texts were not disturbed. This idea of texts cumulating readers' annotation and commentary is seen as an important potential function of some contemporary hypertext systems (e.g., Davenport and Cronin, 1990). For Otlet, documentation involved many ''inventions to be discovered'' (Otlet, 1934, p. 389).

The Information Superhighway and Virtual Reality

Eventually, Otlet suggested, on the work desk there might be no books or other documents at all, but only a screen and a telephone. Somewhere out there in the world would be set up

an immense edifice containing all the books and the information, together with all the resources of space needed to record and manage them, with all of its apparatus of catalogues, bibliographies and indexes, with all the information redistributed on cards, sheets and files, and with search and retrieval [literally: selection and combination] performed by an appropriately qualified permanent staff. (Otlet, 1934, p. 428)

The scholar's work station would be connected to this central host by telephone, wireless telegraphy, television, and telex (''téléaugraphie''—elsewhere, p. 237, Otlet discusses ''téléphotographie,'' which seems to be kind of telefacsimile transmission). The user would simply call up on the screen the document or documents he or she wanted. The machine itself would operate one or more screens—as many as were necessary—to allow the simultaneous consultation of as many documents as might be desirable. A loud speaker would give an extra, auditory dimension to the system and would allow text to be accompanied or augmented by sound. Effective consecutive transmission of information in the system would depend on the materials on which it depended having been recorded analytically—monographically—in such a way that they could be automatically manipulated by ''selection machines'' (Otlet, 1934, p. 428).

But Otlet's version of the Internet or World Wide Web, only recently achieving the multimedia dimensions that he foreshadowed, had yet another dimension. He imagines machines having an important interactive capability that could create a ''virtual'' reality.

Cinema, phonograph, radio, television—these instruments considered to be substitutes for the book have become in fact the new book, the most powerful of means for the diffusion of human thought. By radio not only will one everywhere be able to hear, one will everywhere be able to speak. By means of television not only will one be able to see what is happening everywhere, but everyone will be able to view what he would like to see from his own vantage point. From his armchair, everyone will hear, see, participate, will even be able to applaud,

give ovations, sing in the chorus, add his cries of participation to those of all the others (Otlet, 1934, p. 431)

In *Monde,* he expresses his vision in terms of a

machinery unaffected by distance which would combine at the same time radio, x-rays, cinema and microscopic photography. All the things of the universe and all those of man would be registered from afar as they were created. Thus the moving image of the world would be established—its memory, its true duplicate. From afar anyone would be able to read any passage, expanded or limited to the desired subject, that would be projected onto his individual screen. Thus in his armchair, anyone would be able to contemplate the whole of creation or particular parts of it. (Otlet, 1935, pp. 390–391)

The invention of the machines with these capabilities would help realize the new kind of encyclopedia, the Universal Book, derived from all existing books, that was the ultimate desideratum of documentation. But Otlet thought of the encyclopedia as potentially taking a number of formats. One form was the central, super information center to which enquirers could be linked as described above. It might, however, take the encyclopedic form of ''a certain number of works'' into which ''all knowledge, all information'' had been compacted and which are ''indexed in such a way as to make possible the easiest form of consultation.'' They would be ''arranged on one's own work bench and thus close at hand.'' In this way, ''the world described in the ensemble of books would be very much within everyone's reach. The Universal Book formed from all books would have become very approximately an annexe to the brain, the substratum of memory, an exterior mechanism and instrument of the mind, but so close to it and so fitted to its use that it would truly be a sort of appended, exodermic organ,'' an organ that ''would have the function of making our being 'ubiquitous and eternal' '' (Otlet, 1934, p. 428).

As early as 1903, long before the sorts of development he described in the *Traité* stimulated him to technological speculation of the kind reported above, Otlet spoke of the practical aim of the Science of Bibliography as bringing into being ''a machine for exploring time and space'' (Otlet, 1903, p. 86). This image of a mechanical ''brain'' was to be echoed in his idea of a ''World Brain'' by H. G. Wells (1938) and by Bush (1945) in his famous article describing the functions of memex.

Documentation/Information; Documentation/Information Science

Otlet coined the word ''documentation'' to express a broader approach to the organization of sources of knowledge than was conventionally associated with ''bibliography.'' He occasionally uses the word information but in relation to facts and data. As first formulated in 1907, documentation was for Otlet an activity that was separate from, but complementary to, education and research. Initially it had for him an aspect of meaning that was an

extension of our conventional usage in such phrases as ''to document something'' or ''to provide comprehensive documentation about something.'' For Otlet documentation was ''the means of bringing into use all of the written or graphic sources of our knowledge. . . . Documents consist of whatever represents or expresses and object, a fact, an impression by means of any sign whatever (writing, picture, diagrams, symbols).'' But his usage soon took on an expanded signification that suggested it was a new intellectual discipline with which a range of new, typical technical practices was associated. The sources of documentation are ''written documents (books, periodicals, newspapers and manuscripts), pictures (engravings, drawings, photographs, etc.), ideograms (maps, plans, schemas, diagrams, etc), and music'' (Otlet, 1907, pp. 105–106).

Documentation involves not only organizing these documents as sources of information but of extracting and organizing the information that they contain as well. He identified six stages of documentary activity: Production of works in which ''ideas, experiments, new discoveries, etc. are registered in publications.'' A second stage involved collecting these works, the basic function of libraries (and one might add museums, depending on the nature of the ''document'' involved). Next comes analysis to provide a summary of a work. This is followed by ''systematic redistribution''—the publications are dissected and their various parts are physically redistributed in such a way that similar information is assembled in documentary files. Finally comes ''codification and the encyclopaedia'' involving what is original in each work being incorporated into ''a general structure, the objective blueprint of the scientific edifice,'' all repetition and duplication that were revealed as a result of the previous stage having been eliminated (Otlet, 1920, p. 185).

Documentation is not only a set of complex professional tasks based on the tools and techniques that Otlet and his colleagues devised, it also may be considered to be the set of rationalizations that provide a context for their application. Thus, while Otlet speaks prescriptively of what is desirable of organization at each of these stages, in effect he is identifying areas of study and research. Otlet begins with what is explicitly referred to as the ''science of bibliography and documentation'' (Otlet, 1903), and then develops the enlarged notions of documentation that led to his lifelong preoccupation with the never very effective experimental systems of the International Institute of Bibliography and the Palais Mondial. These systems formed the basis for the visionary extrapolations recorded in his various publications. These publications culminate in the *Traité de Documentation.* This is, in effect, a treatise on information storage and retrieval placed in a broad context of, then contemporary, communication and knowledge practices. In most cases, our modern term, ''information,'' substitutes effectively for the abstract phenomena and technical and professional processes that Otlet discusses. Otlet's understanding of documentation or the organization of documentation as a field of study and research is, in effect, encompassed by our term information science.

Deconstructing Otlet

A problem that must be recognized when one tries to interpret and reformulate what Otlet wrote is that of his own writing. It is diffuse, repetitive, and prescriptive. Often he presents little more than long lists of desiderata for achieving the reorganization of the world and access to knowledge along the lines he thought desirable. Nothing is too grand, or general, or difficult to appear in these lists. Committed to a thick encyclopaedism which has an almost imperceptible pulse of argument, his major books present little or no momentum of thesis, evidence, and conclusion. If they make a case for something, it is at such a general level that today we might well see the exercise as banal or pointless.

The modern reader must make a special effort of interpretation to get back to what is now of interest in these texts. They have to be dipped into or, to use Otlet's own term, ''consulted,'' and in a sense reshaped from the reader's own point of view in the process of reading according to what the reader seeks for his or her own purpose. To effect a process of this kind as quickly and efficiently as possible was a major goal of documentation for Otlet, and we must assume that he would applaud what we are doing in attempting to rediscover his ideas by rewriting them.

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