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## Melvil Dewey's Ingenious Notational System

### Abstract

Historically, the notational system of the Dewey Decimal Classification provided for non-institution-specific, relative location shelf arrangements, thus substantially reducing bibliographic classification effort. Today its decimal notation continues to provide the classification scheme with flexible granularity, is hospitable to expansion, expresses relationships, interfaces well with modern retrieval systems, and is internationally understood.

### 1 Introduction

Melvil Dewey, self-proclaimed library reformer, made numerous contributions to modern librarianship. Foremost among those contributions is the knowledge organization system that bears his name, the Dewey Decimal Classification<sup>1</sup> (DDC) system. While the original system “was devised for cataloguing and indexing purposes, . . . it was found . . . to be equally valuable for numbering and arranging books and pamphlets on the shelves” (Dewey 1876, 3). Evidence of the ingenuity of the DDC notational system is found in its use as a tool for both physical access (as a system of shelf arrangement) and intellectual access (as a classification system).<sup>2</sup>

### 2 Shelf Arrangement

The initial motivation for Dewey's system was simply that of library economy, a desire to avoid inefficient library practices. As Dewey (1920, 151) described the general situation (his simplified spelling has been retained):

In visiting over 50 libraries, I was astounded to find the lack of efficiency, and waste of time and money in constant recataloging and reclassifying made necessary by the almost universally used fixt system where a book was numbered according to the particular room, tier, and shelf where it chanced to stand on that day, insted of by class, division and section to which it belonged yesterday, today and forever.

For example, in his history of the General Library at Columbia, Joseph Brennan (1992) describes the situation that would have greeted Dewey when he became the librarian at Columbia College in 1883. The room in which the collection was housed contained ten alcoves, each corresponding to one or more broad subjects, as follows:

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<sup>1</sup> All copyright rights in the Dewey Decimal Classification system are owned by OCLC. DDC, Dewey, and Dewey Decimal Classification are registered trademarks of OCLC.

<sup>2</sup> Dewey biographer Wayne Wiegand (1998, 181) argues that Dewey's scheme “joined strong points from [systems designed by] Cutter, Harris, Shurtleff, and Schwartz. Dewey's contribution to classification was in joining and adjusting them, not in creating anything new.” Henry Ford's insights clarify Wiegand's observation: “‘I invented nothing new,’ he once declared. ‘I simply assembled into a car the discoveries of other men behind whom were centuries of work, and the discoveries of still other men who preceded them. Had I worked fifty or even ten or even five years before I would have failed. So it is with every new thing. Progress happens when all the factors that make for it are ready, and then it is inevitable. To teach that a comparatively few men are responsible for the great forward steps of mankind is the worst sort of nonsense’” (Greenleaf 1961, 138). In the same light, this paper discusses the contributions of the DDC's notational system without meaning to imply that they arise exclusively from the mind of Melvil Dewey.

- Theology
- Mathematics, also Fine Arts, Architecture, Medicine, Natural History, Printing and Music
- Greek and Roman Classics
- Philology and Bibliography
- Moral and Intellectual Philosophy, Logic, Rhetoric and General
- Literature
- History
- Biography
- Jurisprudence
- Astronomy, also Transactions of Societies, Physics, Chemistry
- Polygraphy and Miscellany, including Encyclopedias, Journals, Atlases

Entries in the library's catalog gave the size of each book, as well as a number, apparently for the section in which it would be found. This information could be used to direct the searcher to the correct alcove and then to the correct shelf or shelves (books of like size being shelved together to reduce space requirements). Then, "unless there was some further undocumented system, like arrangement by author's name, it was then necessary to scan all books of the right size."

The shelf arrangement system used at Columbia was but one of several kinds in use in the 1800s. James Duff Brown (1898, 14-16), focusing on European libraries, describes several others:

- The location of each book is designated by a "press mark," indicating the press/case, the shelf, and the position on the shelf; for example, "supposing Press A to contain books on Chemistry, and Roscoe's *Chemistry* was the fifth book on the second [B] shelf, it would receive the press mark A B 5."
- The books in the library are shelved in "one immense sequence of progressive numbers, each new book receiving the number after the last one already on the shelves. . . . shelf and accession numbers coincide."
- The library is divided into some reasonably small number of broad classes (probably in the neighborhood of a dozen or fewer). Within those classes, the arrangement follows accession order, as just described.

Macfarlane (1898, 149) also mentions several prominent libraries in which "books have been put on the shelves according to sizes only."

As we see, first and foremost, shelf arrangement was institution-specific. Where a particular item was shelved in one institution might bear little relationship to where it would be shelved in another institution (unless the broad subject schemes used were compatible). In deciding where to shelve a newly acquired item or in seeking to locate an item in one institution, little or no effort would be saved either the librarian or the library patron who happened to know the shelf location of a copy of the item in another institution. From one perspective, this is not altogether nonsensical. Shelf arrangement is, after all, very physical; it provides physical locations for physical items so that people can acquire physical access to those items. Why then should shelf arrangement not be governed solely by the physical layout of the housing institution? Here let us draw an analogy with the OSI (Open Systems Interconnection) Model, where each layer in the seven-layer model—with the physical layer at the bottom—provides services to the layer above it. In the OSI Model, the highest layer is the application layer, and "the other layers exist only to support this layer" (Zimmermann 1980, 430).

Shelf arrangement is a key element of the library's physical layer, while the uses to which the library patron applies the intellectual or artistic content of library materials comprise the library's application layer. Shelf arrangement should therefore be considered from the perspective of supporting access to and eventual use of intellectual and artistic content.

Given the difficulties associated with the various fixed location schemes of his day, Dewey (1920, 152) gave considerable thought to how shelf arrangement might be made more efficient.

For months I dreamd night and day that there must be somewhere a satisfactory solution. . . . After months of study, one Sunday during a long sermon by Pres. Stearns, while I lookt stedfastly at him without hearing a word, my mind absorbed in the vital problem, the solution flasht over me so that I jumpt in my seat and came very near shouting "Eureka"! It was to get absolute simplicity by using the simplest known symbols, the arabic numerals as decimals, with the ordinary significance of nought, to number a classification of all human knowledge in print.

### **3 Subject Collocation**

As we have seen, many fixed location systems achieved a degree of subject collocation, inasmuch as the first element of their notation corresponded to a broad subject class. But often these subject classes were too broad to provide meaningful subject collocation. Practically speaking, the first component in the notation of such schemes indicated in which alcove, case, etc., the item was shelved. Indeed, the entire notation of such schemes was geared toward reflecting the item's location. The notation in Dewey's Decimal Classification, in contrast, has always reflected the subject matter of the item. When used for shelving purposes, the notation only secondarily indicates where an item is located, which it does by indicating its location relative to the location of other items in the collection. In institutions desiring to maintain subject collocation within their collections and using fixed-location shelf arrangement, ongoing acquisition would result in the need to revise the fixed-location notations, since in time the space reserved for given subjects would be filled and volumes would need to be physically shifted. But a relative location system like the DDC would avoid such a need. As new items are acquired, physical shifting of the collection would still be required, but since the relativity of the order is based on subject and the subject nature of the items does not change, revision of the notation is undesirable. Indeed, by not being anchored to a physical layout in the least degree, relative location notational systems also avoid the need for different libraries to establish institution-specific notations for the same bibliographic work; as Dewey (1920, 151) had noted, "Then [with fixed location systems] there was the extravagant duplication of work in examining a new book for classification and cataloging by each of 1000 libraries insted of doing this once for all at some central point."

In order for such a system to be useful for subject cataloging purposes, the subjects recognized needed to be more specific than the broad subject groups used in fixed location systems. The initial publication of the DDC, published anonymously under the title, *A Classification and Subject Index for Cataloguing and Arranging the Books and Pamphlets of a Library*, presented ten main classes, each divided into ten divisions, each divided into ten sections. Apparently many librarians, initially "overwhelmed by its 1,000 class categories, described the scheme as too minute for libraries" (Satija 1989,

19). But the subject classes of a shelf arrangement system would need to be reasonably specific if subject were all that the notation reflected.

#### 4 Hierarchical Organization

Of course, a simple enumeration of one thousand subjects *would* be overwhelming. But the subjects in the DDC, while standing in a linear sequence (as needed for the purposes of shelf arrangement), are also hierarchically organized; indeed the linear sequence falls naturally out of the hierarchical organization. This dual (linear, hierarchical) organization derives from the basic characteristics that decimal numbers have in common with all positional notation systems, coupled with the meaning that Dewey gave to zero. In particular, it was essential that there be no limit on the number of positions that could be used. As long as another digit could be added to the righthand side of a Dewey number, the number would be capable of subdivision, which is the process by which new hierarchical relationships are created. The notational system scales up indefinitely.

The full set of advantages attached to the use of decimal numbers appears to have come to Dewey over time, although the fundamental advantages were clear from the beginning. Indeed, the proposal Dewey made to Amherst College for his new classification system was limited to a proposal regarding notation, with the basic principle (which he referred to as the “decimal principle”) of dividing at any given class into no more than nine subordinate classes (plus a 0 subclass to mean no further subdivision) firmly in place (Comaromi 1976, 4-6).

In the 1st edition of the scheme, one- and two-digit numbers were used for classes that are now numbered 001–099. Dewey (1876, 4) stated, “a General Cyclopedia or Periodical treats of no one class, and so is assigned to the Class 0. . . . No difficulty is found in following the arithmetical law and omitting the initial zero, so these numbers are printed 31, 32, etc., instead of 031, 032, etc.” This omission of initial zeros might convey the impression that Dewey saw his numeric notation acting as integers. And yet he also gives examples of four digit numbers, e.g., 5578 Geology of Mexico, which were clearly not to be interpreted as integers. Indeed, his initial proposal for the system spoke of a decimal point “as if it were written after the first figure” (Comaromi, 1976, 5).

By the 2nd edition, Dewey’s language indicated that his thoughts on the nature of his notation had coalesced. In this edition, all class numbers were given with at least three digits, including leading zeros for Class 0, and within that, Division 0. “The decimal form means simply that the heads are grouped and numbered with the common arithmetical figures *used decimally*” (Dewey 1891, 9; emphasis added). Dewey used the same phrase with reference to Cutter tables: “These tables represent a name by its initial followed by figures *used decimally* (to allow intercalation)” (Dewey, 1898, 54). Now integers do not allow for intercalation (i.e., interpolation) in the way that decimal numbers do: we cannot insert another integer between 356 and 357, but we can insert infinitely many numbers between .356 and .357. Indeed, in looking back at the beginnings of the scheme, he suggested that he had seen it as a thoroughly decimal

notation<sup>3</sup> all along: “The solution . . . was to get absolute simplicity by using the simplest known symbols, the arabic numerals *as decimals*, with the ordinary significance of nought” (Dewey 1920, 152; emphasis added). (Of course, if he really had conceived of the notation as thoroughly decimal, there would have been no need to fill out three-digit numbers with trailing zeros.)

The claim that Dewey came to see DDC notation as if preceded by a decimal point is not without controversy and, in and of itself, is not especially important. What is important is that by retaining leading zeros, the notation is not only more expressive, but has the advantage of creating the correct filing order, no matter whether the notation is considered as a numeric value or merely as a string of characters. This is not an advantage Dewey could have foreseen, but it is convenient in modern retrieval systems, which are not always programmed to distinguish between numeric values and strings of numeric characters.

The advantages that accrue to the DDC through the hierarchical nature of the notation are many:

- New subjects, which typically develop through specification of existing subjects, are accommodated easily by notational expansion, that is, by adding digits after the decimal point to form new numbers (and to express more specific subjects). This represents an implementation of the principle of intercalation and shows the hospitality of the system.
- The hierarchical nature of the notation provides the system with a flexible granularity. An institution can choose how broad or how close its classification will be, depending on how many digits of the most specific notation it retains; Dewey (1885) bragged that the system “[admitted] of the use of any number of headings wisht from 10 to 10,000.” In current practice, abridged editions of the DDC summarize the full editions of the scheme around shorter notation.
- Assuming the basic principles of the system are observed, specific translations of the DDC can expand for, e.g., geographic areas, without fear of usurping notation reserved for another use. Inversely, expansions from translations of the scheme can be adopted back into the standard edition without conflict.
- If notation from the full edition is used, the expressive nature of the notation indicates how broad or narrow the subject scope of a specific work is: bibliographic works with shorter notation have broader subject coverage, while those with longer notation are about more specific subjects.
- At the same time, hierarchical relationships between the subject coverage of two bibliographic works can be observed through their notation.
- Broader searches can be effected in modern retrieval systems by entering the first numbers of the appropriate notation followed by the wildcard operator; for example, a search on 787\* retrieves all works on music for string instruments.

#### 4.1 Mnemonicity

From the beginning Dewey recognized the usefulness of form subdivisions (e.g., philosophy, dictionaries, periodicals, societies, education, history) for organizing the

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<sup>3</sup> Incidentally, Parmar and Bhuta (1995, 365) define decimal classification thus: “Generally any classification which uses numbers arranged decimally for its notation. One adopts the convention that all numbers follow the decimal point and thus ‘0’ on the left-hand side of a symbol is significant.”

large number of items in general classes with a division number of 0. He assigned them numbers such as 203 Dictionaries of Theology and 709 History of Fine Arts rather than leave the numbers 101-109, 201-209, etc. unused. From this choice sprang the set of standard subdivisions that can now be added, unless prohibited, to any Dewey number. Another characteristic of the classification introduced at the start was the borrowing of substructure and attendant notation from general classes to more specific classes. For example, under 410 Comparative philology were found, *inter alia*, 411 Orthography, 412 Etymology, and 415 Grammar. Under 420 English, 430 German, 440 French, 450 Italian, 460 Spanish, 470 Latin, and 480 Greek, were found essentially the same subdivisions, using the same notation at the section level (e.g., 425 English grammar). Similarly, at 800 Literature, the subdivisions under 810 Treatises and collections were repeated under 820 English literature, 830 German literature, 840 French literature, etc. From such patterns arose the many instructions in the current system to notate the subdivisions of one subject area by dividing like another subject area. Because appending notation has the effect of subdividing a subject, the DDC has a reasonably high degree of mnemonicity, with a subdivision found in multiple places often being expressed by the same notation (but the same notation is likely to have different meanings in different contexts; for example, in some contexts 5 corresponds to Italy/Italian, but in others it corresponds to grammar).

#### **4.2 Number Building and Interfacet Relationships**

All the hierarchical relationships referred to thus far are generic-specific relationships, where a simple subject is made more specific through the addition of attributes associated with its semantic type: for example, red oaks are more specific than oaks. But specification in classification systems can also rely on the combination of two or more subjects of different semantic types (i.e., from different facets). For instance, jazz songs, a subject which combines form and genre, can be treated as a specification of jazz or as a specification of vocal music. In the DDC such subjects are typically expressed through number building; that is, a complex subject is reflected by appending notation that represents one subject to the base notation that represents another subject. The DDC notation for jazz songs, 782.42165, reflects a combination of 782.42 Secular songs + 165 Jazz (from 781.65). Batty (1976, 3) suggests that with the process of number building, seen in rudimentary form in even the first edition, Dewey made one of his greatest contributions. He describes the model thus: “the recognition of the characteristic aspects of the subject, the separate listing of those aspects in general-to-specific order, the availability of the detail from general aspect to divide the specific aspects further, the consequent assembly order of specific aspects divided by general aspects, and the mnemonic effect of the consistent use of simple notation from the two aspects.” And it all takes place within and dovetails with hierarchically expressive notation.

#### **5 Arabic Numerals as International Language**

Another advantage of the notational system that Dewey devised is that by exclusively using arabic numerals, the DDC notation can serve as a quasi-international

language;<sup>4</sup> that is, for example, 713 has a constant meaning around the world, no matter whether it is associated with the caption Landscape architecture of traffieways, Arquitectura paisajística de las vías de tráfico, Aménagement paysager des voies de communication, Landschaftsgestaltung für Verkehrswege, Landskapsarkitektur for trafikårer, Αρχιτεκτονική τοπίου για αρτηρίες μεταφορών, Ландшафтная архитектура транспортных путей, תחבורה דרכי של נוף אדריכלות, or الناظر الطبيعية للطرق تصميم. As Young (1960, 72) notes, “The use of arabic numerals has not, of course, contributed to its acceptance in the United States as much as it has in foreign countries.” In contrast, notation that mixes numbers with alphabetic characters presupposes the use of a particular writing system. However, no writing system is as universally recognized as arabic numerals. Indeed, among translations of the DDC published in the last ten years or currently under way, four (Arabic, Greek, Hebrew, and Russian) have used a non-Roman alphabet.

### **6 DDC in the Post-Modern Age**

Miksa (1998, 83-90) summarizes why Dewey created the kind of classification system that he did: “because that is how knowledge was viewed in the times in which he lived, that is, as a relatively simple, one-dimensional hierarchical structure of subject categories with the most general subjects at the top of the structure and the most concrete categories at the lowest levels of the structure.” Miksa continues by reflecting on the challenges faced by the DDC in assimilating to the post-modern age, in which information environments are becoming personalized spaces and in which assertions of truth are considered relative. Among his suggestions for how the DDC should respond to these changes are: (1) provision for various levels of specification so institutions and individuals can choose their desired level; and (2) provision of alternative arrangements based on different citation orders. In order to achieve these purposes, Miksa notes that effort will be needed “to discover new hidden patterns of relationships among categories and sequences of categories so that these new patterns might be applied elsewhere.” Fortunately, such efforts would build on fundamental characteristics of the system. (1) The hierarchical structure of the system supports varying levels of specification; based on this, research efforts in machine-assisted derivation of the abridged edition have already been reported (Mitchell, 2007, 28-35). (2) Because of the manner in which DDC numbers for complex topics are built (that is, the appending of notational segments that represent topic components), citation order is expressed in the notation. The principle of maintaining the integrity of the notation militates against generating notational variants that adopt alternative citation orders. However, there is no stricture against alternative (even user-customized) displays that organize complex topics in ways that mirror alternative citation orders (Mitchell 1998). Generating such displays could take advantage of information recorded in the 765 (Synthesized number components) field of the MARC authority format. It should be noted in a related vein that the 085 field in the MARC bibliographic format has recently been enhanced to support retrieval on the notational components that correspond to facets, e.g., the 165 from 781.65 in 782.42165.<sup>5</sup>

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<sup>4</sup> As Dewey (1876, 8) noted, the use of familiar arabic numbers offers greater accuracy, economy, and convenience than the use of Roman numerals, found in many fixed location systems.

<sup>5</sup> For further information, refer to <http://www.loc.gov/marc/bibliographic/bd085.html>.

## 7 Summary

While the notation system used in a bibliographic classification may appear on the surface to have only utilitarian value, this analysis of the notational system used in the Dewey Decimal Classification has provided ample evidence to the contrary. Indeed, the decimal notation of the DDC is a central feature of the system.<sup>6</sup> Not only did Dewey's insight into the use of decimal numbers provide for relative location shelf arrangements,<sup>7</sup> freeing librarians from considerable duplication of effort, but his insight also provided the basis for a classification scheme with flexible granularity, that is hospitable to expansion, where the notation is expressive of relationships, interfaces well with modern retrieval systems, and is international. Some of these qualities are essential to ongoing efforts (Panzer 2007; Green 2008) to establish an ontological representation of the scheme. Not bad for a system of "absolute simplicity, . . . using the simplest known symbols."

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<sup>6</sup> The value-added proposition of the DDC includes the following: large amount of categorized content, worldwide user community, language-independent representation, interoperable translations, mappings and crosswalks, and organizational support. All but the last of these benefits derive, at least in part, from the notation.

<sup>7</sup> There was one point on which Dewey conceded that his notation was not the equal or superior of all others: "A book which this year stands, e.g., at the end of a certain shelf, may not be on that shelf at all another year, because of the uneven growth of the parts of the library" (Dewey 1876, 10). During the life of a specific classification of a collection, fixed location does have that one advantage!

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