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Ranganathan and after: Coates' practice and theory

Abstract: This paper studies the works of Eric Coates who put into practice and advanced Ranganathan's thought mainly through the British National Bibliography, the British Technology Index and the Broad System of Ordering. Following a description of these three systems demonstrated are: (1) how his works are connected with each other, (2) why his achievements should be estimated by a global standard, and (3) which of his contributions will throw light on unsolved problems in knowledge organization. The conclusion is that the underlying conceptual coherence of the work of Coates should be highly regarded as the persistent survival of interest and concern about classification despite its marginalization.

1. Introduction

A librarian of the Far East is deeply impressed with the underlying conceptual coherence in the work of a still-active near-contemporary British classificationist. This paper studies the works of Eric James Coates. He was formerly Chief Subject Cataloguer of the British National Bibliography (BNB) from 1950 to 1961, Editor of the British Technology Index (BTI) from 1962 to 1976, and Rapporteur of the Broad System of Ordering (BSO) Panel from 1977 to 2000. The purpose of this paper is, however, not merely to trace his career nor merely to enumerate his achievements, but to demonstrate: (1) how his works are connected with each other, (2) why his achievements should be estimated by a global standard, and (3) which of his contributions will throw light on unsolved problems in knowledge organization. He was one of the original members of the Classification Research Group (CRG) that was formed in London in 1952. CRG was influenced by Ranganathan's thought. Coates recognized that Ranganathan's contribution in the field of knowledge organization was principally of two kinds (Coates, 1978a). The first was the notion of "the unity of subject indication" that embraced all kinds of classification and indexing. The second was his exhaustive illumination of syntactic problems in subject indication using the notion of "facet." These were two factors that influenced Coates' turnaround from earlier scepticism in thinking on classification and indexing (Coates, 1999).

2. British National Bibliography

BNB launched its actual service in January 1950 under the editorship of Arthur James Wells. The first year of BNB operated with a staff of eight. Coates was one of the four qualified cataloguers who had been appointed late in autumn of 1949. It is interesting to know that at that time he thought of himself as the possessor of some degree of cataloguing rather than classification expertise. But after a few months at BNB he was assigned to the post of the chief of subject indication side of the enterprise.

BNB was a classified bibliography designed primarily for systematic search of books, pamphlets and monographs published in the United Kingdom. The scheme of classification specified in the BNB remit was the Dewey Decimal Classification (DDC) 14th edition, supplemented by selective adaptations from DDC 15th edition. DDC matched up neither to

the specificity required even at book level, nor to the need for a consistently orderly display of the classified material. To mitigate this problem BNB adopted Ranganathan's method of facet analysis using the PMEST formula. Because BNB was not authorized to develop new extensions to the DDC schedules, the superimposition of the facet formula on a non-faceted scheme of DDC was carried out without notation. For this reason the practice was called "verbal extensions." But later a supplementary notation was added to meet the requirement that the alphabetical subject index should indicate specific addresses. An accumulation of faceted extensions was published as "Supplementary Classification Schedules" in 1963. The schedules were not only used in BNB but also influenced the then contemplated Bliss Bibliographic Classification (BC) revision. Ranganathan's idea which had not previously been put into practice outside India was fully carried out by BNB (Wells, 1957).

In the meantime BNB started to issue the British Catalogue of Music (BCM) in May 1957. BCM was also a classified bibliography supplemented with a chain index as BNB was. The classification scheme used for BCM, i.e. the British Catalogue of Music Classification (BCMC), was later published (Coates, 1960a). This faceted classification was compiled by Coates as a result of a discussion with a small committee of music experts. It was not an easy task to construct a music classification since the subject field of music required a variety of facets. Coates recognized 10 facets in compiling BCMC.

BCMC had another prominent feature for its "retroactive notation" which did not rely upon facet indicators. For a larger notational base than that of decimal system BCMC employed Roman alphabets. The reversal of schedule and citation order was the usual practice of faceted classification. The combination of facets could be recognized without facet indicators by using a technique which apportioned part of the alphabet to serve as an invisible facet link indicator while reserving another part to accommodate enumerated (uncombined) topics. At the Dorking Conference of 1957 Coates demonstrated that there was a mutual constraint between hospitality and expressiveness (Coates, 1957). BCMC was hierarchically non-expressive. Therefore BCMC fulfilled all the three notational requirements: simplicity, brevity and hospitality. Though retroactive notation in itself is not new in the history of library classification, it is again used in the sections of the Bliss Bibliographic Classification, 2nd edition (BC2) which have so far appeared.

3. British Technology Index

In 1960 Coates published a valuable book on subject catalogues (Coates, 1960b). While the ideas set out in the book were an outcome of the 10 years' experience with BNB, he put forth a new approach to alphabetical subject catalogues. He had recognized that the predecessors of this field were Cutter, Kaiser, Ranganathan and Farradane (Coates, 1953). The new approach comprised a set of rules based on Ranganathan's facet analysis as further illuminated by Farradane's relational system. Just at that time it was felt in the British library world that there was a need for a bibliographic tool for technical information service. Coates did not miss the opportunity. He became the first editor of BTI that was commenced by the Library Association (LA) in February 1962.

In the design of BTI Coates set out three criteria: coverage, currency and retrieving power. BTI was a monthly and annual subject index to the technical articles in about 400 British journals (Coates, 1970). BTI kept up a remarkable currency as an indexing system with vocabulary control. The time-lag was between three and seven weeks. Because it was felt that a prompt answer to specific inquiries was more important than broad field browsing in the field of technology, BTI chose a form of alphabetical indexing. The indexing methodology was governed by the same rules as described in the book of 1960. Following subject analysis by his own words, the indexer analysed the relation between categories of

concepts, and formulated the subject heading by reference to the BTI Relationship Table that was also carried in the introduction to annual volume. Subject terms in a syntactic citation string were connected by a small set of punctuation marks, each of which indicated the degree of conceptual closeness. For instance, the comma was used for generic relations, and the colon and the semicolon were used for syntactic relations. Cross-references were produced both from articulated subject headings by using chain procedural method and from an authority file. The page layout of BTI interestingly exhibited a "block structure" of related subjects, which was quite helpful for broad searching. This kind of collocation was due to the logically articulated subject headings and to the underlying classificatory principle throughout the indexing procedure.

BTI was a pioneer as an independent alphabetical subject retrieval tool which used a chain procedural technique as an economical alternative to a multiple permutation system. It was also a very early example of a concept-controlled subject retrieval system which computerized its clerical and typesetting operations in an integrated manner. These pioneering attempts supported BTI which started as a self-supporting venture. There had been two previous efforts at technical indexing service in the United Kingdom, both of which had failed. In recognition of the success of BTI, which owed above all to the effectiveness of indexing methodology, the Library Association awarded Coates the title of Honorary Fellow in 1979.

4. Broad System of Ordering

BSO is an implicitly faceted general classification that incorporates many of the theoretical developments in information retrieval which emerged after World War II. The scheme was constructed at FID in association with Unesco in the framework of the UNISIST programme and was intended as a switching mechanism for various indexing languages. The project started in 1973 and the first hard copy publication appeared in 1978. During this period 10 classificationists contributed towards the completion of BSO. Coates was the latest member who joined the project. However, as Geoffrey Arthur Lloyd who had been Rapporteur of the BSO Panel from 1974 to August 1977 persuaded Coates to take up the rapporteurship, it was largely thanks to Coates' energy and expertise that the raw BSO draft was refined, completed, subjected to a field test in 1977 and finally published in 1978.

UNISIST had envisaged that a universally acceptable list of broad categories for subject cataloguing was both feasible and desirable to facilitate switching. Accordingly UNISIST advised the BSO Panel not to make the scheme too detailed on the one hand, and not to omit various specialized subject fields on the other. The criterion adopted by the BSO Panel for the inclusion of terms in the scheme was the manifestation of organizational activity and institutionalization in relation to particular subject field or area of study. For this reason the criterion was called "institutional warrant." In practice, a subject which had an actual "organised information source" devoted exclusively to it was given to be its own code in BSO. This resulted in about 4,000 terms in the first hard copy publication mentioned above.

The order of BSO main classes is to a greater extent different from most of conventional schemes than it appears. BSO is based mainly on the theory of integrative levels. It begins with the natural sciences which are additionally preceded by preliminary sciences, such as philosophy, science of science, logic, mathematics, and so on. The natural sciences are followed by the life sciences, and these are followed by human sciences. Thus the natural sciences and technology are separated by the human sciences, but science and technology, when treated together in the same document are assigned a place immediately before the natural sciences. While there are some separations against conventional practices, including the separation of religion from philosophy, careful arrangement of BSO main classes exhibits an interesting collocation.

BSO is a discipline-oriented general scheme, but phenomena- or mission-oriented classes are inserted in the sequence of main classes. These are: human needs class, including foods, clothing and housing; sports and games; area studies; and social groups and communities. Coates thinks that topics in these classes do not satisfactorily fit into any framework of disciplines because they stride over both human sciences and technology, and often parts of life sciences and natural sciences. In addition to these inherent phenomena classes, provision for accommodating works with all or many aspects of phenomena is made at the top of the schedules (088). This requires a mechanism for individualization of each entity or phenomenon. BSO uses the principle of "uniquely definable class" suggested by Farradane in the 1950s. Thus individualization is achieved by adding to 088 the BSO number found in the class within which it is uniquely defined.

The schedules of BSO are constructed by considering both facets and relations, which is reflected in combination rules. The procedure for combining elementary concepts within a specified combination area is a simple clerical one which links notations in reverse schedule order usually with a connecting link symbol. External linkages which cross combination area boundaries require analysis of the meaning of the link which connects the respective elements. However, the external combination is in many cases likely to be the reversal of main class order, because the order of BSO main classes is in the sequence of preliminary (or methodological) sciences, natural sciences, human sciences, technology, and products of human mental activities. This ordering pattern is again that of the reversal of the standard citation order. Thus the reversal rule applicable in many cases to the external combination as well as to the internal combination in every case may open a potential for future automation.

The structural isomorphism or constant repetitive pattern of BSO brings two kinds of advantage. The first is simplicity in dealing with subject matters, which minimizes the dilemmas of classifiers. The second is predictability for a new concept, which enables both system revisers and users in a broad sense to find a logically correct place. The second advantage reduces the likely costs of updating provided that the notation is fully hospitable. BSO uses a hierarchically non-expressive notation.

Following the publication of the BSO schedules and index (Coates et al., 1978b) and of the BSO manual (Coates et al., 1979), the BSO Switching Test of 1981 and the BSO Referral Test of 1982-83 were carried out. Based largely upon the findings and experience of these field tests, revision of BSO was set forward. As a result the revised BSO in machine-readable form, of which the vocabulary has increased to about 6,800 terms, was released (Coates, 1991). The revised BSO must be very useful in any information system covering the whole field of knowledge. An updated version is downloadable from a Website of the present base institution (UCL/SLAIS, 2000).

5. Need for a coherently structured general classification

The grafting of a faceted structure on to a non-faceted classification by BNB was a decisive departure from previous subject indication practice which had been regarded as a virtually intuitive art or craft. It fitted in with the notion of subject indication as a unitary discipline implying a comprehensive set of rules embracing both classified and alphabetical structures. Such communicable procedures become very important in operations requiring teams of classifiers or classification compilers. The same idea was used at BTI. Coates encouraged the BTI staff to deal with subject heading problems in classificatory terms.

The efforts of BNB inevitably pointed to the need for constructing a new general classification. It was anticipated that such a new general classification would be beneficial to non-general documentation systems, such as BTI. However, in the event, no general classification emerged from BNB.

Coates argued that classification was the essential tool for vocabulary control (Coates, 1960b, p.20). Therefore, BTI indexers endeavoured to resolve problems of assigning appropriate headings for "new" concepts by consulting a variety of classification systems. Unfortunately a single classification system which might have helped did not exist.

The classified form of catalogue was predominant over other forms in the United Kingdom at the time when BNB started. BNB was not only a national bibliography based upon legal deposit system but also an effective tool for book selection and an aid for classifiers. The latter functions would have not been possible if the classified form had not been provided. Coates put value not only on specific entry for individual subjects but also collocation of their related subjects as the "block structure" of BTI showed. He argued that all forms of subject catalogue had a two-fold objective: specific searching and broad browsing (Coates, 1960b, p.19). This is a very important requirement of the subject catalogue, which has been, and is still neglected. Although the character of the original BNB (1950-70) and BTI (1962-80) has been largely abandoned by the owners of their current successors, it is still arguable that the standards of excellence that they set have, and will continue to have, a positive influence on subject indication practice world-wide.

Of two legacies which are recognized in Ranganathan's thought, the notion of "the unity of subject indication" has been faithfully put into practice by Coates. However, the categorical approach to the notion of "facet" has been to some extent clarified by the impact that Farradane's relational system has made on him. Coates advanced the theory of relations in the light of classification (Coates, 1973). Relational analysis is very useful because it compels an indexer/classifier to carry out concept analysis by reference to the meaning of the spaces between two terms in syntactic structures. It is also worth observing that how many relations are necessary for information retrieval. BTI tabulated 11 types of relations and BSO does 15.

Coates recognizes that since the Dorking Conference of 1957, progress in classification has been exclusively related to facet and syntactic structures (Coates, 1978a). On the semantic side, however, he says that there has been little progress. An obvious symptom of the delay in classification semantics has been found in the cross-reference systems of thesauri. There are two points which need research in the neglected area of classification semantics. The first is the RT references to which standardization activities could not give a satisfactory answer. The second is the arbitrary polyhierarchies on the BT/NT link. While classifications have stood on monohierarchy for the purpose of linear display on the two-dimensional media, thesauri have admitted tangled hierarchies. It may be argued that the thesaural RT and polyhierarchical BT/NT references offer useful search pathways and that these are no problem in the day-to-day use of the indexing language. However, Coates draws our attention to the serious problem associated with operations on the indexing language itself, such as updating and transformation.

Indexing languages attempt to be tabulations of concepts, necessarily labelled by words, as distinct from tabulations of mere words. The very essence of the notion of a concept is that it is related in some explicit way to a more or less systematic body of other concepts. Classification systems need to embody two kinds of relations: semantic and syntactic. Semantic relations are a priori or necessary relations since they are inherent in each of the concepts as defined. They are given in the notion of the concept itself. They usually offer neither a linguistic nor a symbolic cue indicating their presence in the ordinary language of discourse and also in the context of computerized retrieval. They are characterized by their "invisibility." Syntactic relations are a posteriori or accidental relations since they arise from combinations of words. In natural language they are indicated by a variety of grammatical forms, such as case inflections, prepositions, word order or simple juxtaposition. In indexing languages they are indicated by facets, roles, links or citation order, and so on. They are characterized by their "visibility," which is applicable even to the white spaces between

words. We must bear in mind that semantic relation is recognized only on the concept plane, or the plane of meaning, and that this plane is invisible to the computer except through the mediation of the classificatory structure found in indexing languages.

From the above discussion we can see the reason why many systems predominantly syntactic in nature have been mechanized, and why human intermediaries who interact between users and systems are often needed. In the age of computerized retrieval and of the Internet, the ability to navigate through the diversity of knowledge fields is an essential part of the required skill (Coates, 1997a). The established general classifications do not seem to fulfill the role of teaching aid, or of search aid, in the new information age. It is here that a new general classification is expected to play an important role. This includes the clarification of semantic relations and the return of useful data to subject relations. As the BSO arrangement of the fields of human knowledge is conceived to be as nearly as possible in accordance with the present world view, in so far as such a world view exists, BSO might well be a possible starting point model for use in in-depth research on semantic relations. BC2, when completed, with an outline arrangement similar to BSO, could be another possible candidate. Coates indicates that pursuit of the semantic side of classification would inevitably lead into the realm of user behaviour in searching and to the social and cultural environments affecting classification (Coates, 1997b).

6. Conclusion

BNB, BTI and BSO are successful demonstrations of faceted classification principles in action. Coates developed the theory of library classification through the practice of these systems. The underlying conceptual coherence in the work of Coates should be highly regarded as the persistent survival of interest and concern about classification despite its marginalization, both in the library and information science community and more widely, by the dominant enterprise management, information technology culture of the present day. The longevity of the CRG is another example of this persistence, yet a further example is the emergence of classification, under such names as ontology and taxonomy, as a lively concern of the Internet users and service providers. This persistence can be attributable to the fundamental role of the capacity to generalize in the early development of the human ability to engage in thought. Classifying that is the formation of classes by reference to properties of objects, is an integral part of the long process of making unitary sense of the otherwise confusing and meaningless variety of experiences during infancy and childhood. It pervades the very process of thought itself at all stages of life.

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- Wells, A.J. (1957). British National Bibliography. *Annals of Library Science*, 4(3):73-89.

Aruna Ranganathan Stanford GSB Alan Benson. Carlson School of Management. August 31, 2019. Abstract Technological developments and the big-data revolution have facilitated fine-grained, high-frequency, low-cost measurement of individuals' work. Yet we understand little about the effects of this quantification of work on workers' behavior and performance. This paper contributes to the study of quantification, organizational practices and work design, and highlights important policy implications of increasing quantification of work. 1. New technologies and the big-data revolution have enabled the measurement of individual work performance (for example, see Anteby and Chan 2017, Christin 2018, Kim 2019). Ending of aot theory. **DISCLAIMER**, the chapter 138 leak is NOT 100% verified yet. So based on the "leak" I read this is my theory. If it's completely wrong and fake then it's irrelevant but tell me your opinion. So as you see on Twitter, the chapter spoilers for 138 are also out. Contrary to popular belief, this ends with Eren winning. He uses the baby. Rumbles the world and wins, that's what the last panel is, it's him with Historia's child after he accomplished the rumbling and wins. This ending would be great, greatest of all time because the moral is to not discriminate, not to hate others bc of the extent he went to eliminate the discrimination to the subjects of Ymir. That's my theory what does everyone think? SPOILER. 284 comments. Shiyali Ramamrita Ranganathan (S.R.R.) (listen 12 August 1892 – 27 September 1972) was a librarian and mathematician from India. His most notable contributions to the field were his five laws of library science and the development of the first major faceted classification system, the colon classification. He is considered to be the father of library science, documentation, and information science in India and is widely known throughout the rest of the world for his fundamental thinking in the field. Ranganathan's "universe of knowledge" is the universe of subjects (as an analogy of what occurs in chemistry, three types of subjects are distinguished: basic, compound and complex). This universe is described in terms of a complex, dynamic multidimensional space. It is a "dynamical continuum" which is "turbulently growing at every moment" and made up of an "infinity of points" (Ranganathan 1951). Being a mathematician, a certain correlation between mathematics and classification theory is noticeable. For example, the idea of infinity with which Ranganathan describes the universe of subjects h