Rutgers Series on Systems for the
Intellectual Organization of Information

edited by Susan Artandi

VOLUME I

THE UNIVERSAL DECIMAL CLASSIFICATION

by

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Rutgers • the State University
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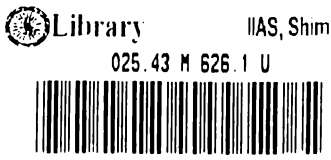

This work was supported by the
National Science Foundation.

Distributed by
The Rutgers University Press
New Brunswick, New Jersey

PREFACE

This volume is the first in a series resulting from an investigation concerned with systems for the intellectual organization of information. It was recently undertaken by the Rutgers University Graduate School of Library Service under a grant from the National Science Foundation.

The investigation is intended to examine the various methods or systems individually, study them in depth within the framework of a seminar series, and then produce a group of papers which, in addition to being state-of-the-art contributions to the scholarship of the field, should also serve as a basis for the ultimate objective, systems comparisons. Each paper then should be a description, a discussion, a critique, a collection of facts and data. Together they should give a good idea of the contribution each system has to make to specific problems in information organization.

The term "system" is used here to mean methods for carrying out that part of the complete information cycle which is directly concerned with the organization of materials for the effective retrieval of the information contained in those materials. It is not used to mean systems which store and retrieve data.

Thus, while the ultimate objective of any meaningful effort in information organization should be to make available existing information for future use -- or, to paraphrase Shaw, to make available the right information, to the person who needs it, at the time he needs it, in the form in which he needs it -- the investigation described here considers only part of this total cycle. The steps which are studied provide for the identification of the right informational materials in response to a given information need within the framework and limitations of the materials that are part of a given system.

Therefore, some important aspects of the total information cycle are omitted; for example, the identification and acquisition of materials for input or the actual dissemination

of information or materials in the desired form at the output end.

An important objective of the investigation should be the preparation of reasonably uniform descriptions and discussions of the systems included in the study, in terms of their distinctive characteristics, advantages, disadvantages, weaknesses, and limitations. This objective is based on the assumptions that a set of descriptive criteria, applicable to information organization systems in general, can be created and that sufficiently uniform descriptions can serve as a useful basis for comparative studies.

The comparative studies then should help to determine which system is the most efficient under a given set of circumstances or, conversely, to outline exactly the conditions that apply to a given system. In other words, the studies should show what can be gained or lost by adopting a particular system and to determine where those gains and losses are.

It is assumed that

(1) there is a finite (basic) set of functional characteristics that exists for information organization systems in general;

(2) while a particular system may not have all of these characteristics, all systems have a number of them; and

(3) the systematic indication of the presence or absence and of the specific nature of the functional characteristics will add up to fairly uniform system descriptions.

The systems included in the Rutgers Series on Systems for the Intellectual Organization of Information were studied within the framework of seminar-type meetings. The presentation of each study was followed by a panel discussion with the audience participating. The points brought out in the discussions are incorporated in each published volume.

Thus, the published volumes represent both an exposition by an authority on a particular system and the comments of a group of knowledgeable people in the field, interpreted by the authority for maximum usefulness.

In this volume the Universal Decimal Classification is presented by Mr. Jack Mills of the ASLIB-Cranfield Project and the Northwestern Polytechnic, London.

The seminar meeting was held on October 31 and on November 1, 1963, and the panelists included Mr. Benjamin A. Custer, Dewey Decimal Classification; Dr. Phyllis Richmond, University of Rochester; Mr. Malcolm Rigby, Meteorological and Geoastrophysical Abstracts; Dr. Maurice Tauber, Columbia University; Dr. Harold Wooster, Air Force Office of Scientific Research. Dr. Susan Artandi, Rutgers, The State University, was moderator.

The Rutgers project staff worked under the direction of Dr. Ralph R. Shaw and included Dr. Paul S. Dunkin and myself.

While the general pattern of the studies is loosely based on an outline prepared by Dr. Theodore C. Hines at the Rutgers Graduate School of Library Service, the papers were presented and edited for publication with a modified, somewhat broader organization in mind.

Susan Artandi

New Brunswick, New Jersey
May, 1964

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I. INTRODUCTION TO THE UNIVERSAL DECIMAL CLASSIFICATION

Historical Background

The first International Conference on Bibliography, held in Brussels in 1895, resulted in the founding of the Institut International de Bibliographie (IIB), known since 1938 as the Fédération International de Documentation (FID). Following on this Conference, a great classified index to all published information was projected and a classification system was sought to provide its arrangement. The persons chiefly responsible were two Belgians, Paul Otlet and Henri La Fontaine. After examining existing systems, Otlet and La Fontaine concluded that the Dewey Decimal Classification (DC) - then in its 5th edition - offered the most promising basis, being a purely subject classification, a general one, and one possessing an infinitely hospitable notation using the internationally known Arabic numerals in a decimal system.

Permission to modify and expand his scheme was obtained from Dewey on condition that the order of main classes and divisions be maintained and that maximum compatibility in development be sought.

Otlet and La Fontaine then proceeded to enlarge greatly the range of the DC by adding extensively to its enumerated classes (those pre-coordinated in the schedules, with ready-made numbers) and, more significantly, providing a much more extensive apparatus for synthesis, or number-building. The new scheme, the Classification Décimale (CD), was first published in a complete international edition (in French) in 1905 as the 'Manuel du répertoire bibliographique universel'. From 1927 onwards, further full international editions, embodying the fruits of international cooperation in additions and revisions, appeared in French, German and English, together with numerous abridged editions in these and other languages.

Although correspondence with Dewey in the first 1000 classes (000/999) has been maintained, constant revision has produced increasingly serious deviations between the detail in the two schemes. Of the estimated 130,000 enumerated classes

in the present full UDC only a few thousand are left from the DC.

Basic Concepts

UDC is a universal scheme of classification in two senses: firstly, it is a general classification covering all knowledge, 'not as a patchwork of isolated self-sufficient specialist groupings but as an integrated pattern of correlated subjects' (Abridged English edition, 1957, p. 7); secondly, it aims to provide subject descriptions of the utmost precision, whether such precision demands coordination of terms from within one subject field or from quite distinct fields.

Precision in subject description is sought by an 'analysis of ideas', seen most clearly in the separation of auxiliary schedules, both common and special, from the other facets enumerated under each class, in order to produce relatively elementary concepts, and the provision of synthetic devices whereby 'compounds' may be formed by coordination.

It aims to provide a practical system for retrieving information in which the fine order of subjects is considered to be of less importance than the provision for detail in specification (achieved by exhaustive enumeration of terms combined with notational synthesis). Nevertheless, order of subjects is still regarded as important, since this is what marks off a classified system from any other; i.e., related concepts are systematically brought together and their connections displayed in a systematic arrangement.

So far as the order of classes is concerned, UDC formally accepts certain traditional principles; notably, the general preceding the special, mutually exclusive classes, collocation of cognate classes, and consistency of approach.

However, it fails to provide, often deliberately, precise facet formulae in each class, or to recognize the principle of inversion, whereby general before special is maintained, and so these theoretical principles are imperfectly implemented in practice.

It is international. By the transference of all national and racial factors to separate common facets, the classification of subjects is unimpeded by any bias to the needs of one particular nation. Nevertheless, it is undeniable that the viewpoint is essentially a Western one. It neglects, relatively,

non-Christian religious systems, for example, and non-Western philosophy, while in the social sciences the traditional political and economic systems of the West are used as the basis for classification.

It is a decimal system in its notation, allowing maximum hospitality to the insertion of new terms.

There are no restrictions on the information materials which can be organized by UDC, which is designed to accommodate recorded information, whether 'macro-thought' or 'micro-thought', and whatever the vehicle communicating it. As to subject content of the material, UDC is universal in scope. But historically, there has been a bias towards science and technology in the development of its schedules. As to the form of presentation of the material, UDC can indicate, by the use of Common Auxiliaries, whatever peculiarity of form distinguishes the record.

There are restrictions to the use of UDC. Its weaknesses in order and collocation and its sometimes complicated notation make it less suitable in smaller, general libraries (e.g., school libraries) in which detailed analysis in indexes is not undertaken and the use of the classification on the shelf is important.

Significance of the System

UDC was the first system designed to provide for the detailed control of large or specialized information stores. It now provides a detailed and extensive scientific and technical vocabulary, systematically organized and indexed.

It is widely used throughout the world (by some 5,000 organizations) for the classification of complete libraries, of book and non-book materials, and of articles, abstracts, etc. in scientific and technical publications (a form of cataloging in source).

It has a highly organized international machinery for maintenance and development.

Major Claims for UDC

Although an imperfect species of the genus, it can claim to be the first 'analytico-synthetic' library classification.

UDC is "essentially a practical system for numerically coding information, so designed that any item, once coded and filed correctly, can be readily found from whatever angle it is sought" (Abridged English edition, 1957, p. 7).

Overcomes the drawbacks of numerous private classifications, often made by subject specialists with little knowledge of library classification, by providing a standard system, available to all, and covering all topics.

It is truly general, not a bundle of special classifications but an integrated whole.

It is truly universal; i.e., able to specify any subject. This is the result of combining exhaustive enumeration in the schedules with a large apparatus for synthesis, or coordination.

It is extremely flexible; i.e., adjustments to special needs can be made with relative ease. This is because citation order in any given class often allows several alternative treatments. Also, the use of the synthetic devices, especially the colon, allows a high degree of coordination of elementary concepts in different permutations, thereby minimizing the rigidity of a pre-coordinate system.

UDC is an international language in that a file organized by UDC makes sense in any language. One organized on the basis of alphabetical order of terms for example suffers a national limitation.

The extensive machinery for maintenance and revision, allowing the full cooperation of users, guarantees the continued existence of the system as a current, up-to-date one.

It forms a carefully organized and comprehensive vocabulary of terms for indexing and for search programming.

Major Claims Against the UDC

For a special collection, the subjects of central interest are likely to be scattered rather than collocated, owing to their subordination to different aspects. (See example of metals, p.29.)

Inadequate attention paid at the beginning (and subsequently) to the principles of analytico-synthetic classification

has resulted in the perpetuation of various inconsistencies and the production of further ones. Concepts which are in fact common to a number of different areas are developed separately, to form incipient 'special classifications' within the structure of the general one; e.g., Coating of metals occurs at 621.793 (Workshop practice), 621.357.7 (Electro-deposition), at 669.. .8 (Metallurgy, where the intervening numbers represent any non-ferrous metal), and at 686.4 (Silvering, Bronzing, etc.) and so on.

The general order and collocation, based on the DC reflects the age and drawbacks of that scheme. Often it is neither scientific nor practical; e.g., its separation of science and technology, which produces serious overlapping of classes between, say, 54 Chemistry and 66 Chemical technology, between 532 Fluid mechanics & Hydrodynamics and 626/7 Hydraulic engineering. The order in Class 3 Social sciences suffers particularly from its origins in DC (although UDC has tried to remedy the worst separations).

The poor allocation of the notation, its distribution over the whole field of knowledge, and the extensive use of arbitrary symbols in synthesis together result in long and sometimes complicated class numbers.

The delay in publishing up-to-date expansions and revisions is another complaint made against UDC. There is still no complete full edition available in English.

Partly as a result of the last weakness, the aim of UDC to provide maximum detail is not implemented for the areas affected during the time taken to assign numbers to new terms. In some cases delay in incorporating new terms is accompanied by a general failure to provide up-to-date, integrated schedules for new clusters of subjects, such as Astronautics or Plasma physics. Its neglect of Class 3 Social sciences is particularly noticeable here.

Use of Mechanical Devices

UDC is usually employed in conventional card or book-form indexes. It is, however, amenable to use with machines in several ways: 1) It provides a carefully organized and very comprehensive vocabulary of terms, providing a search programming aid (by indicating a very large range of connections) more thorough than any existing thesaurus. 2) The terms are the product of intensive analysis; they exist in a form suffi-

ciently elementary to allow a wide range of post-coordination, which is the essential modus operandi of machines here.

3) Its notation is often hierarchical and is readily usable as a code (for punched-cards, say) expressing hierarchical relations. However, coding directly by UDC class numbers is usually wasteful of coding space. 4) The production of full, detailed schedules, continually updated, and perhaps in a number of different languages, is susceptible to mechanization, and this problem is now being actively investigated.

Generally speaking, a UDC index does not require any mechanization of its indexing or searching functions, except, possibly in certain areas such as that of chemical compounds where the advantages of post-coordination cannot be matched by pre-coordinated classes. But mechanization can certainly help the physical production of UDC schedules and indexes.

Aids to Operation of UDC

The schedules of the classification are absolutely essential. They consist of full international editions, abridged editions, multilingual editions, and 'excerpt' or 'selection' schedules. Each schedule is normally accompanied by a printed A/Z index. These vary in quality. The A/Z index to the current Abridged English (3rd) edition is probably the best so far. Even the current Abridged Dutch (9th) edition does not have one.

Extensions and corrections to the UDC, issued by the FID half-yearly and cumulated in three-yearly series, keep the published editions up to date. Most users incorporate in their schedules, at the very least, the class numbers relevant to their everyday needs.

'Excerpt' schedules are available for some subject areas, bringing together in one handy volume classes which, although related, are scattered in the UDC; e.g., the ABC (Abridged Building Classification for Architects, Builders and Civil Engineers) which includes material from 62 Engineering, 69 Building technology, 72 Architecture, etc.; also, a Swiss schedule, less wide in range, for the color industries (paint, varnish, dyes, etc.) mainly 667. (Oesterle, K. M. UDK für ...Lack-und Farbenindustrie sowie des Maler-und Gipsergewerbes, Zurich, 1960.)

An authority file of decisions is very helpful in main-

taining consistency and minimizing the difficulties accompanying staff changes, etc.

The following publication is a comprehensive guide to the theory and application of UDC. This includes a brief account of the fundamentals of library classification and indexing theory, with discussion of the problems of citation order, multiple and single entry, etc. It also includes an outline of UDC schedules and an example of a fully developed section, with select bibliography, and list of typical UDC users, arranged by subject.

Guide to the Universal Decimal Classification (UDC). BS. 1000C: 1963 (FID no. 345). London, British Standards Institution, 1963. 15s. (Available from: American Standards Institution, Inc., 10 East 40th Street, New York 16, N. Y.)

Survey of UDC Editions and Extensions
(taken, with amendments, from the Guide, op. cit.)

Full Editions

French (1st 1905 FID no. 63 and 2nd 1927-33 FID no. 151 out of print). New ed. (1940--) Assn. Belge de Doc., Bruxelles 4. Issued: 0 (1951), 2 (1951), and 3 (1952) in print; 61 (1940), 62 (1941), and 65 (1942) temp. O. P. photocopies only.

English (1943--). FID publ. no. 179, B.S. 1000, B.S.I., London W. 1. Parts issued: 0 plus Auxils (1943); 5/53 & 54 & 55/59 (1943 all O. P. --new one-vol. ed. 5 in 1963-4); (621.3 (1946) O. P. --new ed. spring 1963); 622/623 (1955); 669 (1949 --new ed. 1963-4); 678/679 (1954); 69 (1958). In prep.: 61, 621, 624/628, 71/72, 77.

German (1934-53), FID publ. no. 196. Dt. Normenausschuss, Berlin W. 15. 10 vols. complete. 0/2 (1-1934); 3/4 (2-1935); 5 (3-1937 O. P. --new ed. 1958); 61 (4-1951); 62 (5-1938 O. P. --new ed. 1963?); 63/66 (6-1940); 67/9 (7-1948); Index (8, 9 & 10--1951-53).

Japanese (1951--), FID publ. no. 253. Issued: 5, 62 & 66 (1951-2); 61 (1955).

Spanish (1955), FID publ. no. 243. Inst. Nac. Rac. del Trab. (IRATRA), Madrid. Issued: 0 (1955); 2 (1959); 3 (1959); 61 (1958); 62/621.3 (1959); 7 (1957). In prep.: 621.4

et. seq.

Polish (1959--), FID publ. no. 327. Issued: 53 (1959); 0(1960).

Portuguese (1961--), to be issued jointly by Port. & Brazil member bodies of F.I.D.

Intermediate Edition: Russian (1961)

Abridged Editions

3-Language (1958), FID publ. no. 277, Dt.-Eng.-Fr.; Dutch (1962, FID 343); English B.S. 1000A (1961, FID 289); French (1958, FID 306); German (1955, FID 279); Japanese 2nd ed. (1960, FID 330); Portuguese (1961, FID 275); Polish (in prep.); Serbo-Croat (in prep., FID 323); Spanish (1953, FID 222); Swedish (1961, FID 333), etc.

Extension and P-notes

The "Extensions and Corrections to the UDC" (FID publ. no. 248) are issued by the Fédération Internationale de Documentation half-yearly and cumulated in 3-year series (of 6 numbers each). No sectional lists are available but the contents, arranged in broad UDC groups, keep the published editions up to date.

P-notes are lists of proposed extensions circulated by the FID and are intended primarily as working documents for active participants in UDC revision work.

Basic Publications About UDC

Bradford, S. C. Documentation. 2nd ed. London, Crosby Lockwood, 1953.
This well-known collection of Dr. Bradford's papers includes a number of chapters on different aspects of UDC by one of its pioneers.

British Standard 1000A:1961 (FID No. 289)
This is the 3rd edition of the English Abridgement--used in every English-speaking UDC installation. In addition to fairly detailed schedules it includes a very full A/Z Index and a long introduction setting out the principles and practices of UDC.

Cleverdon, C. W. Aslib Cranfield Research Project: Report on the first stage of an investigation into the comparative efficiency of indexing systems. Cranfield, England, College of

Aeronautics, 1960.
Report on the testing and analysis of an investigation into the comparative efficiency of indexing systems. Cranfield, College of Aeronautics, 1962. These two reports contain a wealth of description and commentary on the testing of a UDC index for 18,000 documents, with details of problems met in compiling the index, and analysis of its operation.

Donker Duyvis, F. Policy of revision of the Universal Decimal Classification. FID Rev. Doc. 23: 140-2, December 1956; 24:29-30, February 1957; 24:95, May 1957; 24:157-9, November 1957; 25:82-4, August 1958.
This series of articles by one of the outstanding figures in UDC history is collected together in FID publication No. 335, 1961.

Kyle, Barbara. The Universal Decimal Classification: a study of the present position and future developments, with particular attention to those schedules which deal with the humanities, arts and social sciences. Unesco Bull. Lib., 15:53-69 (2), March 1961.

Vickery, B. C. The Universal Decimal Classification and technical information indexing. Unesco Bull. Lib., 15:126-38+ (3), May 1961.
Most textbooks on library classification include accounts of UDC. A full and up-to-date one is that in Mills, J. A Modern outline of library classification. London, Chapman & Hall, 1960.

A number of periodicals publish progress reports, commentaries and other contributions on UDC, amongst them the following:

Aslib Proceedings - e.g., 13(7):182-4, July 1961.
DK-Mitteilungen (DNA, Berlin, W.15) - devoted entirely to UDC.
FID News Bulletin - has regular items of UDC news.
Revue internationale de la Documentation (FID, 7 Hofweg, The Hague) - has frequent contributions and bibliography on UDC.

Further Reading

Donker Duyvis, F. The UDC: what it is and what it is not. Rev. Doc., 18(2):99-105, June 1951.

Dubuc, R. La classification décimale universelle (CDU). Cour. Normalisation, 19e année, no. 106, 1952, pp. 255-268.

F.I.D. UDC revision procedure. 2nd ed. FID publ. no. 338, 1961 (provisional), 21 pp.

Guiding principles, rules and procedure for the development and revision of documentary classifications, with special reference to the UDC. 2nd ed. FID publ. 283, 1955.

Fill, K. Einfuhrung in das Wesen der Dezimalklassifikation (DK). Berlin, Beuth-Vertrieb (Dt. Normenausschuss), 1960, 40 pp.

Frank, Otto. Die Dezimalklassifikation (Handbuch d. Klassifikation - Hefte 1 and 12): Aufbau und Arbeitsmittel, 3rd ed. rev., 64 pp., and Anwendung und Weiterentwicklung, 88 pp. Stuttgart, Dorotheen-Verlag, 1960.

Grolier, Eric de. A study of general categories applicable to classification and coding in documentation. Paris, Unesco, 1962.

Harper, Shirley F. The Universal Decimal Classification. American Documentation 5 (4):195-213, October 1954.

Hermann, P. Praktische Anwendung der Dezimalklassifikation - Klassifizierungstechnik. 4 Aufl. Leipzig, 1962, 92 pp.

Lorphevre, G. Sur la révision de la classification décimale universelle. FID 17th Conf. 1947. Rapp. I, pp. 42-48.

Öhman, Einar, and J. P. Saville. The Universal Decimal Classification applied to metallurgical literature. J. Iron and Steel Inst., 177:183-8, May 1954.

Proc. Brit. Soc. Inst. Bibliog., 9:13-34, 1947. Beginners' questions on the use of the UDC, pp. 13-22. The use of UDC in abstracting services for scientists and engineers, pp. 23-34.

Richens, R. H. An abstracting and information service for plant breeding and genetics. (in Casey, R.S. & Perry, J.W., eds. Punched cards: their application to science and industry. 2nd ed. New York, Reinhold, 1958. pp. 191-204.)

Vickery, B. C. Classification and indexing in science. 2nd ed. London, Butterworth, 1959.

II. USE OF CLASSIFICATION FOR FILE ORGANIZATION - SOME GENERAL CONSIDERATIONS

Introduction

The central aim of information organization is the retrieval of specified information from stores or libraries. A vital instrument in this retrieval is indexing, and the UDC is above all an indexing system.

The basic tactic in indexing is the description of documents and other records in a succinct manner whereby their information is assigned to a limited number of particular classes. A search of the store is then reduced to the examination of a certain class or number of classes only - those which are judged to be the likely containers of the desired information. The greater part of the store is ignored and the enormous saving in time which results is the whole point of the exercise. An English librarian, Wyndham Hulme, half a century ago defined library classification as a "mechanical, time-saving device for the discovery of knowledge in books." If we replace 'books' by 'records' we still have an accurate definition of our subject. Hulme was attacking, inter alia, the tendency to confuse library classification with the theoretical classification of knowledge, with all the metaphysical implications, acknowledged or otherwise, which tend to accompany this. It may be noted here that UDC does not claim to provide anything but a utilitarian organization of pigeon holes for information. That in some areas this organization closely reflects a scientific taxonomy means simply that this particular form of organization serves a utilitarian function also, that in fact there is a correlation of properties here.

Classification is a term with many undertones and overtones, even in our relatively sober field. Librarians recognize in their indexes, which include their shelf arrangements, a number of different kinds of classes; e.g., 'Documents by the author x,' 'Documents published since 1960,' 'Documents having three citations in common,' 'Documents about the subject y.' All these are usually means of getting at subject content, although only the last does it directly. UDC is concerned only with this last kind of classification. It is purely a subject

classification. It is also commonly referred to as a hierarchical classification, and this is often thought to have the restrictive implication that UDC recognizes only a certain limited number of relations. This is misleading. The relations between the concepts recognized and displayed in UDC are numerous, as will be indicated, and the strict genus/species relation, although a central one, is by no means the only one.

The effectiveness of an indexing system is determined largely by the effectiveness of the classes it establishes in accommodating and screening both the information to be organized and the information contained in the search prescriptions. The economical matching of the latter with the classes utilized in the index descriptions is essential if the system is to function efficiently. How confident can we be that a particular class definition provided in the index includes just what we want, with an absolute minimum of irrelevant material included and of relevant material excluded? We cannot begin to evaluate this attribute of an indexing system without considering the methods of class definition utilized by it.

How are classes defined? Indexing systems have only a limited number of devices for class definition and the operational range of an indexing system will depend on how many of these devices it uses. These devices fall into two groups. Firstly, those which are used to enlarge the scope of a class. This can be done by compounding synonyms, by compounding word forms (adding Conical to Cone, for example), by moving up a hierarchical chain (from Cone, say,to Body of revolution), by forming bibliographical coupling groups (of documents linked by the possession of citations in common), by machine-derived groupings of various kinds. It is not yet certain that the last constitute a distinct device. Using statistical and linguistic relations observable in the use of terms in the literature to be indexed, such methods as associative indexing, clumps, etc. arrive at classes of related terms deemed to be useful in retrieval. Whether these classes will differ significantly from those established by the conventional 'intellectual' methods mentioned here, or whether they will prove to be simply other ways of arriving at much the same classes, remains to be seen.

Secondly, those devices which are used to restrict the scope of a class and give more precision. This can be done by coordination (moving, say, from Cone to Cone x Hypersonic x Flow), by weighting (giving some measure of the importance of the term or concept used in the document being indexed and accepting only a high weighting when searching precisely), by

links (demanding a term's presence in a particular, separate theme or part of a document) and by roles (where, for example, Cone is the element influenced, not the influencing element).

When we consider UDC's armory here, we find that it controls synonyms (in the last resort, close classification is the only infallible way of detecting synonyms); provides hierarchical chains, of course; coordinates; provides a large range of role indicators in the form of distinctly cited facets; accommodates links automatically, like any pre-coordinate system (e.g., as in the heading and subheading in an alphabetical subject catalog entry). Word forms are not usually compounded, since different forms imply different facets, usually; so Conduction will go in a Process as facet and Conductive in a Properties facet. But the A/Z index, which brings different forms together, facilitates the use of this as a searching device. Weighting could be added, theoretically; its principle is implicit to some extent in the choice of a limited number of entries for a pre-coordinate index.

This leaves only bibliographic coupling and machine-derived classes unused as devices in UDC. The former must inevitably stand alone as a form of index, and the latter are still in an experimental stage. So UDC is an exceptionally well-equipped system and as a result, allows a very wide range of performance.

To use the terminology of the Aslib-Cranfield Project, the performance, or operating efficiency, of an indexing system is measured most accurately by the recall-relevance ratio it can observe. By recall ratio is meant the ratio of relevant documents actually retrieved to those which should have been retrieved in answer to a request. By relevance ratio we mean the ratio of relevant documents retrieved to the total number retrieved.

The performance achieved by a system depends on two policies governing the indexing and the searching. High recall is obtained by exhaustive indexing and searching. By exhaustive indexing is meant the thoroughness with which the different concepts dealt with in a document are recognized in the indexing. An index which uses 30 terms on an average to describe its documents is more exhaustive than one using five terms to describe the same sort of document.

Exhaustive searching is the analog of this; i.e., search-

ing under all the concepts demanded in a question, not just the salient ones. High recall is also attained by generic searching; i.e., widening the search by examining the successive genera of a sought concept; e.g., moving from Cone to Body of revolution (i.e., all kinds of Body of revolution).

Clearly, search policies are not determined by the indexing language, although their success or failure will be. Strictly speaking, the exhaustivity of indexing is not dependent on the indexing language, either. This is obvious in the sense that if the indexer chooses to describe a document by the terms abcdefg rather than by just abcd, it is his own choice. But theoretically, if an indexer wishes to recognize terms from a dozen different categories when describing a document, the indexing language may fail to allow this to be done with precision; e.g., a term representing a specific property like Hardness may have to be indexed by a less specific term like Surface property, or even, at the worst, by the name of the general category (i.e., Property). But it is assumed that it will be indexable at some level, whatever the indexing language - that the latter will always recognize every category present in the area to be indexed, even if recognition is only at a very broad level.

Classification for File Organization

1. All library classification systems consist of three distinct structural parts: a sequence of terms (subject descriptions, classes) in some systematic order; a code (notation) whereby the systematic order is maintained in a mechanical fashion, each class being assigned a symbol which indicates its relative position in the sequence; an A/Z index whereby the existence of a class in the scheme can be verified and its exact position given, using terms of the natural language as the access points.

2. In the sequence of classes (the classification proper) it is convenient to distinguish two basic relations between the terms: (i) those obtained by traditional hierarchical definition, with the genera and species usually arranged in a sequence reflecting general before special, e.g.,

Field crops
  Cereals
    Wheat

(ii) those obtained by the coordination of terms from different categories or facets, as when a term from the Crop category above, say, is qualified by such terms as Storage (an Operation), Disease (a Process), Harvesting (a piece of Equipment).

These have the appearance of pseudo-hierarchies when arranged in classified sequence; e.g.,

Cereals
  Sowing
  Harvesting
  Storing
  etc.

Despite the traditional use of the term 'classification' to imply a genus/species relation, we will disregard the distinctions and refer to such subjects as Wheat, Storage of cereals, Pests of cereals, etc., as being equally subclasses of a containing class Cereals if, in the classification, they are subordinated to Cereals (i.e., collocated or juxtaposed with Cereals rather than with the other categories they reflect).

3. A great and legitimate simplification of the problem of determining and evaluating the sequence of classes in a given field (in which the possibilities are almost infinite) is to see the process as one of division of a class by different principles of division in order to produce categories, or facets, within each of which the subclasses are arranged hierarchically. For example, the class Agriculture (= 'documents dealing with the subject of Agriculture') is divided by the principle of Operation to give an Operations facet, consisting of [documents dealing with] Sowing, Harvesting, Storage, Clamp storage, etc.

4. The same process may be continued within a category; e.g., division of Transport engineering by the principle Medium gives Air, Land, Sea, etc. Each of these is further divisible by the principle Vehicle (a 'sub-facet' of Medium) to give a whole series of further sub-facets according to the precise principle by which the vehicle is distinguished; e.g., Aircraft are divisible by Number of wings (to give Monoplane, Biplane, etc.), by Design speed (to give Subsonic, Supersonic, etc.), by Function (to give Passenger, Freight, etc.), by Base of operation (to give Landplane, Seaplane, etc.) and so on.

5. When we come to the physical index itself, we find two quite separate files - the classified index and the A/Z index.

The classified index which implements the organization of classes described above consists of document entries arranged in systematic order, maintained by the class numbers which appear at the head of each entry and which constitute the filing medium. Each entry consists of its class number (which represents a subject description, of course) followed by a bib-

liographical description - author, title, publisher, date, etc.

As first applied to book collections, the normal situation was that each document received one entry only (unless it dealt with two or more quite separate themes, as for example, Printing and Bookbinding, when it would get an entry under each theme). The following is an example of such a classified index as envisaged by Melvil Dewey. In this example, each term represents one or more documents on that subject; the alignment of terms is designed to indicate the subordination of some classes to others by indentation (a card file cannot observe this indentation except by the positioning of guide-card tabs):

63	Agriculture
631/635	Plant husbandry and forestry
631.1	Farm management
631.3	Implements, machinery
631.31	Soil working machinery
631.312	Ploughs
631.5	Operations
631.52	Selection, propagation
631.55	Harvesting
631.55-13	Machinery for harvesting
632	Diseases, pests and their control
633	Field crops
633.1	Cereals, grains
633.1-13	Implements, machinery
633.1-15	Operations
633.1-152	Selection, propagation
633.1-155	Harvesting
633.1-2	Diseases, pests
633.11	Wheat
633.11-13	Implements
633.11-2	Diseases, pests

So a document on, say, Insect pests of stored grain would appear under the class Grain crops, subclass Storage, subclass Pests, subclass Insects.

Such a restriction (to one entry per item) has two major implications:

(i) Some sort of citation order is required for the coordination of the different elements within a given class; e.g., the above arrangement implies a division of the class Agriculture by Crop, then by Operation, then by Process, which is another way of saying that in the construction of the class num-

ber the element from the Crop facet is cited first, the element from the Operations facet next, and the element from the Process facet last.

Without some such plan of campaign, the systematic sequence can easily develop into a complicated, inconsistent and unpredictable, and therefore seemingly arbitrary, sequence.

(ii) Depending on the position of a facet in the citation order, the entries referring to that facet may be kept together (in the case of the primary facet, the first to be cited) or scattered in numerous different locations by subordination; e.g., documents on Harvesting, or any other member of the Operations facet, might appear under dozens of different crops.

6. The A/Z index consists only of references, from the names of subjects appearing in the classified index to their location in that file. An example is:

Harvesting : Cereals see 633.1-155

It does not contain entries for individual documents. Since the 'see' is common to every entry it is usually dropped in practice; here is a selection of A/Z index entries to the Classified index in the previous section:

Agriculture	63
Agriculture: Economics	338:63
Agriculture: Wages: Economics	331.2:63
Cereals: Agriculture	633.1
Diseases: Cereals: Agriculture	633.1-2
Diseases: Plants: Agriculture	632
Diseases: Wheat: Agriculture	633.11-2
Grain: Agriculture	633.1
Harvesting: Agriculture	631.55
Harvesting: Cereals: Agriculture	633.1-155
Harvesting: Wheat: Agriculture	633.11-155
Wheat: Agriculture	633.11

The A/Z index performs two major functions:

(i) It is a key to the location of classes, providing a lead-in from the terms of the natural language to the highly artificial notational language.

(ii) It remedies to a significant degree the great drawback implied in 5(ii) above; i.e., the scattering of what are called 'distributed relatives'. The entries above under Harvesting show how the remedy works. All the different classes

under which the subject is scattered are automatically assembled together as qualifiers of the common factor. Thus the A/Z index provides a supplementary display of relations (Dewey called his a Relative index to emphasize this). The relations it displays in this way are comparable to those seen in an alphabetic-subject catalog.

It is necessary to distinguish clearly the printed A/Z index which accompanies a classification schedule from the A/Z index which the compilers of a classified index make to that particular collection. It is as unreasonable to accept the former as an adequate A/Z subject index to a collection as it is to use the Library of Congress Author-Title catalog as the author-title catalog for any particular collection. All discussion here assumes an A/Z index compiled specifically for a given collection, showing no more and no less than is in that collection.

7. The combination of classified index, with one entry per document, and an A/Z relative index has proved an excellent tool for the indexing of book collections. Its great weakness for the detailed indexing of scientific and technical literature is the limited access afforded to the searcher in the sense that in many cases the document entries for a particular subject are seriously scattered. A point may be reached when the partial remedy offered by the A/Z index is inadequate, remembering that it collects only see references for the different aspects of a distributed term, not the actual document entries, which still have to be sought in their various subordinate positions.

The usual answer of indexers, particularly UDC users, to this is the adoption of multiple entry. Here, a document on a subject containing elements from several facets will get several entries, so that each facet in turn is cited first. In effect, the size of the classified index is multiplied several times to accommodate several different classifications together. For example, a classification of Crops, each subdivided by Operation, Process, etc.; plus a classification of Operations, each subdivided by Crop, Process, etc.; plus a classification of Processes, each subdivided by Crop, Operation, etc. These different classifications could, of course, be housed as separate sequences, but this is rarely, if ever, done. Below is an example of a UDC index using multiple entry. As in the example of single entry, each term and its class number represents a block of entries on that subject.

63	Agriculture
631/635	Plant husbandry & forestry
631.1	Farm management
631.3	Implements, machinery
631.3:631.55	Harvesting
631.3:633.1	Cereal crops
631.3:633.11	Wheat
631.312	Ploughs
631.5	Operations
631.52	Selection, propagation
631.52:633.1	Cereal crops
631.55	Harvesting
631.55:633.3	Machinery
631.55:633.1	Cereal crops
632	Diseases, pests
632:633.1	Cereal crops
632:633.11	Wheat
633.1	Cereal, grains
633.1:631.3	Machinery, implements
633.11	Wheat
633.11:631.3	Machinery, implements
633.11:632	Diseases, pests

This expansion of the classified index is accompanied by a reduction in the A/Z index. There is no longer need to indicate that Machinery, for example, will be found subordinated to this crop and that crop, for all these entries will now be duplicated and collected together under Machinery in the classified index. The following example shows this reduction:

Agriculture	63
Cereals : Agriculture	633.1
Diseases : Plants : Agriculture	632
Grain : Agriculture	633.1
Harvesting : Agriculture	631.55
Implements : Agriculture	631.3
Machinery : Agriculture	631.3
Pests : Plants : Agriculture	632
Ploughs : Agriculture	631.312
Propagation : Agriculture	631.52
Selection : Plants : Agriculture	631.52
Wheat : Agriculture	633.11

Multiple entry, with a reduced A/Z index, is the normal way in which most special libraries form a UDC index.

8. In Section 3 we suggested that the concept of analysis

into facets gives us the clearest picture of what underlies the development of classification schedules. But different systems vary as to the consistency with which they perform this analysis.

UDC, from its inception in 1895, regarded as a fundamental requisite of indexing for science and technology the analysis of subject fields into their constituent concepts and the provision of devices allowing the subsequent synthesis of these relatively elementary concepts in order to provide subject descriptions of compound and complex subjects. This was seen most clearly in its provision of auxiliary schedules (essentially, facets).

9. However, examination of some UDC schedules shows that the method of displaying the results of this analysis are not always consistent.

In modern analytico-synthetic (i.e., faceted) classifications, the only enumeration of classes provided in the schedule is that of the hierarchy within a facet. As a rule, all compound subjects (those containing elements from two or more different facets, which constitute the vast majority of the subjects, dealt with in the literature) are indexed and given a precise class number by synthesis or number-building. But in UDC the division of a class in a schedule frequently mixes two distinct methods:

(i) Analysis into clear and homogeneous categories or facets, for subsequent synthesis, or coordination, at the discretion of the indexer.

(ii) 'Enumeration'; i.e., listing under a heading a mixture of subclasses, some of which represent true species of the containing class but others of which are derived from different categories. This is a form of scheduled pre-coordination, as distinct from the pre-coordination implied by the selection of certain combinations only for inclusion in the physical index. It is typical of most schedules in the DC and the Library of Congress classification.

Below is an example taken from the Metallurgy schedule of UDC. In this class the primary facet (Metals) is allocated 669.1/.9 and all other facets are provided in the form of separate Auxiliaries, except that here and there, especially under Ferrous metals, parts of these other facets are enumerated as direct (un-synthesized) divisions of the metal concerned.

(i) Analysis, providing the relatively elementary concepts used by the indexer to synthesize compound classes:

669	Metallurgy
-1	State (with regard to treatment)
-12	Rolled, extruded
-4	Shape
-41	Flat surfaced, plate, sheet
-46	Hollow
-462	Tubular, pipe
.018	Properties
.018.2	Mechanical
.018.25	Extra hard
.04	Heating processes

The symbols - and .0 above introduce Special Auxiliaries. These may be used to qualify other subclasses anywhere in class 669, as required. For example, 669.3 is Copper, and 669.35 Alloys of copper. Mechanical properties of copper alloy pipes would be 669.35-462.018.

(ii) Enumeration (i.e., listing subclasses as direct divisions of a class):

669	Metallurgy
669.1	Ferrous metals
669.13	Cast iron
669.14	Steel (generally), carbon steel
669.15	Alloys of iron (except with carbon), alloy steels
669.16 /.18	Production of pig iron & ferro-alloys
669.18	Production of steel
669.183	Reverberatory furnace processes
669.183.2	Open hearth processes
669.183.21	Open hearth furnaces
669.183.211.1	(Kinds of Open hearth furnace)
669.183.211.18	Modified
669.183.211.184	Composite
669.183.211.2	Hearths
669.183.211.3	Furnace walls
669.183.212	Blocks. Gas and air uptakes
669.183.213	Regenerators
669.183.213.1	Design
669.183.213.8	Reactions
669.183.213.85	Heat transfer in checkerwork
669.183.214	Gas and air parts. Valves
669.183.214.4	Cleaning

669.183.216 Cooling of hearths
669.183.217 Firing
669.183.218 Operation
669.183.25 Continuous process
669.183.3 Acid open hearth

Here, the category of Operations is introduced as a pre-made number 669.16/.18 Production of Pig iron and ferro-alloys (instead of achieving this by synthesis) and its hierarchy now follows, including Heat transfer processes. Agents of the operations are similarly enumerated directly rather than achieved by synthesis, and this facet includes Furnaces, although this, like many other heat transfer processes, is a concept obviously applicable to the processing of other metals and in principle should be coded as an auxiliary, applicable to all metals. The selection of details under Open hearth furnaces (669.183.21) shows the direct enumeration of subclasses from a number of different facets; e.g., Kinds of Open hearth furnace (669.183.211.1), Parts (669.183.211.2/669.183.215), Operations and Processes (669.183.216/669.183.28). Subordinated directly to these (not by synthesis) are elements from a mixture of facets; e.g., under 669.183.213 Regenerators is Design (an Operation) and Heat transfer (a Process).

10. This mixed method of providing for the division of a class has several results:

(i) An enumerated schedule can provide a 'tailor-made' quality more easily than can coordination by synthesis via auxiliaries. For example, if furnaces for ferrous metals production have peculiarities not found in furnaces for other metals, enumerated scheduling can take care of the situation: each metal gets its own little set of subclasses for furnaces, etc.

(ii) The notation is provided very economically. If the Furnace hierarchy appeared only once in the Metallurgy schedule (in an Equipment or Agents facet) and the different peculiarities of the furnaces for various metals were incorporated together, longer class numbers would be required to encompass the extra detail, although most of this detail would be applicable to particular metals only, not to all.

(iii) There is a danger of detail being confined to certain classes only, even though some of it would be applicable to others; e.g., Open hearth furnaces are not in principle restricted to ferrous metals, but a number for them appears only under ferrous metals. This undermines the principle of

maximum hospitality (via synthesis) which is fundamental to UDC.

(iv) The tactics of multiple entry are made more difficult. For example, a synthetic number for Steel - Furnaces, with separable notational elements (669.14:669.041) allows permutation quite easily (to give 669.041:669.14). The enumerated number 669.183 does not.

(v) In some cases there is clear duplication of the same concept, and care is needed to maintain consistency in indexing; e.g., in Class 3 Social Sciences, a Persons facet gives

3-05 Persons
-053 By age
-053.2 Children
etc.
-055 By sex
-055.2 Female

But under 331.3/.5 Forms of labor (in Economics) we find

331.3 Children
331.4 Female

Similarly, Heat transfer processes occur both as Special Auxiliaries and as enumerated subclasses in 669 Metallurgy, and yet again in other parts of Technology, e.g., 621.7 Workshop practice, which is mainly concerned with operations on metals.

11. Nevertheless, in most cases, the UDC schedule for a class reflects a consistent pattern in which a clear distinction is made between the major facet and other 'auxiliary' facets, and this distinction is reflected in the notation by allocating decimal numbers proper to the primary facet and providing distinctive facet indicators (hyphens, brackets, etc.) to introduce the rest. We saw this in 669 Metallurgy, above; it is found also, to a large degree, in 4 Linguistics, where the divisions 42/49 represent the Languages, in 59 Zoology, where 592/599 represent Animals, in 66 Chemical Technology, and allied industries, where 661/669 and 671/679 represent the Products. It might be said that in this respect UDC implies a limited citation order in that it always indicates the primary facet.

12. The auxiliary facets in UDC are conveniently distinguished as being either Special Auxiliaries or Common Auxiliaries.

(i) Special Auxiliaries, of which examples have already

been given (see Section 10), are designed especially for one particular subject, whether this be a relatively narrow one like 533.6 Aerodynamics, or a very broad one like 6 Technology. Notationally, they are introduced by a hyphen or point zero (.0). The apostrophe (') is also usually considered to be a Special Auxiliary, although it is confined to Chemistry and Chemical Technology. But it differs significantly from the others in that it introduces subfacets of the primary facet (i.e., further species of chemical compounds) rather than truly auxiliary facets; e.g.,

547 Organic chemistry
547.26 Alcohols
547.29 Carboxy acids
547.29'26 Esters (i.e., carboxy-acid and alcohol)

(ii) Common Auxiliaries are applicable as required throughout UDC:

(a) Place (1/9)
e.g., 002.6(47) Documentation centers - USSR

(b) Race " " (=0/9)
e.g., 321(=927) Political science - Forms of organization - Arabic

(c) Time " "
e.g., 327'1919/1939"(43:47) International relations - 1919-1939 - Germany and USSR

(d) Point of view .00
e.g., 621.438-257.004.65 Gas turbines - Gears - Damage or, using x to represent a particular organization,
x.006 Space, site, accommodation point of view
x.006.1 for directorate and administration
x.006.2 for study, research, design

(e) Alphabetical & numerical (non-UDC) subdivision A/Z and No.
e.g., 629.135(410) (DH Comet) Passenger planes - Great Britain - De Havilland Comet
656(421).132.022 No. 53a Transport - London - Bus services - Route 53a
N.B. These two devices differ from (a-d) in that they allow individualization of various concepts by alphabeting marks or words or by numerals. These divisions are in no way 'common' - only the device is that.

(f) Colon :
This and the Square Brackets device are the heirs to the instruction found in the Dewey DC to "divide like the whole classification".

e.g., 026:61 Special libraries - Medicine
656(421):711.13 Transport - London - effect of Planning - of Population distribution
622.33:622.232 Engineering - Mining - Coal - Mechanical cutters

(g) Square brackets [ ]
This replaces Colon when permutation for multiple entry is not required; e.g.,
002.3[31] Documentation centers - Statistics of
It also allows intercalation of any facet at whatever point in the citation order is required; e.g.,
33[622.33]1.881 Economics - Coal mining industry - Labor - Trade unions
or, 331[622.33].881 Economics - Labor - Coal mining industry - Trade unions
The effect of intercalation is that a facet which, if coloned at the end of a number, inevitably becomes a badly distributed one (because it is cited last) can be cited at whatever point the indexer wishes.

(h) Aggregation + and /
e.g., 655.1+688.1 Printing and bookbinding
624/628 Civil engineering
Unlike the preceding Auxiliaries, these do not divide a class but enlarge it to give a logical sum. It must be distinguished clearly from the colon device which implies a relation between the linked classes - a logical product.

(i) Form of presentation (0)
e.g., 61(032) Medicine - Dictionaries
002.3(043) Documentation centers - Thesis
Unlike the preceding Auxiliaries, this, and the next device, do not signify subject relations.

(j) Language of the document =
e.g., 61(032)=82 Medicine - Dictionaries - in Russian

If a situation arises in which a concept should be indexed but for some reason does not appear in UDC, either by enumeration or in a special or common auxiliary, it can be added by extending the principle of (e) and manufacturing a (temporary) place for it by writing out its names after the nearest containing head. This device, which is not unofficial and not peculiar to UDC, is used with the Dewey DC by the British National Bibliography, and is called a 'verbal extension.' It differs from (e) in that it is essentially a temporary expedient until an official UDC number is allocated, whereas (e) is a deliberate use of the alphabetical device to accommodate long, sometimes indefinitely long, arrays of coordinate classes.

Examples of verbal extension are:

62-40(serrated) Technology - Shape of product - Serrated
621.885(stitching) Engineering - Mechanical joining - Stitching

13. Analogous to the distribution of terms from secondary, tertiary, etc. facets (as when Mechanical properties of metals appears as a subclass under dozens of different metals) is the distribution of many terms at a much broader level. This reflects the fact that UDC, following the DC, is an 'aspect' classification, in which a 'concrete' is subordinated to the specialized disciplines ('aspects') within which it is usually studied; e.g., Metals occur under Chemistry, Mineralogy, Geology, Mining engineering, etc., reflecting the specialized occupations of chemist, mineralogist, geologist, etc. Below is an extract from UDC schedules showing a few of the contexts under which Copper appears. Other contexts are indicated in the sample of UDC printed A/Z index.

62	Engineering
622	Mining & mineral dressing
-1	State of the mineral
-18	Heat treated - roasted, sintered, etc.
.02	Physical properties
622.1/.2	(Various operations)
.3	Specific minerals (division similar to 553 Economic geology)
.34	Metalliferous ores
.343	Copper (cf. 553.43 copper ores)
.4/.8	(Various operations)
.7	Mineral dressing, ore preparation
.78	Heat treatment
66/67	Chemical & allied industries
66	Chemical technology
-2/-8	Plant, process, product details (as 621-2/-8)
-4	Shape & form of product
-41	Flat surfaces. Slabs, plates, etc.
.01/.09	Chemical engineering. Operations, processes, plant
661	Chemicals
661.8	Metallic compounds
.856	Copper
.856.53	Sulphates

669 Metallurgy
-4 Shape & form of product (as 621-4)
.018 Metals according to properties
.018.2 Mechanical properties
.018.25 Extra-hard (cf. 661.665 Carbides)
.04/.09 (Various metallurgical processes)
.04 Heating processes & equipment
(as 66.04 Heat transfer treatments)
.041 Furnaces
669.1 Ferrous metals
669.2/.8 Non-ferrous metals
669.3/.6 Non-precious, heavy industrial metals
669.3 Copper
.33 Extraction from ore
.34 Refining
.35 Alloys
.35'5 Copper-zinc (from 669.5 Zinc)
.35'5'781 Copper-zinc-boron
(from 669.781 Boron)
.35'5'781'884 C-z-b-lithium
(from 669.884 Lithium)
.36 Fabrication, finishing
.36:621.774 Tube manufacture
.37 Applications
.37:69.024 Roofing
.386/7 Coatings (of copper) (or use .058)
.389 Coatings (on copper) (or use .056.9)

N.B. Each non-ferrous metal can be subdivided using a special table from 1 to 89; e.g., 4 is for Refining (as in 669.34 above).

14. Elementary consistency in the development of classification schedules implies adherence to the old logical principle that a class should be divided by only one principle at a time and that this principle should be exhausted before another is taken up.

In other words, division should be strictly into facets or categories, whether these are subsequently pre-coordinated to varying degrees in the schedule, as in Dewey, or kept strictly apart for the indexer to coordinate as he wishes, as in the modern faceted schemes.

UDC, like most other library classifications, sometimes fails to conform here. The schedule extracts above demonstrate this; e.g., the first part shows the division of Mining engineering by State of mineral, by Property, by Operation,

by Mineral, in that order. But the Mineral facet appears before the Operation facet is completed (before the principle of division is exhausted) and more operations follow at 622.7. Again, under 656 Transport services, the Thing Conveyed facet is begun as part of an auxiliary 656.072 Passengers, 656.073 Freight, then discontinued and recommenced by direct enumeration at 656.8/.9 Mail, etc.

15. Notation: the major criteria here are usually judged to be hospitality (the ability to incorporate new classes in their correct, logical place - often called, rather ambiguously, flexibility), simplicity (the ease with which symbols convey position) and brevity (a central element in simplicity).

(i) Hospitality is secured primarily by the decimal fraction principle, whereby another number, representing a new class, can be inserted anywhere. It should be noted that this holds true only if we are prepared to abandon the principle of expressive, or hierarchical, notation. This is the principle which demands that class numbers reflect the hierarchical relations between the terms represented, as when 622 Mining engineering has the appearance of being a division of 62 Engineering.

(ii) Simplicity is not a quality which can be claimed for the UDC notation. Despite the virtual purity of its numerical system for basic notation, its use of many facet indicators for auxiliaries makes it very mixed when fully used. An important result of this is that a definite ordinal value has to be awarded each of these non-numerical symbols. The official filing order is given in the description of the Alphabetical Subject Index.

(iii) Brevity is another quality not usually claimed for UDC's notation, which suffers from the small base of its decimal radix, from the poor allocation of numbers to classes (whereby extensive and dynamic subjects get less room than relatively restricted and static subjects), and from its inheritance of hierarchical notation in many areas (see the example below under 15(iv) for Income tax).

If multiple entry is used, the need to provide easily permutable class numbers leads to the replacement of the relatively brief elements taken from the auxiliaries by the longer numbers made up of coloned elements; e.g., 669.715-415 for Aluminum alloy - Sheet becomes 669.715:669-415 in order to reverse the number to give an additional entry at

669-415:669.715.

A simple demonstration of how these different factors contribute to the lengthiness of UDC numbers is seen in the two examples below. The first shows how each step of division is reflected by an additional digit; the second is an analysis of a fairly typical UDC number to show redundancy in notation.

574/578	Biology
575	Genetics. Development of organisms
576.3	Cytology. The cell
576.35	Reproduction
576.354	Methods of multiplication
576.354.4	Meiosis
576.354.46	Synapsis. Chromosome pairing
576.354.465	Reproduction division

Assay in cells of tritium, with liquid scintillation counter 545.8 :612.014 :546.11.023 :621.387.444 (19 digits. The decimal point is put in only to break up the number and has no filing value.)

Analysis of class number (necessary digits underlined)

5 Science	5 Science
4 Chemistry	4 Chemistry
5 Quantitative analysis	6 Inorganic
8 Other methods	1 Nonmetals
	1 Hydrogen
6 Applied science	02 Isotope
2 Engineering	3 Mass 3
1 Mechanical & electrical	
3 Electrical	6 Applied science
8 Electronics	1 Medicine
7 Counters, etc.	2 Human physiology
4 Radiation counters	01 General
4 Liquid	4 Cell
4 Scintillation	

However, in a collection largely concerned with one or two subjects, notation can be shortened considerably by replacing that part of the notation which is common to most of the documents by a single symbol. Below is an example from Nuclear engineering in which Reactors 621.039.5 is represented by R. At the same time, the simplicity and brevity of the notational device for compounding different facets (by Coolant, by Fuel, etc.) may be noted, and the use of 0 as a link compared with the use of the apostrophe in Chemistry.

R	Nuclear fission reactors
R24	Reactor types - Thermal
R24.2	Graphite-moderated
R34	Reactor components - Coolants
R34.3	Gases
R43	Fuels - by fissile component
R43.6	Plutonium
R77	Reactor purpose - Production of electrical power

So R24.2034.3043.6077 stands for Thermal reactor - graphite moderated - gas-cooled - using Plutonium fuel - for electrical power. Compare this with the fully written-out UDC number: 621.039.524.2:621.039.534.3:621.039.543.6:621.039.577 or, using R allowing permutation: R24.2:R34.3:R43.6:R77.

(iv) A notable quality of the UDC notation is its flexibility, in the sense that it allows alternative arrangements (different groupings) to be achieved. This is a by-product of its use of a large element of faceted notation, whereby different facets are distinctively introduced and so can be cited at different parts of a complex class number without ambiguity. Below are examples of two UDC hierarchies and of flexibility in constructing class numbers, using different citation orders.

33	Economics
332+336	Finance
336	Public
336.2	Taxes
336.21	Direct
336.215	Income
336.215.1	Salaries

e.g., Income tax system in Great Britain

	336.215(410) Finance-Public-Taxes-Direct-Income-G.B.
or,	336.21(410)5 " " " " G.B.-Income
or,	336.2(410)15 " " " G.B.-Direct-Income
or,	336(410).215 " " G.B.-Taxes-Direct-Income
or,	33(410)6.215 Economics-G.B.-Finance-etc.

8	Literature
820	English
820(73)	American
820(73)-3	Prose
820(73)-32	Short story
820(73)-32"19"	20th century
820(73)-32"19".015	Movements, schools
or, 820(73)"19"-32.015	
or, 820(73)"19".015-32	
etc.	

The use of square brackets for intercalation of any facet at any point in citation order has already been mentioned in the example of Common Auxiliaries (see Section 12) which shows that the Industry facet can be cited as the primary facet in Economics, or at any subsequent level.

III. DESCRIPTION OF THE UNIVERSAL DECIMAL CLASSIFICATION

A library, or documentation center of any kind, implies the existence, somewhere, of the information bearing materials themselves and of various files designed collectively to assist retrieval of information from these materials. These groups of materials and files together make up a system for organizing information.

Three different types of groups are distinguished - the information materials themselves, indexes to the content of the materials, and tools for the construction of the indexes.

What follows is an account of how these groups appear in a system organized by UDC.

A. Information Materials

UDC is used mainly for particular collections of materials, i.e., libraries. But it is also used extensively by abstracting services, for periodical indexes, and by some publishers (who add UDC numbers to their publications, a form of cataloging in source). In these cases, where no particular collection is assumed, the problems of using UDC are almost entirely those described under IIIB. Here, we confine ourselves to UDC as a system for the physical arrangement of a particular collection. It should be remembered that this is a relatively minor aspect of UDC use and features of UDC which are common to its use in shelf arrangement and to its use in indexes (e.g., the helpfulness or otherwise of its collocation or grouping together of related items) are dealt with primarily in IIIB. Emphasis here is entirely on the problems peculiar to physical arrangement of the materials themselves.

The purpose of using UDC for shelf arrangement is to provide direct access to information arranged systematically in a helpful fashion whereby, as far as possible, documents likely to be sought together are found together. In some libraries as much as 25 per cent of enquiries can be answered directly by reference to the shelves.

The physical form of the information materials varies from books on shelves to such items as leaflets, offprints, plans, illustrations, etc., in vertical files, pamphlet boxes, etc.

Shelf order is 'relative', not fixed; materials are constantly being added and subtracted, and these additions and subtractions may take place at any point without disturbing the relative sequence.

Material consisting of conglomerates of diverse subject matter which are retained and bound as such (e.g., periodicals) is not usually shelved in UDC sequence. Insofar as their individual content items (articles, etc.) are indexed separately, these will appear in the normal UDC classified index, together with their exact address (location mark, volume, and page number). Materials such as slides, phonograph records, etc., which are not susceptible to UDC shelf arrangement, are usually treated similarly. Otherwise, there are no limitations on bibliographic or physical form, or subject content.

A document or other information bearing item is identified primarily by the class of information which it mainly deals with. Unless several copies of the same item are individually shelved at different numbers (which is not unknown), a document as such can get one subject-description only, and this determines its position. This implies a consistent citation-order to be followed in assigning the class. But a subject-description in terms of the natural language cannot convey a document's position, relative to the other materials, in a classified sequence. For this a code is necessary.

So the language of the identifying terms is purely synthetic - 'an artificial language of ordinal symbols.' That is, the materials themselves are labeled only with a single class number, although these may consist of a number of different elements, of course.

A formal limit may be observed on the length of class numbers used in shelving; i.e., the identifying class may be a broader one than that recognized for the same item in the index.

For this reason - the limited length of symbol feasible - it is very rare that any other element, apart from subject (author, for example), is distinguished in the identifying element.

The systematic arrangement of a UDC shelf carries with it an implicit reference to related classes in the form of juxtaposition of these classes. That is to say, related classes are physically close, generally speaking.

The connection between juxtaposed documents may be made explicit, in many cases, by the hierarchical notation; e.g.,

336	Public finance
336.2	Taxes
336.21	Direct taxes
336.215	Income tax

Direct access to materials is available to any desired level of generality; e.g., to a broad class (336 Public finance), to a more specific class (336.215.1 Taxation of salaries), or to a quite precise class (336.215.1(410)"194" Taxation of salaries in G.B. in the 1940s).

Since a document can go into one place only, the shelf arrangement suffers irremediably from the inevitable scattering of many closely related classes; e.g., documents on the public finance system of Great Britain would be scattered in many places according to the citation order implied in the above example.

Access to these closely related but scattered documents is still available of course, assuming that the searcher consults the index (classified and/or alphabetical) and finds what the other class numbers are.

Physical limits must also be noted. Shelf display of total resources is hampered by:

(i) the need to shelve some material separately, out of UDC order ('broken' and 'parallel' order).
(ii) the difficulty of marking clearly UDC class numbers on the spines of books, etc.
(iii) the difficulty of providing detailed guiding.
(iv) the difficulty of maintaining impeccably accurate arrangement with withdrawal and replacement of items by users constantly taking place.
(v) the absence of some items at any given time (on loan etc.).

B. Input to the System and the Store to be Searched

The store to be searched consists of the indexes proper - the systematically arranged file of document entries ('classified file', 'UDC index', 'classified index') and the alphabetical index of see references from the names of the subjects to their location in the classified file.

The initial purpose of the classified index, which is the heart of a UDC system, is simply to give a complete statement, in one file, of total resources. The physical items themselves are inevitably scattered through several different sequences, which are themselves often incomplete; e.g., when some items have been withdrawn for consultation; so consulting a particular class on the shelf will rarely give a complete picture of the library's holdings in that class.

Another fundamental purpose is to provide multiple access to the information by supplying a number of different pathways to it. Just how this is done is the central theme of this paper.

The physical form is usually one of cards (usually 3 x 5) or book; it is rarely a sheaf catalog; very rarely is it on punched cards. Recently a few examples of UDC indexes on tape have been reported, although these are primarily for the production by computer printout of book-form indexes for scanning in the normal way.

The nature of this index is essentially that of a pre-coordinate, non-manipulative index, created for a particular body of information, continuously added to and subtracted from (although, in the case of periodical indexes, etc., the number of cumulations feasible is naturally limited, and deletions may not be made).

The construction of such an index requires observance of particular rules for the representation of subject classes by notational symbols ("class-numbers") and for their filing. These rules are considered later.

There are virtually no limitations on the sources of information which may be analyzed for this index. UDC provides index descriptions of information content in any subject area known to man. The physical vehicles by which this information is conveyed are immaterial. UDC can also designate non-factual (i.e., imaginative) material; e.g., literary works, mu-

sic scores.

Processing of the input takes the form of representing each item by one or more catalog (index) entries. Each entry usually contains,

(i) a class number, standing for an extremely condensed subject description of the item in terms of the general class to which its contents belong and the exact subdivisions of this class which characterize the content specifically; e.g., 629.138.56:621.45:533.6.015.74 stands for Aircraft - Passenger - Private - Jet propelled - Performance - Range.

(ii) a bibliographic description (author, title, date, etc.).

(iii) an address (which may simply be the class-number or a further designation for material shelved outside the main shelf sequence).

A given item may be, and usually is, represented by a number of different subject entries. These may bear the same subject description but with those elements which are separated by colons re-arranged for permutation:

e.g., 629.138.56:621.45:533.6.015.74
and 621.45:533.6.015.74:629.138.56
and 533.6.015.74:629.138.56:621.45

or they may bear different subject descriptions if the item has more than one distinct theme calling for recognition; e.g., if the document above also contained a section on the Take-off, approach and landing performance (533.6.015.1/.2), it would get entries, in addition to those above, under

629.138.56:621.45:533.6.015.1/.2

and the permutations of this. This procedure 'partitions' the document and constitutes a form of link.

Index language. Class definition is the central function of any indexing system. The degree to which the contents of documents are identified in terms which allow fruitful matches with search prescriptions is the measure of the system's effectiveness.

Choice of terms is limited, by and large, to the classes represented by the terms of the UDC schedules. 'Limited' is rather misleading, in that a major objective in UDC is to allow specificity in indexing. To this end, UDC provides extremely detailed enumeration of hierarchies (facets) plus very full facilities for coordination (seen in the example above in which a term from the Aircraft facet is coordinated with one from the Method of propulsion facet and one from the Aerodynamic behavior facet). It has been said that the full edition of the UDC

contains some 130,000 terms. But this is the basic vocabulary. The working vocabulary - the number of discrete classes or pigeon-holes - achievable by synthesis ('number-building') is virtually infinite.

Choice is unlimited in another, more restricted sense, in that UDC allows indefinite expansion of some facets by the use of terms in the natural language (or alphabeting marks standing for them). This occurs in facets of individual class members, e.g., particular (named) stars, plants, persons, towns, trade products, etc. Yet further expansion, independent of the schedules, may be made in a classified index by using 'verbal extensions', as used by the British National Bibliography to supplement areas of Dewey which are inadequately detailed, e.g., 025.343 (classified) would be an expansion of 025.343 subject catalogs. The difference between this unofficial practice and the scheduled 'A/Z device' is firstly, that the latter is deliberately provided to accommodate a large array of coordinate classes in an obvious mnemonic way - i.e., alphabetically; secondly, that the latter is generally restricted to 'things' or 'concretes', whereas any type of facet can be represented in verbal extensions; e.g., an operation - 621.885 (Stitching) under the class Mechanical joining.

Assignment of UDC terms in order to provide an index description of a document is a skilled job. The basic skills called for are:

(i) knowledge of the principles of practical classification in general (fundamentally, the awareness of the implications of the notion of citation order at all levels);

(ii) knowledge of the principles of the classified catalog;

(iii) knowledge of the principles of UDC structure and in particular its apparatus for synthesis, or number-building;

(iv) acquaintance with the major concepts at least in the subject field concerned; but expert knowledge is very rarely necessary.

The first two skills should be possessed by any trained librarian who has pursued a course in cataloging and classification. The third skill is a simple extension of the first. The last is difficult to generalize about. Most special librarians quickly acquire some familiarity with the subject fields concerned, and there is much evidence to show that this, backed up by the detailed and systematic map of the subject provided by the classification schedules, enables them to index quite efficiently.

Choice of terms entails decisions by the indexer on several points.

(i) Those features of the document which are important in the context of the collection must be assessed, i.e., its subject must be decided. This decision does not rest on the UDC; but it is possible that the map of the subject provided by the schedule assists the indexer to clarify the situation.

(ii) Having decided the subject or subjects, the degree of exhaustivity of the indexing is decided. Again, this does not rest on the UDC. If the document deals, say, with properties x y and z of metals a b and c in condition q, it is entirely a matter of indexing policy as to how many of these features are now incorporated in the index, e.g., the organization may be interested only in properties x and y and metals b and c and entries would thus be made for xbq, xcq, ybq, and ycq.

(iii) Having decided which of the features are to be recognized in the indexing, the UDC descriptions are now decided. This may involve decisions at two levels: firstly, what general aspect of the subject is being dealt with (remembering, for example, how many different aspects of a metal are provided for under UDC); secondly, having narrowed the decision to a fairly precise area, the citation order of the elements present in that area is decided. UDC itself provides some clues here; e.g., an enumerated number (a 'simple decimal number') is always cited before an auxiliary; hence 669.295.018.5 Titanium - Electrical properties rather than 669.018.5-669.295 Electrical properties - Titanium. Fuller rules for determining citation order are available (see Guide to the UDC, op. cit.). But an established index will have had these decisions made and recorded already in many cases, and it should not be thought that this step is always or often a time consuming one.

(iv) Having decided just what subject description to assign, the correct UDC number is worked out. In practice this step is usually taken concurrently with (iii), but in principle it is the class and its location which is determined first and the number merely added to make the location obvious and easily referrable to.

(v) We have assumed that the indexer chooses the most specific description available and does not classify at a more general head. UDC aims to provide for a high degree of specificity in indexing, and we have seen that the indexer can increase this on occasions, if necessary, by the use of verbal extensions.

Consistency in applying class numbers has two aspects. Firstly, whether or not the same person at different times or different persons at the same or different times would assign the same subject description to a document has nothing to do

with the indexing system. Secondly, once the subject description has been settled, consistency in assigning the same UDC number for it on the part of different persons should be high. In the same organization, consistency between different persons indexing the same subject can be made virtually 100 per cent provided that (i) an explicit facet formula (citation order) has been settled for each subject area (and this includes a clear policy for permuting); (ii) an authority file of decisions is maintained; (iii) an explicit policy is followed as to the maximum number of UDC elements to be used in one class number.

The wide use of the UDC in published indexes and bibliographies as well as by journals and abstracting services makes consistency between these in the use of UDC desirable. To assist this, some users have advocated the extensive use of the colon device in place of special (and even common) auxiliaries in order to facilitate the routine production of permuted entries; e.g., 669.295:669.018.5 would be preferred to 669.295.018.5 for the example in (iii) above. There is no general agreement on this, however.

In practice the needs of the organization concerned usually take precedence over standardization, and it is said, to indicate the most pessimistic view, that there are as many UDCs as there are users of UDC.

Language of the terms. A subject description from UDC is usually represented, in an index entry, by the UDC class number only. In this sense, the language is a synthetic one, an 'artificial language of ordinal numbers' as Ranganathan calls it. Natural language terms usually appear only at intervals on the guide cards, or, in the case of a book-form index, as guide headings.

UDC class numbers are frequently purely numerical in composition, but a number of non-numerical symbols are also used, such as hyphen, colon, square brackets and curved brackets. Of these, easily the most used is the colon, while the hyphen and curves (for geographical designations) are fairly common.

The notation is strongly mnemonic. Within any given subject, the repetition of the same auxiliary facets produces memorable elements (e.g., .018 for Alloy properties in Metallurgy; -07 for Diagnosis throughout 616 Pathology and Medicine). The common auxiliaries, such as place, are similarly mnemonic by repeated use (e.g., (73) for U.S.A.) - these are

also mnemonic, usually with the Dewey place numbers. 'Divide like ...' instructions provide further mnemonics; e.g.,

632 Plant diseases, pests (in Agriculture)
632.4 Fungus, mould diseases. As or by: 582.28

In 58 Botany 582.285 is Hemibasidii or rust fungi; so the number for rust fungi diseases would be 632.45 or 632.4: 582.285. The 631 and 632 divisions of 63 are separated from 631 and prefaced by a hyphen to become the Operations and Diseases facets applicable to specific crops in 633/634. Here, Potato is 633.491. So fungi diseases of potato would be 633.491-24 (or 633.491:632.4 if permutation were required).

In a vast majority of cases, UDC numbers stand for subject classes, ranging from very broad ones to highly specific ones. In a few cases, part of the number stands for the intellectual or physical form of presentation of the subject matter represented by the rest of the number; e.g., A glossary of town and country planning 711(038): Official archives of the American Revolution 973"1775/1783"(093.2).

In a very few cases the number refers entirely to the form of the work; e.g., Schubert's piano works 786.2 (Schubert).

A UDC number consists of either a simple decimal number (i.e., one enumerated completely in the schedule or built synthetically, as 632.45 was built in the example above; or, a simple number plus an element taken from an auxiliary schedule (e.g., 711(038) or 633.491-24); or two or more simple numbers (or simple numbers plus auxiliary) joined by a colon (e.g., 629.138.56:621.45:537.6.015.74 Range performance of private passenger jet aircraft, in which the 015.74 is a special auxiliary standing for range performance under 533.6 Aerodynamics).

Permutation of the different parts is effected by the colon device. Permutation need not be of all the parts together; e.g., the number could be permuted using two elements only at a time:

629.138.56:537.6.015.74 Passenger aircraft - Jets
621.45:537.6.015.74 Jets - Aircraft range performance
537.6.015.74:621.45 Aircraft range performance - Jets

But the possibilities of very high relevance are diminished by this, since the resultant classes are broader in scope.

The compilers of the UDC have not claimed that the ex-

tensive auxiliaries are consistently derived facets, but this is, in fact, what many of them really are and what revision is tending to make others. For example, the very large sequence of terms called 'brackets one to nine' (1/9) represents a whole series of subfacets with the broad category of Place, ranging from special Zones (e.g., (-04) Frontier zones), and Orientations (e.g., (1-12) Southeast) to Physical place (e.g., (212) Temperate regions) and Political place (e.g., (45) Italy). It should be noted that a given facet indicator does not necessarily confine itself to a single facet; e.g., the hyphen divisions of 669 Metallurgy include a number of facets - e.g., -1 state of the metal, -4 shape of the metal.

Similarly, the simple decimal divisions of a class are not always confined to one primary facet. Although in 669, say, all the divisions labeled 669.1/9 represent the one Metals facet, in 63 we have seen that the primary facet (agricultural products) is assigned the numbers 633/639; or, in 59 Zoology the primary facet (Animals) is assigned 592/599.

In the case of subjects which happen to have a fully worked-out class number already assigned to them, the problem of citation order of the elements does not arise. But in the majority of cases UDC numbers are built up by the indexer from two or more components and the problem of citation order is of great importance. It determines under which head entries will be collected, e.g., whether Harvesting equipment for root crops is subordinated to Root crops, or Harvesting, or Farming equipment. It is true that multiple entry diminishes the importance of this decision, since entries can be placed under all three headings. But there are limits to the number of permutations feasible in a pre-coordinate index and an element of choice as to what aspects of a compound subject remain distributed (by subordination to different, more significant, aspects) is still unavoidable. If multiple entry is not pursued, or only in diminished strength, citation order becomes very important indeed. It also determines shelf location for those items which are susceptible to shelf or vertical-file display.

UDC provides some general guidance on this question which approximates to the old indexing principle of citing more concrete elements first, place and time elements after all other subject elements, and 'form' divisions last of all. (see Abridged English edition, BS 1000 A: 1961, p. 9-10.) Briefly, this citation order is as follows:

Main class number
Special auxiliaries: ' .0. -
Common auxiliaries: Point of view .00; Place (1/9);
Time " "
Forms of presentation: Form (0); Language =

A more extended, systematic discussion will be found in the Guide, op. cit. A 'standard' citation order applicable wherever no strong arguments exist for another one is the following:

Whole thing - Kinds - Parts - Materials - Properties - Processes - Operations - Agents

e.g., Use of plastic film liners for fruit pulp barrels would be classified as: Fruit (Whole thing) - Pulp (Kind, according to state or condition) - Storage (Operation) - Barrels (Agent) - Liners (Part of agent) - Plastic (Material of part of agent). This order reflects several compatible principles (e.g., most concrete elements first).

The choice of citation order is in principle quite simple. The indexer asks himself what aspects of the subject content of items deserve to have the documents on them kept together according to the interests of the organization. These facets are then each given first place in citation order for at least one entry if the document deals with them; e.g., in subject abcdefg, if a b and f belong to facets of particular interest then basic citation order might be abfcdeg and permutation made to bring b and f to the front in further entries.

The tracing of hierarchical and class-containment relations generally is a function not of the indexing terms and the notation representing them, but of the subsequent arrangement in the index, i.e., by the juxtaposition of entries.

Exactly what hierarchies are displayed by the index depends on the citation order pursued in a given area. For example, in the hierarchy taken from the Public finance class, an indexer could make the basic arrangement one in which all aspects of the public finance system of a given country are kept together, each one subdivided into kinds of revenue, administrative procedures, etc. But if the country were cited last, the material on a country's systems would be distributed under all these different features of public finance.

In a great majority of cases the principle of general before special can be assumed, and search for more specific material is made by moving backwards in a card file, or downwards in a book catalog.

In a large file, the clarity of this tends to be obscured because a considerable bulk of entries may intervene between a containing class and one of its subclasses, if the containing class happens to belong to a distributed facet; e.g., between 632.7 Insect pests in agriculture and 635.65-27 Pulse crops - Insect pests.

An even greater and less obvious separation of the general from the special occurs when a subject is distributed between separate major classes; e.g., aeronautical engineering aspects of aerofoils are located in 629.13.014, but purely aerodynamic considerations go in 533.691; or, the botany of trees is at 582, their treatment under Silviculture (Forestry) is at 634.9 (or 634.0.2 - the alternative for locating the Oxford System of Decimal Classification for Forestry as a special schedule for this subject), their processing and properties as timber is at 674; this results in widely separated files if the index contains much material on intervening subjects. The fact of this separation should be always quite clear, however, from the A/Z index.

Notation. The UDC notation is usually hierarchical in character, and to this extent a single class number might convey its relation to another class number to a limited degree; e.g., a user of UDC might assume that 621.315.221 represents a species of the genus represented by 621.315.22, which is in turn a species of the genus represented by 621.315.2. He would be correct in that these numbers represent respectively Lead-sheathed electrical cables, Armored cables, and Electrical cables in general. There are relatively few occasions when this expressiveness of the notation is not maintained; e.g., 574 Biology, 59 Zoology, 592 Invertebrates, 594 Mollusca.

This fairly strict adherence to hierarchical notation is a major reason for the length of the class numbers. When hierarchy is not shown, considerable economies are possible, as when the various regions of the U.S.A. have class numbers no longer than the containing head: e.g., (73) U.S.A.: (74) North -eastern states.

The central display of the relations, or connections, between classes in a UDC index is by means of juxtaposition. At any given point in the index a class is usually preceded by coordinates of that class (i.e., hierarchically equal classes) in the particular containing class, and by the containing class itself, and it is followed by its subclasses and, perhaps further coordinate classes. The precise relation is implicit rather

than explicit, e.g., in the sequence in the example in the General introduction, the fact that 631.3 introduces subclasses related to Plant husbandry as agents, 631.5 introduces Operations, 632 introduces particular processes and 633 introduces particular plants is made clear only on examination of the entries or the UDC guide headings. That is to say, the role of a given term in a subject description is implicitly provided for by the facet it occurs in. Sometimes the role is explicitly scheduled; e.g., in metallurgy we find

669.24 Nickel
669.248 Coatings of nickel
669.2489 Coatings on nickel

In the case of some common auxiliaries, the distinctive symbol acts as an indicator of one particular relationship only; e.g., (1/9) numbers always signify a spatial role.

Links are provided for by the pre-coordinate nature of the UDC index; e.g., if a document dealt with the hardness of titanium and the conductivity of copper, separate entries would be made, one under Titanium - Hardness and one under Copper - Conductivity.

But links occur at different levels. The last example is a fairly simple one and corresponds to 'partitioning' - i.e., treating the document as though it were two (or more) separate documents. A more difficult problem in post-coordinate systems is ambiguity within a quite common theme; e.g., in the subject: the effect of low aspect ratio on high speed aircraft, how can we show that 'low' qualifies the aspect ratio and 'high' qualifies the speed, and not vice-versa? UDC takes this in its stride; e.g.,

629.13.072.2:533.69.031(low) means
Aircraft - by Design speed - High - in relation to - Aerodynamics of aircraft elements - Aspect ratio - Low.

The 'interfix' which binds terms is an integral part of the pre-coordinate system. (N.B. This also demonstrates a verbal extension, since UDC as yet lacks a common auxiliary for 'low'.)

Most UDC indexing aims to be specific, and if this entails the compounding together of several elements, this price is usually paid. The long numbers which result are occasionally abbreviated (by making the description shorter) for shelf arrangement, but seldom in the index. It should be remembered that in an index sequence in which a dozen or more entries commence with a common element (e.g., 621.436 Diesel

engines) this common element is virtually disregarded when searching for a particular qualifying division.

When assessing just how 'specific' a UDC subject description is, it should be remembered that a single UDC number would require several 'uniterms' to convey the sense of the elementary terms incorporated in the number, and these would still fail to convey the relations between the terms; e.g., a document on Thermocouples with curved characteristics composed of Fe Al Cr and Cu - Ni alloys (621.362:537.323:669.15.71.26:669.35.24) provides access through these terms: Technology - Engineering - Electrical - Heating - Thermoelectricity - Generators - Thermocouples - Science - Physics - Thermoelastic Constants - Chemical technology - Metallurgy - Metals - Ferrous - Alloys - (Iron - Aluminum - Chromium) - (Copper - Nickel).

Perhaps the best criterion here is the detail provided by modern special classifications. B. C. Vickery's article (op. cit.) is particularly valuable in assessing this. It could be said that UDC rarely fails to provide all the necessary detail somehow, but sometimes only at the expense of clumsy notation (particularly when using main class numbers coloned together in place of a special auxiliary). There are also occasions when UDC simply cannot specify a concept; e.g., when the distinguishing characteristic governing a facet itself appears as a class - as in Mode of hardening, or Arrangement of cylinders. Or being unable to distinguish an operation (e.g., Spraying) from an attribute (Sprayed).

As to the level of analysis, the number of identifying terms assigned per document is entirely a matter of indexing policy. Some twenty terms are included in the above entry. If the document had called for two or three different entries (implying the recognition of 'links' by pre-coordination) the exhaustivity of indexing would be reaching an impressive level. But so would the size of the index, if full permutations were made.

It should be noted here that although permutation multiplies the number of entries, it does not add to the exhaustivity of indexing. It simply re-arranges the concepts in order to relocate the same compound subject and so afford easier access. For example, suppose a document were indexed as being about four separate 'themes'(i.e., the indexer partitions it): abc:def:ghi:jkl. If each 'theme' is represented by coloned UDC numbers, the exhaustivity of this analysis is not

altered by making permutations of these (bca, cab, efd ...) to give 12 separate entries.

Items stored with index terms. In a conventional UDC index, the UDC class number heads an entry in which some or all of the following items of information indicated below occur. But there are no UDC rules on this point. It is entirely a matter of the organization's policy as to what and how much is included.

Author and title;
Journal citation, or Imprint and collation (in the case of a book);
Annotation or brief abstract;
Accession number, or other unique identifier of the document (in the case of a particular collection);
Address, if other than a UDC class number (if the document is not shelved by the latter).

Such an entry is clearly designed primarily for referral to the information proper. Only in the case of indexes which include an informative abstract can the index provide subject information directly, although the use of microcards could achieve this.

Whether it refers to a total document, an article in a journal, or simply to another source, depends on the organization producing the index.

UDC is designed primarily for an item entry system. Each entry represents an item (document) and carries on it the subject description of that item in the form of a UDC number. Usually one item receives a number of entries, and these are usually unit entries so far as the bibliographical information on them goes. Different entries for the same item may bear the same UDC number, but in different forms (i.e., permutations). Or the UDC numbers may be different if the indexer 'partitions' the document (as in the example above of links).

It is theoretically possible, however, to use the UDC in a term-entry system. The more usual uniterms or single-word descriptors would be replaced by relatively brief un-coloned UDC numbers, and the cards kept in UDC order. Assuming the system of scanning columns of numbers, the document quoted above on Thermocouples would have its identifying number (accession number, say) written on cards for each of the major concepts dealt with - Thermocouples, Thermoelastic constants,

Fe - Al - Cr alloys, Cu - Ni alloys. If an enquiry is received for any single one of these topics, a rapid search is possible by looking at the systematically subdivided file under that particular topic. If however coordination is required with one or more of the other topics, the cards for these are removed and compared in the usual way.

Cross references. The central purpose of a classification system in indexing is to provide a device which systematically maps the major relations between subjects and thereby allows the searcher for information to focus his requirements onto as broad or as narrow a class as he finds necessary. Broadness and narrowness here are not confined to the relative levels of a hierarchy, that is, between genera and species, but to any relation of documentary containment; e.g., Control of insect pests in cereal storage is a narrower class contained in the broader classes Control of pests in cereal storage, Control of insect pests in storage of crops, Storage of cereals, Insect pests of cereals, etc. That is to say, hierarchical relations and coordination of terms from every kind of category go hand in hand in defining the classes in the system.

This display of relations is accomplished by the systematic order itself and this is the major referral system. Where an alphabetic subject catalog provides a cross reference: Aircraft see also names of particular kinds and parts of aircraft, e.g., Helicoper, Wing, the UDC locates these in immediate juxtaposition to Aircraft and this is the referral; for the essence of a synthetic connection, by cross-references, is that it joins items which are seriously separated physically. As to the helpfulness of the order and collocation of classes in UDC, this has been much written about. At the broad level, the sometimes unhelpful separation of pure and applied science has been referred to. At a slightly more specific level, the order within main classes is often open to criticism; e.g., the complete scattering of Social anthropology and Sociology in Class 3 and 5. The fragmentation of Political science (parts at 32, 34, 35), of Medicine and Psychology; the failure of, say, Physics and Physical chemistry to reflect modern views - all these features have been criticized, with many other details.

The additional limitations of a single classified order, whatever this is, have already been indicated and this is remedied to varying degrees by at least three devices:

(i) by multiple entry; the connection between, say, Storage of agricultural produce and the Storage of a particular crop (entries for which may be widely separated in a single-entry

system) is established by juxtaposition when an additional file is made under the operation of Storage so as to collect all its subclasses;

(ii) by the addition of see also references and scope notes in the body of the index. This is perfectly feasible, of course, but it is not usually practiced as much as it might be. A simple example from an abstracting journal is:

621.3.01 General Theory of electrical engineering
see also 537 Electricity (Physics)
538 Magnetism and Electromagnetism
and 621.311 Power supply systems, Power stations substations
see also 621.315 Transmission lines
621.316 Distribution lines

It can be seen that these references may be from very widely separated classes (from 621.3 to 537) or from relatively near items in the same facet if a particularly close connection exists (from the point of view of the organization, perhaps, rather than of the subject itself).

(iii) The chief source of cross references is, however, the A/Z subject index.

Arrangement of the store. The importance of this in the UDC has already been indicated. Only the purely formal features whereby the systematic order is maintained are dealt with here.

In filing entries by UDC number the whole class number is considered. Within a group of entries sharing the same UDC number, arrangement is next by author or by date of publication, the latest date filing first. There are no UDC rules on this point.

UDC notation is essentially mechanical in that its primary function is to convey position, and it can be sorted without any knowledge by the sorter of the concepts it represents. The fact that it also has considerable hierarchical expressiveness is irrelevant here.

UDC class numbers are overwhelmingly numerical and this element in them is filed decimally. Very rarely the Numerical (non-UDC), or Private Code Number device is used (analogous to the alphabetical device in specifying particular items in administrative records - e.g., insurance policy numbers) and these are usually filed as integers.

The non-numerical devices are given an ordinal value,

of course, for filing purposes and this is shown in the following example:

Filing order: the recommended order is as follows:

Plus + e.g.,	651+657	Office management & accountancy
Stroke /	651/653	Office management, copying, shorthand & typing. Note: 652 & 653 are now included in 651.9
Simple number	651	Office management, office work
Colon :	651:338.962	Offices in large-scale enterprises
Square brackets [ ]	651[332.1].5	Offices - in banks - records filing
Equals =	651=82	Office management (document in Russian)
Brackets zero (0)	651(03)	Encyclopedia of office management
Brackets 1 to 9 (1/9)	651(73)	Office management in U.S.
Brackets equals (=)		[Race - not relevant here]
Inverted commas " "	651"196"	Office management in the 1960s [Alternative: may precede (1/9)]
Alphabetical device A/Z	651 ICI	Office management in the ICI Ltd.
Point zero zero .00	651.006	Office management - accommodation point of view
Hyphen -		[Not used in 651 so far]
Point zero .0	651.011.56	Offices - automation in
One to nine .1/.9	651.2	Offices - equipment
	651.5	Offices - records filing

The principle underlying the assignment of ordinal values to the different symbols is one which seeks to maintain an order of general before special. Ranganathan uses the same principle more thoroughly in his own classification and calls it the principle of inversion. It is best demonstrated by an example (it is assumed that the citation order subordinates the Operation (Biopsy) to the Part of Body (Skin):

'Inverted'		'Uninverted'	
616	Pathology	616	Pathology
616-076	Microscopic tests. Biopsy	616.5	Skin disease
616.5	Skin diseases	616.5-076	Biopsy
616.5-076	Biopsy	616-076	Biopsy

In the inverted schedule the subclass Biopsy of skin diseases (616.5-076) follows both its 'parent' classes Biopsy and Skin diseases; the facet which is cited first (when constructing a compound class number) - i.e., Parts of the body affected - files last. In the uninverted schedule, where the facet cited first files first also (by giving the hyphen an ordinal value greater than 9 instead of less than 0) this is no longer the case. The more general class Biopsy files after its subclass Biopsy of skin diseases.

This means that facets likely to be cited first are filed last and vice-versa, and this is achieved by assigning an appropriate ordinal value to the different facet indicators. This is why a simple decimal number (which invariably denotes the primary facet) files after any auxiliary.

Needless to say, general before special is not perfectly maintained - different indexers may prefer different citation orders, whereas, the filing value of the symbols is obligatory and is never varied in any UDC file. But it is maintained most of the time.

The Alphabetical Subject Index (i.e., to a particular set of documents and constructed by the indexer). The purpose of this index is:

(i) to show the location, by class number, of any given named subject, e.g., Diseases: Wheat: Agriculture 633.11-2

(ii) to show these aspects of a subject which may be distributed in the classified index, e.g.,

Diseases: Animals	636.089
Diseases: Medicine	616
Diseases: Plants: Agriculture	632
Diseases: Wheat: Agriculture	633.11-2

(iii) to provide an exhaustive 'lead-in' vocabulary to the system in the natural language, i.e., even if a subject is not yet provided for in the schedules, the A/Z index can indicate the nearest containing head under which the subject is put. This ensures recall, but with diminished relevance in that reference is made to a somewhat broader class than is theoretically possible. If verbal extensions are used in the classified index, reference can be made to the specific subject even though it lacks a specific class number -

e.g., Masers 621.384.2 (Masers)

It will also include all synonyms of term used, usually giving the class number directly under each form, rather than giving a see reference to one selected form:

e.g., Cereals - Agriculture 633
Grain - Agriculture 633

As to physical form, this may be on cards, in book form (which is of course less flexible) or on a visible-strip-index. Or it may consist of a copy of the printed A/Z index of the UDC schedules plus cards for those newer or more specific topics not in the printed index and which the library provides as a supplement.

This index is an index of a particular set of documents, a tailor-made special index rather than a key to universal knowledge (the printed index). It is constantly being added to to keep up-to-date.

For a classified index without multiple entry the most economical and systematic way of constructing an A/Z index is by 'chain procedure' (to give a 'chain index'), and this is the method used more or less in the printed indexes to the schedules and to other printed indexes where economy of space in producing the joint classified and alphabetical indexes is important. It has grave limitations, however, in large specialized collections.

Chain indexing reduces considerably the number of entries in the A/Z index by directing enquirers only to where a given class begins, in the classified index, and never indicating (by qualifying phrases) sub-classes of the term which will be found following that term in the classified index. For example, in a Metallurgy file, in which the metal is the primary facet, everything on a particular metal is collected together under the one heading. So the only A/Z index entry for that metal would be, say,

Copper 669.3

Entries like Copper: Electrical properties 669.3.018.5
Copper: Tubes 669.3-462

would not be given, since these classes would appear in the systematically arranged sequence following 669.3 in the classified index. Careful guiding of the latter is assumed.

But terms which are distributed (i.e., subordinated to other categories in the subject) will have all the different con-

texts under which they appear in the classified index displayed as qualifiers following the term in the A/Z index; e.g.,

Tubes: Copper	669.3-462
Tubes: Lead	669.4-462
Tubes: Metallurgy	669-462

The methodical, almost mechanical, way in which entries are derived from a chain of a class is shown in the following example:

Entries (subsequently filed A/Z) for a document on Ploughs for grain crops (assuming this was the first document in the collection to be indexed)

Chain		
63	Agriculture	Agriculture 63
633/635	Crops	Crops: Agriculture 633/635
633	Field	Field crops: Agriculture 633
633.1	Grain	Grain crops: Agriculture 633.1
633.1-13	Machinery	Machinery: Grain crops 633.1-13
633.1-1312	Ploughs	Ploughs: Grain crops 633.1-1312

Any synonyms of these are added at the same time; e.g.,

Cereals: Crops: Agriculture	633.1
Implements: Grain crops	633.1-13

Here the class is displayed on the left as a chain or series of subdivisions; each step of division, if it can be expressed by a keyword (a 'sought term'), is given an entry commencing with that term. Qualification of a term is always by superordinate terms (i.e., terms representing containing classes) so as to avoid the display of subclasses under a term. The fact that each level of the 'hierarchy' represented by the chain gets its own index entry means that access is automatically provided at every generic level. A searcher could begin looking under Ploughs specifically or under Agriculture generically. It should not be thought, of course, that every document produces as many entries as this example. Most, if not all, of the entries for a given document will already have been made in most cases.

In certain circumstances it becomes very laborious to search via a chain index. An example adapted from the first Cranfield investigation demonstrates this:

Pressure gradient: Cones 533.696.4:533.69.0482

Pressure gradient: Shear flow: Supersonic flow: Cones 533.696.4:533.6.0115:533.386:533.69.048.2

Pressure gradient: Shock waves: Cones 533.696.4:533.6.011.72:533.69.048.2

A request for everything on Pressure gradient on cones would require the searcher to examine all entries beginning with

Pressure gradient (this element being cited after Cones, and therefore being the distributed element whose whereabouts the A/Z index is designed to disclose) and then to note all those entries which contain Cone also. Since 'Cone' might appear as a first qualifier, second qualifier, third, etc., the whole sequence would need to be scanned. This looks easy when there are a small number of entries, but if there are several dozens or even a hundred or more it becomes no joke. It should be remembered that these entries are only see references and each relevant class number found now has to be separately located in the classified index to see what documents are represented.

The use of multiple entry in the classified index immediately reduces the load on the A/Z index, since fewer classes are distributed (and it is the display of distributed aspects which is half the load of a chain index).

Certain controlled modifications of chain indexing are in any case possible to provide readily locatable coordinations; e.g., certain elements, not usually sought under as leading terms in the A/Z index are transposed; e.g.,

Gas turbines: Performance

Here, the term 'Performance' is not a 'sought' term, i.e., it is not likely to be consulted directly but only in connection with a particular machine. This method, combined with limited multiple entry, was used with the UDC index at Cranfield and is described in the Report on the first stage (op. cit.).

Another alternative method recently advocated is the 'rotated' or permuted A/Z index, in which major qualifying elements are successively brought together:

Cones: Pressure gradients
533.696.4:533.69.048.2

Cones: Pressure gradients: Shear flow: Supersonic flow
533.696.4:533.6.0115:539.386:533.69.048.2

Cones: Pressure gradients: Shock waves
533.696.4:533.6.011.72:533.69.048.2

Shear flow: Supersonic flow: Cones: Pressure gradient
533.696.4:533.6.0115:539.386:533.69.048.2

Shock waves: Cones: Pressure gradients
533.696.4:533.6.011.72.533.69.048.2

Supersonic flow: Cones: Pressure gradient: Shear flow
533.696.4:533.6.0115:539.386:533.69.048.2

Here, the conjunction of 'Cones' and 'Pressure gradient' is readily seen. This is analogous to permutation in the classified index. But whereas every document entry has to be multiplied several times in the classified index, only entries for classes

have to be multiplied in the A/Z index. If we assume that on the average each distinct UDC number has several document entries under it in the classified index, this means that single entry in the classified file plus a rotated A/Z index would still be more economical in size of total index.

The raw material here is formed by the terms used in the classes (subject descriptions) of the classified index. In the example above we saw how the class 'Ploughs for grain crops' gave rise to a number of A/Z index entries.

There are basic rules in the processing of the class descriptions in order to get A/Z index entries.

(i) All keywords (sought terms) should appear as the leading term in some entry. The natural language approach must be fully provided for, and we assume that the terms used in the documents are reliable clues to the terms used by enquirers. The language of the A/Z index is not restricted to what the indexer finds in the UDC schedules but should reflect the vocabularies of the documents indexed and of the users of the index. So the more familiar the indexer is with the latter the better.

(ii) If a concept appears in more than one part of the classified index, these different contexts must be displayed clearly (as qualifiers of the concept) in the A/Z index.

Choice of terms depends essentially on the indexer's judgment as to what constitutes sought terms in relation to the information indexed. Only the subjects represented in the classified index are indexed, of course.

An apparent, but not real, exception to this is when an intermediate link in a chain is indexed although no document refers specifically to it; e.g., a document on Cereal crops (633.1) would automatically produce an entry:

Field crops 633

That the collection indexed has (perhaps) no document devoted to this exact topic (all field crops) does not make this entry a false one, for the collection certainly has something on field crops, i.e., the document on cereals which gave rise to the entry.

The skills required in assigning A/Z index terms are a logical extension of the ordinary skill of indexing. Once the decisions have been made as to the assignment of class descriptions in the classified index, the production of A/Z entries to lead into the classified arrangement is a relatively mechanical task, as has been demonstrated already. So long as the rules

of the method adopted (chain indexing, or chain indexing with transposition of selected unsought terms, or rotated index) are strictly followed, a high degree of consistency is possible.

The language of the terms is derived from the subject descriptions assigned in the classified index, with the addition of any synonyms of terms used there. These synonyms need not appear in the schedules, or even in the documents concerned, although the latter is usually a fruitful source of these; e.g.,

Ground effect: Aerodynamics	533.682
Hovercraft: Aerodynamics	533.682

Terms distinguish classes only, of every level of generality or specificity, as can be seen from the examples above. Very rarely they refer to the form of information materials rather than their subject. But as an economy measure these entries are usually in the form of general references; e.g., Glossaries on a subject See class number of subject followed by (038).

Ideally, the elements of an A/Z index entry are the sought term, or keyword, which begins the entry and which determines its initial position in the A/Z sequence and the fewest possible number of superordinate terms from its hierarchy or chain necessary to distinguish unambiguously the particular aspect concerned; e.g.,

Helicopters	629.135.45
Fins: Aircraft	629.13.014.4

The term Helicopters always implies Aircraft; it does not require the qualification. Fins can have other contexts; it needs the qualification.

Naturally, the shorter the entry, the better it is. But the clerical production of indexes sometimes makes it easier to include all superordinate terms automatically, to save the need for individual judgment; e.g., the A/Z index to the UDC file at Cranfield would have

Carrier waves: Telegraphy: Electrical engineering 621.394.441

although the last two terms are clearly superfluous.

The arrangement of the elements in an index entry is usually strictly controlled. In chain indexing, for example, terms on the right hand side are always the containing classes of the terms on the left of them; e.g., in the entry above, Carrier is contained in the class Waves, which is contained in

the class Telegraphy.

The A/Z index should provide access from whatever hierarchical level it is approached. Chain indexing provides such access as a matter of principle. Whether the searcher consults the term Wheat, Cereal, Field crop, Plant husbandry or Agriculture, he should be led to the correct part of the classified index. Whether he is led to the precise spot, or to some nearby containing head depends on whether he consults the specific term or a more general one.

The number of terms indexed in the A/Z index depends mainly on the number of distinct class terms recognized in the classified index. If the latter is exhaustive and specific, then the A/Z index will be that much larger. But it is possible to have highly specific terms in the A/Z index leading to broader containing classes in the classified index; e.g.,

Stitching: Mechanical attachments 621.885

where 621.885 is only the containing class, Mechanical joining and attachment. UDC puts no restrictions whatsoever on the size of the A/Z index.

An A/Z index entry consists only of the name of the class being indexed and its class number. It is for referral only - and not to individual documents, or to individual document entries, but to the location of the classes (i.e., classes of document entries in the classified index and to classes of documents on the shelf).

Nevertheless, it is theoretically possible to envisage the A/Z index as another vehicle for multiple entry and to convert the entries to subject headings as in the alphabetical subject catalog by inserting document entries under them. This is, in fact, what is done in the Bibliography of Meteorological Satellites which Malcolm Rigby circulated at the Seminar (Rutgers University, fall 1963).

It may be noted here that UDC could function as the source of alphabetical subject headings and systematic syndesis (by the use of chain procedure for the alphabetical subject catalog, advocated by Ranganathan).

Cross references are very rare in the A/Z index. The function of the syndesis in the alphabetical subject catalog is performed in UDC, of course, by the joint operation of the systematic order of the classified index plus the display of distributed relatives in the A/Z index itself. In the latter, the

use of qualifiers is another form of see also reference:
e.g., Forage crops: Fodder 636.086
Forage grasses: Plant husbandry 633.2
This performs the same function as a cross-reference
Forage grasses see also Fodder

Arrangement of the A/Z index entry is alphabetical, and word-by-word, since the whole point of the arrangement is to designate separate classes (represented by separate words).

The need to observe detailed rules for alphabetization seldom arises. The chief occasion is when the index includes terms which are the names of persons and places (both as subjects, of course) as well as classes in the normal sense; e.g.,

Wells, H.G.: Biography	92(Wells)
Wells, Cathedral Church: Architecture	736.6(4238)
Wells (Somerset): Description	914.238(Wells)
Wells: Water supply	628.112

The four categories represented here could be assigned this filing order: Persons (Individual): Persons (Corporate): Places: Other subjects.

UDC provides no rules for alphabetization and a standard code (e.g., A.L.A. Filing Rules, B.S.I. Filing rules) is normally followed.

It may be noted here that an author-title index is a usual accompaniment of a UDC catalog. It is possible to interfile this with the A/Z index, and this is sometimes done. It is probably unwise, in that problems of alphabetization multiply and display of subject relations is impeded.

There is obviously no market for machines to search an alphabetical file. But the mechanical production of book-form A/Z indexes offers considerable advantages. The use of a computer to produce a permuted chain index to a classified file (not UDC) has been described recently, and obviously this could be applied to UDC. (See Dowell, N.G. and Marshall, J.W., Experience with computer-produced indexes. Aslib Proc., 14:323-32, October 1962.)

C. Tools for the Construction of Indexes

Tools used for indexing. Three tools can be distinguished: the schedules of the classification, the printed A/Z index of these schedules, and the authority file of class numbers actually used, with the A/Z entries made for them. Much of

what has been said about the classified and A/Z indexes applies also to the first two of these tools. This will not be repeated here. Only the significantly different features will be described.

UDC Schedules. The purpose of this group is to provide a complete conspectus of the system's basic vocabulary arranged in its systematic order. By basic vocabulary is meant the total list of terms enumerated in the schedules, each with a distinctive symbol. These may be classes represented by simple decimal numbers (e.g., 664.8/9 Preserving and preserves (in Food technology); 664.82 Cereals preservation); or classes represented by a simple number and a special auxiliary (e.g., 664.8.037 Cold preserving); or Common auxiliaries, which cannot exist on their own but must be attached to a simple decimal number (e.g., '18' for 19th century).

It does not provide class numbers synthesized from these three types of basic terms; e.g., it does not enumerate the class number for Cold preserving of cereal foods. This remains a potential class only - to be synthesized by the indexer when constructing an actual index.

This is not to say the schedules only provide 'elementary' terms, whatever that might mean. There is a certain amount of pre-coordination already present in them; e.g., 616 Diseases (of humans), 632 Diseases of plants, 636.089 Diseases of animals (in Animal husbandry), 591.2 Diseases (Zoopathology) etc., as well as the more elaborate examples already given for Ferrous metallurgy.

To give this complete conspectus the schedules cover all human knowledge, and this is the other major distinction between the schedules and a UDC index proper, which is usually restricted to something less.

This complete basic vocabulary is accompanied by various rules for the construction of UDC numbers, scope notes, etc., and the vocabulary, the rules, and the A/Z index together constitute the basic tools from which an indexer derives UDC subject descriptions.

UDC schedules are in book form, but the master file at FID headquarters in The Hague is on cards.

Clearly, the schedules must exist before the construction of an operating index. But they are constantly being added to and amended.

The maintenance and development of the UDC schedules are products of the labor (most of it unpaid) of an army of UDC users, librarians, documentalists, and subject specialists. These people are organized in an international network of UDC revision committees ('panels') which work under the general supervision of the Central Classification Committee (CCC) of the FID. The products of the work of these panels are circulated initially as drafts and then, after discussion and comment, as formal proposals (P-Notes) for amendment or addition to the existing schedules. These P-Notes are sent to participants and any specially interested subscribers. Final decision on these proposals is made, as a rule, four months after their issue and these definite rulings are circulated as cumulative 'Extensions and correction of the UDC' (issued half yearly) which constitute regular supplements to the printed schedules. Below is a brief extract from a P-Note:

P-Note 788 (27 May 1963)
(Deals entirely with 621.9 Tools and tool working.) The symbol PIwp after a proposal means that it was made by the subject panel concerned (FID/C 621.7/9) and the wp stands for Workshop Practice, the subject covered.
621.9 Modify to: Tools and Toolworking. Machine tools and machining. Cutting and sheet working. See also 621.7 Workshop practice (generally) esp. plastic forming PIwp 788
621.9-11 Design and construction characteristics (for use especially with .06/.07) PIwp 788
621.9-111 Simple, monobloc, one-piece design and construction PIwp 788
P-Note 786 (20 May 1963)
Contains miscellaneous proposals, e.g.,
621.039.543.45 (Natural uranium) Modify to: Natural uranium fuels Piaea 786
636.088.3 Ändern in: zur Gewinnung von Fleisch, Fett und Eiern Pd 786
656.884.1/.7 Cancel; see 332.171 PE 786
Here, Piaea means a proposal of the International Atomic Energy Agency; Pd a German proposal; PE a proposal of the FID/CCC Secretariat.
Replies to P-Note 786 were requested within the normal four-month period. Replies to P-Note 788 were acceptable within six months in view of the comprehensive revision entailed (of Class 621.9).

All organizations and persons interested in developing UDC may participate in this work, preferably via their national committee (e.g., the British Standards Institution in Great

Britain) which may have a full time editor and staff. It is widely recognized, however, that a major reason for the delays attending the production of UDC schedules, and of their revision, lies in the inevitable difficulties attending the operation of a cooperative international organization, with barely adequate financial resources.

The principles underlying maintenance and revision of the UDC schedules has been formally described in rather general terms (see Bibliography). The constant revision implies the cancelling of obsolete class numbers as sections of schedules are redeveloped. The physical difficulties of altering documents and indexes is a serious problem here, and a major problem in maintaining UDC is that of keeping a balance between conservation in the retention of existing locations (favored by older users with substantial files already established) and the pressure of new members for relatively radical changes. There is a formal 'ten-year rule' whereby a number which is cancelled is not used with a different meaning until ten years have elapsed. Some users regard this as unnecessarily restrictive and it is sometimes ignored in private files.

Language of the schedules is based on every kind of information material, without restriction, which conceivably can be organized by UDC.

The raw material of terms and concepts suggested by subject specialists and interested librarians and other users is edited for incorporation in UDC through the machinery described above.

Choice of terms is invariably a reflection of literary warrant; users of UDC are continually meeting or anticipating terms in the literature of developing subjects, and it is these terms and notions which are incorporated in the developing schedules, just as the original schedules were developed out of the subject knowledge and subject literature of the time.

Control of the terms used to describe subjects is dependent primarily on the natural language. For example, a class like Bessemer converter is used as it stands. It is located at 669.184.12 (for acid converters) and 669.184.22 (for basic converters). The implicit definition of this class is that provided by its hierarchy:

669 Metallurgy
669.1 Ferrous, Iron and Steel
669.16/.18 Production [Processes]
669.184 Converter process. Converting
669.184.1 Acid Bessemer process
669.184.12 Acid converter

669.184.2 Basic Bessemer process
669.184.22 Basic converter

Access to this class can be made, with varying degrees of directness, from every term in the above hierarchy, and their synonyms; e.g., below are A/Z index terms leading to the subject above (they are not put in A/Z order here so as to show more clearly their derivation from the hierarchy in the schedule):

Metals: Metallurgy	669
Metallurgy	669
Ferrous metals: Metallurgy	669.1
Iron: Metallurgy	669.1
Steel and Iron: Metallurgy	669.1
Production: Ferrous metallurgy	669.16/18
Processes: Ferrous metallurgy	669.16/18
Converter process: Ferrous metallurgy	669.184
Bessemer process: Ferrous metallurgy	669.184
Acid Bessemer process	669.184.1
Converts: Acid Bessemer process	669.184.12
Basic Bessemer process	669.184.2
Converts: Basic Bessemer process	669.184.22

The fact that 'Bessemer converter' could be analysed further (i.e., beyond its level as a term in the natural language) as a class of device, acting on metal, utilizing heat, characterized by iron, does not enter into the UDC description or class number for this subject. This may be compared with the use of semantic factors in the WRU code where Bessemer converter is described in the fashion indicated above: MACH.MWTL. RQHT.RYRN.001. The analysis of the WRU provides one access point not available in UDC, i.e., 'Heat' (and in the same way the WRU code for 'Reverberatory furnace' provides an access point from 'Reflection' which UDC fails to give).

It can be seen from the above that the level at which UDC analysis of subjects stops is the level at which the terms of the natural language fit into the categories recognized in the different containing classes. It can also be seen, however, that this level manages to provide a surprisingly comprehensive access

to each term. It may be added that careful indexing in an A/Z index can provide yet further levels of approach; e.g., the recognition that the divisions 669.16/18 are largely heat processes and the incorporation of this in the A/Z index.

Heating processes: Ferrous metallurgy 669.16/.18

The problem of consistency in the choice of subject descriptions for schedules occurs at two quite different levels. Firstly, consistency between different national committees as to the scope and interpretation of classes and the assignment of UDC numbers to them. The trilingual abridged edition (in English, French and German) showed up certain weaknesses here, at least in the social sciences (see paper by Barbara Kyle, op. cit.).

Secondly, consistency in analysis insofar as it affects the clarity and homogeneity of the categories or facets enumerated in the schedules of special and common auxiliaries. That certain concrete terms are distributed in a number of places, as in the case of Metals, is generally accepted as the price of an aspect classification. But many recurrent concepts which should in principle be assigned to auxiliaries, once and for all, are still found inconsistently scattered and differently coded (the examples of Woman and child have already been given, another is Disease, also mentioned earlier). It is hoped that the growing acceptance by UDC compilers of facet analysis as the obvious way of securing consistency in these matters will gradually remedy this.

The main referral from term to related term is shown in the UDC schedule by the systematic arrangement. Relations are particularly well illustrated here since the display of hierarchies is unimpeded by document descriptions between the headings (as in a UDC index proper). Also, the book form allows the liberal use of typographic aids (heavy capitals for major classes, heavy lower case for major subclasses, and so on) and indentation (as a symbol of subordination) in order to convey relations more clearly.

To this are added many cross-references; e.g.,

621.394.64 Magnifiers and Amplifiers. Repeaters
For relays see 621.318.5
For amplifiers in general see 621.314

Each major class (e.g., 621.3 Electrical engineering, 669 Metallurgy) is prefaced by a table of Principal Divisions, observations on the scope and content of the class and a list of related subjects. Class 52 Astronomy - Geodesy provides

(in the full English edition) a particularly full account of the problems of compiling the schedule. For information on the arrangement of the schedules, see section on the Classified Index.

Possible use of machines for the preparation of the schedules. The difficulties attending the physical production of UDC schedules have contributed to the delays in producing full up-to-date schedules. A tendency continually to hold up publication until various further improvements are cleared from the pipeline and finalised has been exacerbated by awareness of the difficulty and expense of revising printed schedules, and this has been one reason why there is still no complete English edition of UDC.

Proposals for using computer printout facilities for producing and regularly updating UDC schedules have been made by the American National Committee for FID.

Alphabetical Index to UDC Schedules

UDC schedules usually are accompanied by an A/Z index to the terms used in them. In some cases it constitutes a separate volume (e.g., the index to the English edition of Class 54 Chemistry). The growing awareness of the importance of the A/Z index as an integral part of a classified catalog is reflected in the much fuller A/Z indexes which are now appearing at least in the English editions (e.g., the very full index to the 1961 English Abridged Edition).

The primary purpose is to show the location in the classification schedule of simple UDC terms occurring in that schedule. By 'simple' is meant here those classes enumerated and given a simple decimal number (e.g. Metal base paints 667.633.42) or special auxiliaries attached to basic class numbers to which they are applicable (e.g., Metabolism 612.015) and common auxiliaries (e.g., Dublin, Ireland (418.3); Nineteenth century '18').

It does not provide entries for any composite numbers; e.g., Glandular metabolism is a 'composite' class obtained by synthesis of Glandular physiology 612.4 and the special auxiliary for Metabolism .015 to give 612.4.015.

It is in book form. An extract from the second edition of the English Abridgement is given below.

Metabolism 612.015; disorders 616-008
animals 591.05
micro-organisms 576.8.095
plants 581.13
Metachlamydeae 582.9
Metal(s) 546.2, 669
ferrous 669.1; non-ferrous 669.2
light 669.7
articles 672/673
building materials 691.7
cleaning, polishing 621.7.02
household 648.55
coating of 669.86/.87
coating(s) with 669...81, 686.4
Cf. Metallization
compounds 661.8. Cf. Organo-metallic
construction work 693.8. Cf. Steel-framed
Metal-base paints 667.633.42
Metal-cutting and engraving 736, 762
presswork 655.35
Metallic compounds 546.3/.9, 661.8
Cf. Organo-metallic
Metallic pigments 667.622.2
Metalliferous ores 553.3/.4
mining 622.34
Metallization 621.793. Cf. Metal coatings
Metallography 620.18 Cr. Physical metallurgy
Metalloids 546.1/.2
Metallurgy 669; general 669.01
ferrous 669.1; non-ferrous 669.2...1
Metamorphic rocks 552.4; mining 622.354

Generally speaking, these indexes are constructed by chain procedure; i.e., as a rule, no subdivisions of a class are listed under that class in the A/Z index; e.g.,

Metamorphic rocks	552.4
Marble	552.4

but not Metamorphic rocks:Marble 522.4. There are a few exceptions to this rule; e.g.,

Metals	564.3, 669
Ferrous	669.1; non-Ferrous 669.2
Light	669.7

Subject Authority File

Not many organizations appear to maintain this tool, although it is officially recommended (e.g., in the Introduction

to the 3rd Abridged English Edition BS 1000 A: 1961 p.7, E.9).

Its function is to provide an exact statement of every UDC class number used for a given index, together with the A/Z index entry or entries (if there are synonyms) made for that number. Scope notes and other records of decision may be incorporated in it.

The purpose of this tool is to aid consistency in each index and between different indexers, past, present and future. A new indexer taking over or assisting the production of an existing index can see immediately, for any item he indexes, exactly what UDC numbers have been used already and to what extent a new number, or additional A/Z index entries are necessary (if any).

It is usually kept on cards - a separate card for each class number.

It relates only to the particular index concerned. It is continually added to and subtracted from; e.g., suppose a document on the Metabolism of the pituitary gland is received. The authority file is consulted and discloses the following entries at this point (each space marks the end of a card):

612.4	Glands : Physiology Secretion : Glands : Physiology Excretion : Glands : Physiology
612.43	Endocrine glands : Physiology Ductless glands : Physiology
612.432	Pituitary gland : Physiology Hypophysis : Physiology

The precise subject has evidently not been represented until now, so a new number is assigned to the document and the A/Z index entries made:

Metabolism : Pituitary gland : Physiology 612.432.015
and Chemistry : Pituitary gland : Physiology 612.432.015

The authority file shows that no other A/Z index entries are needed; they have been made already up to 612.432. A new Authority File card is made out:

612.432.015 Metabolism : Pituitary gland : Physiology
Chemistry : Pituitary gland : Physiology

If this document is subsequently withdrawn and it is seen to be the last entry in the classified index bearing that exact number, then its Authority File card is also withdrawn and the A/Z index entries for both Metabolism ... and Chemistry ... are withdrawn also. Thus the A/Z index is kept accurate and up-

to-date. It does not index Metabolism of the pituitary if the last document on this precise subject has been withdrawn.

D. Searching Methods and Output of the System

To answer a subject request an approach can be made via classes of every degree of generality or specificity; e.g., a question on the Effect of cathodic protection on the fatigue strength of mild steel in sea water could be sought through such general classes as Sea water corrosion, Corrosion protection, Steel, Mild Steel or through the precise class:
Mild steel-Corrosion fatigue-Sea water-Protection-Cathodic.

Access to these classes can be obtained by consulting the keywords in the A/Z index, if their location in the systematically arranged index is not known. This includes different approaches through synonyms; e.g.,

Sea water: Corrosion	620.194.8
Salt water: Corrosion	620.194.8

Formulation of Inquiry

This is basically the 'indexing' of requests rather than of the documents. It is done in the natural language to begin with. The elementary terms of the question, assuming this has been clarified, must be sorted into the kind of classes provided by the UDC (Corrosion protection, Mild steel, etc.). These are quickly established by consulting the A/Z index if the user is not familiar with the UDC; but librarians working with a UDC file usually soon acquire what to the layman is an impressive knowledge of UDC arrangement and know by heart many frequently used class numbers.

The degree to which these more obvious terms must be linked now to formulate a single integrated UDC class depends on two things. First, if the classified file is constructed with an eye to economy, using a single-entry system with a preferred order, then the terms must be formulated in the regularized language produced by the citation order followed in the index. For example, in a metallurgical library, the request above might be classified as: Metal(Steel) - Kind (Mild) - Property (Defect) - Kind (Fatigue - caused by Corrosion - by seawater) - Operation (Protection) - Agent of operation (Cathodic). This may seem more involved than it is. The citation order in a particular field, once settled as a matter of indexing policy, soon becomes second nature to frequent users of the index. Just as in a Dewey-arranged library, searchers in the Belles-

Lettres class are very soon accustomed to searching by the formula Language of the literature - Form of the literature - Period of the literature - Author.

In practice, any inconsistencies or peculiarities of the UDC also become well known to the constant user and their nuisance-value minimized; e.g., the Metallurgy class (669) has a Properties facet at 669.018.2 used to characterize metals (alloys usually) by property (e.g., to specify Low melting-point alloys). But the testing of materials for specific properties, and defects, are specified at 620.17, which is usually coloned to the metal to signify this aspect of it. The formulation of the subject in the example above takes this into account.

Secondly, the degree to which the terms must be linked to formulate a single integrated UDC class depends on the level at which the user is prepared to begin his search. We saw at the very beginning that when the class examined is broadest the chances of high recall are better, but that a price is exacted in the form of more irrelevant entries to be scanned. If the searcher begins searching under a relatively broad class, a more restricted formulation is all that is required, e.g., Steel - Mild - Corrosion. If the classified index enjoys multiple entry it does not much matter which of the elements of the total class description the searcher begins looking under, since all entries relevant will have been filed under each heading concerned; e.g., the three classes Mild Steel, Seawater corrosion fatigue, and Cathodic protection would all contain entries on the subject sought.

Having formulated the question in the form of a UDC class, this must be converted into a UDC class number (or numbers). As in indexing, this step is usually taken concurrently with the formulation of the question in the regularized form, but conceptually it is quite a distinct step. The class number is determined exactly as in indexing, and the enquirer must know whether the special auxiliaries for example, are added straight onto a primary facet number (e.g., 669.3 - 42 Copper-Wire) or coloned to it (e.g., 669.3:669-42). Again, with multiple entry and a willingness to scan a relatively broad class, such conversion is simpler - the separate UDC numbers are looked up one at a time. But even with multiple entry if specific search is made, some citation order must be observed; e.g., if the class number searched for the question above (on seawater corrosion of soft iron) were 669.141.24:620.194.8:620.197.5 the permuted entries would probably be 620.194.8:620.197.5:669.141.24 and 620.197.5:669.141.24:620.194.8 (assuming

'cyclic' order were used in permuting).

It is clear from the above that the satisfactory use of a UDC index demands a certain basic knowledge not merely of UDC filing order but of the policies followed in the index regarding citation order in a given field. This basic knowledge is not difficult for a regular user to learn, but for the casual user, it is clearly desirable that the aid of the library staff be sought in programming a search, even if the user does the physical search himself.

This does not mean a UDC index cannot be used by any reasonably educated layman. It can be, but the possibilities of precise searching, with high relevance, open to the skilled searcher are less likely to be realized.

What is always demanded of the user is that he define his question as precisely as possible. In persuading an enquirer who asks for information on 'seawater corrosion' to enlarge on this until the precise request given above is elicited, both the UDC classified index and the A/Z index assist, the former by leading him on from class to subclass and the latter by warning him of the distribution of some subjects under different headings; e.g.,

Sea water: Corrosion	620.194.8
Sea water: Corrosion: Steel	669.14:620.194.8
Sea water: Corrosion: Mild steel	669.141.24:620.194.8

Searching

This is indirect at one or two removes, i.e., before the information item itself is retrieved the user must consult either the A/Z index and then the classified index, or the latter alone.

However well versed a user (a librarian, say) is in the UDC numbers occurring in the particular field concerned, he will still need to consult the A/Z index constantly to establish the exact UDC number for a concept (e.g., for mild steel, for seawater corrosion). But in practice many searches are begun, and finished, without these exact numbers being looked up; e.g., if the enquirer knew that steel was 669.14, that corrosion fatigue was 620.193 ..., that corrosion protection was 620.197, he might begin a search at 669.14, locate the subclass mild steel by rapidly scanning the types of steel (and perhaps spotting a guide card, or guiding head in a 'printed index' for it), look under the :620.193 divisions until he came to

seawater corrosion, then consult the :620.197 divisions of this, and so on. If there are relatively few entries under some of these subclasses the need to consult the A/Z index and write down or memorize the exact numbers before consulting the classified index is correspondingly diminished.

On the other hand, if rapid preliminary searching discloses insufficient material, the enquirer naturally checks the A/Z index in case other aspects of the terms he has been searching may be worth pursuing.

Serial searching of a relatively broad class is of course very limited in usefulness; it leads to a poor relevance ratio and a point is soon reached when more precision - more specific - searching is essential. When precise UDC numbers are searched, the serial searching is very limited, i.e., it is limited to the number of entries bearing the same number. This will vary with the organization, the subject, and the size of the index, but if the number of entries filed under one UDC number reaches, say, between ten and twenty, further subdivision will usually be sought.

The main function of a systematic arrangement of entries in an index is to facilitate the rapid widening and narrowing of the classes being searched, remembering that the alteration in scope of a class definition may be by following hierarchical relations (e.g., moving from Cereal to Wheat, or from Wheat to other selected grains (coordinate classes in the same hierarchy) or by coordination (e.g., moving from Cereal to Storage of cereal, or from Storage of cereal to Infestation in storage of cereal). A systematic arrangement of the entries physically is not essential here; a systematic program could be worked out from a classification schedule, or, less satisfactorily, a thesaurus, and the actual search made in an alphabetically arranged catalog. But the physical implementation of the arrangement makes this search easier, and this is a major reason for having a classified index.

The nature of a really methodical, exhaustive search through all the ramifications of a subject are described in some detail (for any classified index, not a UDC one in particular) by E. J. Coates (Subject catalogues, London, Library Association, 1960). It is necessary in such a methodical search to view the specific subject concerned as a chain, or pseudo-hierarchy, i.e., a series of classes and subclasses not restricted to the genus-species relation, reflecting the citation order followed in the index. The possible coordinations of the different

facets are then methodically pursued. A simplified example would be to search for everything bearing on the nature and control of insect infestation of cereal crops in store.

Assuming a citation order: Crop - Operation - Process - Agent of process, this would give the chain:

Cereals
Storage
Diseases and pests
Insect

The following pre-coordinations would now be examined:

1. The precise subject: Cereals - Storage - Diseases and pests - Insect
2. Material on Diseases and pests of Stored cereal generally
3. Material on Storage of cereal generally
4. Material on Cereal crops generally

From this point, search branches out to the coordinate terms at each level; taking first the Crop hierarchy;

5. The subclass 'Insect pests in storage' under each particular cereal
6. The subclass 'Diseases and pests in Storage' under each particular cereal
7. The subclass 'Storage' under each particular cereal
8. Each particular cereal generally

Now the other hierarchies:

9. The subclass 'Insect pests' under Storage (of crops generally)
10. The subclass 'Diseases and pests' under Storage (of crops generally)
11. The subclass 'Storage' (of crops generally)
12. The subclass 'Insect pests' under Diseases and Pests (of crops generally)
13. The subclass 'Diseases and Pests' (of crops generally)

Such a search could be made directly through the classified index, or by first consulting the A/Z index under the distributed terms:

Insect: Pests: Storage (examining all qualifiers which are names of crops, or field crops)
Pests: Storage (examining all qualifiers which are names of crops, or field crops)
Storage: (examining all qualifiers which are names of crops, or field crops)

Search in a multiple entry system is simpler, but it is still methodically based on the hierarchies and pseudo-hier-

archies. Numerous accounts of searches in a UDC index are to be found in the reports of the Cranfield investigations (op. cit.). One of the general comments made there (Report on the testing and analysis... p. 91) which is particularly relevant here is quoted in Chapter V.

For exhaustive searches such as the one above, it would be wise to pursue the one search on its own. But for lesser searches a single user can pursue two or three searches concurrently. It should be remembered however that a great advantage of the pre-coordinate card or book index is that it is readily available at any time. There is little point in accumulating requests, as no time is saved in the search process by such a procedure; in fact, the reverse is probably true. A searcher with his mind on one particular UDC configuration and its possible modifications can probably search faster than if he is looking for several.

Several users can search a UDC card file at a time so long as they are searching parts of the file sufficiently widely separated physically. With book form indexes, where production of numerous copies is implicit, there is no such limitation.

The gravest physical limit on the use of UDC indexes is the size of the card or book index if really exhaustive multiple entry is attempted. In a single entry system up to a dozen entries per item (which is the equivalent of recognizing anything from twenty to a hundred different 'uniterms', interfixed or linked in different batches) would produce a massive file if it were cumulated for any length of time, even for a modest collection. Permutation of this number of entries is impracticable for most collections.

Three other factors are relevant here, as bearing directly on the size of the index. First, the 'winding up' of the index at regular intervals (five yearly, say) after which a new one is begun. In rapidly developing subject areas in which material quickly becomes obsolete this has obvious advantages besides controlling the size of the index. More radical adjustments in the maintenance of the index are feasible if this were to become general policy.

Secondly, extreme exhaustivity of indexing has rarely been practiced and is of doubtful utility in many cases. At the very least it should be accompanied by some sort of weighting so as to distinguish entries which refer to incidental and marginal treatments of a theme from those which refer to mono-

graphs on it.

Thirdly, the degree to which the selective pre-coordination of entries provides an inadequate number of access points compared with free post-coordination is a point on which further information is needed. There is some evidence in the Cranfield test of the WRU index to suggest that a relatively modest degree of multiple entry produces recall figures which are comparable with those of post-coordination. Our judgement as to the seriousness of the physical limitations on index size described above may need revision.

Since searching in UDC indexes does not entail serial scanning, there is no inherent limit to the speed with which items can be retrieved. A given UDC number can be located in a matter of seconds whatever the size of the index. An exhaustive search, if it is planned along the lines suggested before, will rarely take longer than an hour and usually much less. How much longer depends partly on whether multiple-entry or single entry is practiced.

The time elapsing between the initial formulation of the question and its translation into a UDC class number (or numbers, if the question is in fact a composite of several distinct questions) is usually a few minutes. It is, of course, directly comparable with the indexing of a document, but simpler in that questions normally entail fewer concepts.

The speed with which the document or information material itself is obtained once the reference to it (in the form of a UDC index entry) is located depends on the physical accessibility of these materials - a factor outside the scope of the UDC.

Intact Files

In both the classified and A/Z index, the file is intact. Entries, even if they contain brief abstracts, are not removed for use. But the index does not show if the document is immediately available except in the sense of stating, perhaps, that it is for reference only, not for loan outside the premises.

Feedback Provided by the System

In common with other pre-coordinate systems, UDC has particularly effective feedback facilities.

On consulting the classified index for a particular class

number, it is quickly seen how many entries are filed under it. If there are too many, the search can be narrowed at once by refining the search prescription. Conversely, if there are insufficient, or none at all, the search can at once be broadened. Whichever direction is taken - broadening or narrowing the search - two distinct methods are available: either the exhaustivity of the search prescription is retained, but the specificity of the elements is varied; or the specificity of the elements is retained, but the exhaustivity diminished by lowering the number of elements demanded at the same time, e.g., suppose the question asks for abcdefg, and on analysis it is seen that there are four different facets or hierarchies represented and that a is a species of b, d is a species of e and f is a species of g (as when the terms Delta Wing represent a genus 'wing' and a species 'delta'). To vary the specificity of this prescription means that the searcher moves up or down any or all the hierarchies to which the terms belong (e.g., being more specific by accepting only a slender delta wing, or less specific by accepting any kind of wing, or even any kind of aerofoil). To vary the exhaustivity of the prescription means that one or more of the categories are completely dropped; e.g., to ask simply for cdefg, or abde, and so on. Or the two operations could be mixed by removing one of the categories (ab, say) and at the same time being less specific in another category (asking for e alone, instead of de, say) to give the prescription cefg.

Whatever directions are pursued in this type of methodical searching, there is immediate response in that the size of the class at any given point is quickly apparent without benefit of a computer printout of document occurrence frequency. As can be seen from previous examples, if the first class consulted proves unsatisfactory, the systematic display of the file provides numerous suggestions for redirection of search. Hierarchical linkage with superordinate, subordinate and coordinate classes is provided for all the facets represented in a given search prescription.

The approximate nature of the material being traced is of course evident from the brief author, title and bibliographical description which appears on each document entry.

Nature of Final Output

UDC indexes provide only references to information in most cases, although brief abstracts are often included, and sometimes these may be quite substantial. Microcards can

also be filed in a UDC file, of course.

Quality of Output

Most UDC indexes are unlikely to have more than ten to twenty document entries under the same class number, but such a set of similar entries receives no ordering by probable relevance. Certain clues to the latter are present, however; the degree of match between the search prescription and the subject description of the entries 'retrieved' is the most obvious one. Titles and brief abstracts offer more clues; entries carrying the same class number are often filed chronologically, the latest work filing first.

The amount of irrelevant material in the final UDC output is only discovered on examination of the information materials themselves. But the evidence of the Cranfield experiments suggests very strongly that the level of noise is mainly a function of the recall-relevance ratio demanded by the searcher, rather than a function of the system per se. If high recall is demanded, more noise must be accepted. This high recall is achieved in controlled fashion in UDC by its class-widening devices, i.e., its pervasive display of hierarchical relations, allowing the searcher to move up to higher generic levels; its display of precoordinations in the form of subclasses of the primary term so that these can be ignored if the coordination proves restrictive (e.g., by ignoring the Parts facet of a term and examining all the subclasses concerned); its ready indication in the A/Z index of variant word forms (allowing, for example, the widening of a search for 'Conduction' in relation to a subject so as to include Conducted, Conducting and Conductivity also).

High relevance (a low level of noise) depends essentially on the precision, or specificity with which the classes can be defined by the indexing system. UDC provides facilities for this to a marked degree. Its devices for narrowing class definition are specificity in its basic vocabulary (i.e., of terms enumerated in the schedules), coordination (of terms from different categories), role indicators, and hierarchical linkage (allowing movement down a chain to terms more specific than are requested). At the same time linking or interfixing devices are inherent in its pre-coordinate form.

The noise inherent in a UDC system is the same as is inescapably associated with any documentary information retrieval system, i.e., the noise produced by the severe over-

lapping of all manner of concepts in the recorded information and the inevitable failure of a question prescription to match exactly the index descriptions of all the items which are in fact relevant to it.

Machines or Devices

UDC is basically for pre-coordinate indexes, usually in card or book form. A human being can scan an ordered file very rapidly indeed once the class number (the ordinal symbol which locates the sought item) is known. One item can be located with extraordinary precision whatever the size of the file. It is also an extremely flexible instrument for searching, in that the human searcher can re-program his search continuously and rapidly to take account of the response he is getting from the index.

For these reasons mechanized devices for selecting from a UDC index have little to offer except as a possible solution to the problem of the request which demands the bringing together of many scattered entries. These are catered for to a considerable degree by multiple entry which can anticipate many of the most likely demands. But there are situations when facilities for post-coordination would be very useful. Use of UDC on punched cards, with fixed field coding using abbreviated UDC numbers is described by Richens (op. cit.).

IV. APPLICATIONS FOR WHICH THE SYSTEM IS THEORETICALLY SUITED OR UNSUITED

A conventional, non-mechanized index is assumed.

Subject

Any list of UDC users will demonstrate that UDC has been found satisfactory in an enormous range of subject areas. However, the development of UDC in respect to the expansion and revision of schedules and their publication program has undoubtedly tended to favor science and technology rather than the social sciences and humanities. The somewhat severe criticisms made by Barbara Kyle in her paper (op. cit.) should be noted here.

Nevertheless, close specification of concepts in these latter fields is possible with UDC and the flexibility of its notation, which allows numerous alternatives in the classification of a field, is a marked asset here. For example, the Dewey and Library of Congress classifications provide different organizations of the field of literature. UDC can provide either of these (and numerous others, too) and the indexer may choose the one best suited to his needs.

For a special library using a special classification, UDC is still helpful in providing for peripheral areas to any degree of detail desired.

Access Points

The central weakness of UDC here is that it is a precoordinate system; i.e., the indexer must choose a certain, limited number of coordinations and hope that these will prove adequate to the search patterns his users' questions will generate. Three reservations are necessary to this implied criticism:

Multiple entry (permutation) can take care of the major alternative approaches to the collection. Several examples of how this is done have been given.

Experience suggests that a relatively modest degree of permutation (i.e., modest in relation to the theoretical possibili-

ties) can anticipate the great majority of sought coordinations in a given collection and thus obtain most of the benefits of post-coordination. The Cranfield test of the WRU system seems to give support to this view (see Aitchison, Jean, and Cyril Cleverdon. A report on a test of the index of metallurgical literature of Western Reserve University. Cranfield, College of Aeronautics, 1963, p. 55).

The problem of searching for distributed relatives (concepts which remain distributed throughout the file owing to their subordination to other, more frequently sought concepts) is made easier by strict adherence to a definite citation code (which establishes a high degree of predictability as to the whereabouts of these concepts) and the provision of a good A/Z 'relative' index.

Nevertheless, it would seem that for an area in which extensive and unpredictable correlation (coordination) of many different concepts is a regular feature of the search requirements, UDC is at a definite disadvantage compared with post-coordinate systems.

Shelf Access

Smaller libraries in which self-service conditions operate for much of the time, and in which detailed analysis in indexes is not undertaken, are likely to find the weaknesses in the order and collocation in UDC and its lengthy notation a serious drawback.

Size of File

The use of multiple entry as a solution to the second reservation named raises another evident limitation to the application of UDC in that it considerably increases the size of the file. A collection of 50,000 items, for example, using an average of five entries per item, would require a file of 250,000 cards. This brings serious problems of storage and may suggest an approaching limit to the size of collections in which fairly exhaustive indexing is practiced. (It has already been noted that a single UDC number may represent several different terms; e.g., 543.361.3 is equivalent to using the following terms: Chemistry, Chemical, Analysis, Analytical, Water, Salt content, Halides, Fluorides. So the use of several UDC numbers to index a document represents fairly exhaustive indexing, even with one entry.)

A reservation to this criticism of UDC is that excessive

file-size, with all its accompanying problems of physical bulk, adaptation to changing vocabularies etc., can be countered to some extent by the practice of making a chronological division of the file, e.g., beginning a new file every five years. This practice seems to be growing in favor.

Organizations with Numerous Scattered Service Points

The 3x5 card is not a convenient form of displaying an index if this index is needed at a number of separate service points. But the use of machine printout aids in the production of multiple copies of the index is of course perfectly consistent with use of UDC. (Installation 3)

Staff

The indexing of documents by UDC calls for a trained indexer and one who can acquire a certain amount of subject knowledge in the field concerned. The evidence of existing organizations (and of the Cranfield tests) is that specialist subject knowledge is not usually an essential requisite.

V. SUGGESTION FOR METHODS OF EVALUATION OF THE SYSTEM

Easily the largest and most thorough test of a UDC index ever to have been made was that made as part of the first Aslib-Cranfield Research Project, 1957-61, in which four systems were tested and compared.

The basic figures for the controlled variables on that test are as follows:

18,000 documents (research reports and periodical articles) in high speed aerodynamics and general aeronautics,
Three different indexers,
Indexing time varied - 16, 12, 8, 4 and 2 minutes per document were tested,
Three subprograms of 6,000 documents each, undertaken successively, allowed for evaluation of the learning factor.

Questions were formulated by experts and checked for validity by experienced information workers, each question being based on a document in the collection (the 'source document'). 1,200 such questions were used.

The test was to find out the percentage of source documents retrieved when the questions were put to the index. For example, one question was for "A comparison of alclad and unclad aluminum sheets riveted together and subject to fatigue loading." This was programed for searching as: 669.715: 620.178.3 (Aluminum alloys - Fatigue testing). The first search was for 669.715:620.178.3 and this produced 12 references - but not the source document. The second search was for 620.178.3:669.715 and this produced 32 references, including the source document. This was judged a success, penalized by the need to make a subsearch and by the retrieval of 43 other documents as 'noise.'

The following extracts from the numerous tables giving the search results give some of the salient figures for UDC:

Table 3.1 Total searches: 1,157
Percentage successes (i.e., source document found) 75.6

Table 3.2 Retrieval for various indexing times:

16 min.	12 min.	8 min.	4 min.	2 min.	
82	80	74	77	72	per cent

Table 3.8 Searches by technical staff (of cooperating bodies): 79.6 per cent successes

Table 4.9 Percentage of successes according to number of searches (programs) required:

No. of Programs needed	Percentage of successful searches
1	42
2	39
3	10
4	7
5	2

Table 5.4 Reasons for failures (given in percentages)
Question 13 Indexing 70 Searching 11 System 6

Some points to observe are:the surprisingly low figure for failures attributable to the system as such. Human error in indexing and searching was easily the chief factor in failure.

The effectiveness of the indexing at four minutes was borne out by supplementary tests by outside organizations. In a real life situation (the Cranfield indexers worked to a stopwatch) an allowance of six to ten minutes would seem to give very economical service.

The indexing was much more specific than the questions. Only one search in ten demanded more than two UDC elements, whereas over half the entries had been indexed with three or four coloned numbers. But see below.

"The main advantage of the classified arrangement appeared to be in being able to combine in alternate searches specific and broad concepts. The question, for instance, might be 'Buckling stresses of circular fuselages'. The specific heading would be 629.13.012.213.1:531.224.4 (circular fuselages - buckling stresses). If this failed, each concept could be broadened in turn, searching first under 629.13.012.213.1:531.2+ (i.e., stresses plus any subdivision of 531.2) and then 531.224.4:629.13.012.2 (Fuselages in general) or even 531.224.4:629.13.012+ (i.e., Aircraft structures plus any subdivision of 629.13.012). Such searches frequently resulted in success without paying too high a penalty in retrieval of irrelevant information." (Cleverdon, C. W. Report on testing and analysis of an investigation into comparative efficiency of indexing systems. Cranfield, College of Aeronautics, 1962.)

Table 3.8, showing the high score of successes by technical staff, suggests strongly that UDC notation is not too clumsy to be mastered by non-librarians.

The Cranfield UDC index enjoyed a particularly well-made and exhaustive A/Z index.

The great weakness of the test was its lack of figures giving the 'relevance ratio' accompanying a particular recall figure, since the production of these was impracticable in such a large-scale test. But small sample tests, in which all retrieved documents were assessed for relevance to the question concerned, seemed to suggest a relevance figure of between 6 and 14 per cent for documents of very high relevance; for wider searches, embracing documents of lower relevance, the figure was higher.

After comparison of four systems, Cranfield proceeded to test two working systems (not UDC) and in doing so developed a method of testing an index in which accurate figures for both recall and relevance were obtained. This method is suggested as being particularly appropriate for the evaluation of the operating efficiency of any UDC index. Its overall economic efficiency would require, in addition, accurate measurement of time and cost factors in the indexing, the physical establishment and maintenance of the indexes, and the searching. If such a test were made of installations in some typical subject areas, then the suitability of UDC for particular uses would be demonstrated.

Test Method

A selection is made (750, say) of documents in the collection. With the aid of subject specialists, and of library records of previously asked questions (perhaps with bibliographies attached), questions (100, say) are formulated, based on documents from the test selection. The relevance to the question of any other documents out of the 750 is now established by examining all the 749 others. It is understood that the source document itself is highly relevant. So for each question it is known that, in the 750 documents, a certain number are highly relevant to it, some more are fairly relevant, some more are marginal, etc.

The questions are now put to the index. The number of relevant documents retrieved via the index gives the recall ratio (the percentage of relevant documents actually found) while

the total number of documents retrieved during the search will give the relevance ratio (the percentage of documents retrieved which actually are relevant).

The figure of 750 documents and 100 questions can, of course, be reduced with some loss of statistical accuracy. How far this might be done is difficult to say, but it is certain that a reduction in the number of documents (to say 500) would be preferable to reducing the number of questions.

The essential requirement is for a number of questions to which the total answer available in the collection is known (a sample collection, that is) and to find recall-relevance figures for these. It is possible that this could be done by taking a relatively small sample of questions and making searches of extreme exhaustiveness, well beyond anything normally attempted, and comparing the performance under these conditions with normal operation.

In addition to these vital performance figures, detailed analysis of the retrieval failures and of the false drops should lead to a thorough appreciation of where the indexing or the searching might be improved. In many ways this analysis will be as valuable as the performance figures obtained above.

VI. SEMINAR PANEL DISCUSSION

The following are the main points which were raised and discussed by the Seminar.

Skills Required for Classifying by UDC

Mr. Benjamin Custer (Dewey Decimal Classification) wondered if the skills suggested as necessary were in fact learned easily. His experience with Dewey DC and with the H.W. Wilson Company indexes, where the staff were applying the simpler DC, did not lead him to be so hopeful. Just how easy is it?

Mr. Jack Mills replied that the bare bones of the problem of analyzing subjects into their categories or facets and the subsequent operation of combining terms from different facets to form a compound subject were simple. The literature itself suggests the categories in any area fairly clearly - after all, there are not that many different categories demanding recognition. At the North-Western Polytechnic, students were drilled in this sort of analysis for some four to six weeks before they even looked at Dewey. More attention to basic theory and less to the minutiae of particular systems could, he thought, make the training of indexers that much easier and better, without preventing them from seeing the wood for the trees. His impression was that American library schools tended to neglect, relatively, the teaching of the fundamentals of library classification. If the Library Association examinations in Britain had sometimes tended to overstress classification and cataloging, perhaps the Americans tended to understress these basic disciplines. (He would also add here that UDC is in many ways an easier system to use than DC or LC; e.g., the mechanics of synthesis, complicated in DC by its dropping and adding of zeroes, is less difficult. Facet structure is often clearer. Relatively broad classification can often lead to ambiguities which a much more detailed system is forced to clear up.)

Theodore Yerke (U.S. Forest Service) applying UDC in the field of Forestry said that nothing in his training at an American library school had prepared him for UDC and the

classified catalog. He was not surprised that Mr. Malcolm Rigby (American Meteorological Society) sent his abstracts to England to be classified. Mr. Rigby said that people familiar with UDC could index at the rate of 20 an hour. Add this to jet airmail facilities and a very rapid service was possible. Mr. Elton Shell, a Rutgers University student, also thought there was insufficient information on and study of the classified catalog in the U.S.

Dr. Harold Wooster (Air Force Office of Scientific Research) asked how an American library would recruit indexers if it adopted UDC and how long would it take to train them. Mr. Erick Hoegberg (American Viscose) said that in the course of organizing a technical correspondence and report service for a department concerned with polymer research he had compiled a small manual of the UDC numbers and devices appropriate to the material covered. From this, UDC numbers were assigned by authors to their own documents and this required very little training.

Dr. Ralph R. Shaw (Rutgers University) said that this problem was treated at the Engineering Societies Library simply as a problem of in-training which would be necessary to anyone going to a new system. But if library schools want courses, would there be a sufficient market for these skills? Mr. Rigby pointed out that the Russians, having decided to adopt UDC throughout a complete system of libraries, established training courses as a logical accompaniment. He remarked on the fact that the more items an organization indexed by UDC the faster and more efficiently it was done. Small organizations seemed less effective, e.g., in the facilities for using UDC enjoyed by editors of primary journals. Dr. Maurice Tauber (Columbia University) suggested that library schools with advanced programs could help through projects and sponsored studies.

Dr. Wooster wondered if "that agreeable institution, the summer course," might be the answer to the problem. Would an intensive two-week course, say, suffice? Mr. Mills thought it would. He said that in the recent past, a British library school might provide a part-time course for one session in which classification and cataloging were taught to a level sufficient to allow a student to use, inter alia, five different classification schemes, with reasonable competence - one of them UDC. The whole session might contain less than 100 hours instruction, and the theory of classification and the study of UDC together might account for less than a seventh of that

time. He referred the seminar to the details of the first Aslib-Cranfield Project in which UDC was one of the four systems tested. There, a young man, straight from library school and a county library system (in which detailed indexing would be a highly unlikely event)was indexing, in a more or less strange field (Aeronautics) with impressive efficiency within a few weeks. There was no reason to suppose that this was a fluke.

Mr. Rigby, with others, thought intelligence was the only thing that really mattered when looking for prospective indexers. Given that, the rest followed easily enough. Might not the resources of spare-time work at home be drawn on to solve the recruitment problem? Mr. Mills said that in one of the Cranfield investigations, all the indexing, which was of a very high standard, was done on a part time basis at home by a young married woman, with a family to look after in the bargain.

Mr. Hoegberg and other speakers referred to the filing of UDC numbers by clerks, and none of them thought this offered any particular problem.

The Subject Knowledge of the Indexer

Dr. Phyllis Richmond (University of Rochester), referring to the human element in indexing, emphasized how important might be the personal predilections and attitudes of the classifier. Sometimes, strong subject knowledge was essential; e.g., in a situation of heavy recall in which rapid scanning of numerous items was necessary. But in tracking down narrowly defined classes a good indexer might be preferred to a subject specialist. 'Scientists are about as broad-minded as paper-clips; each one organizes the world around his specialty and anything else either doesn't exist or is wrong; they suffer a congenital expectation that all the material on their specialty will be kept nicely together," said Dr. Richmond. The dispassionate indexer was better able to appreciate the needs of the organization as a whole.

Dr. Susan Artandi (Rutgers University) wondered just how much subject knowledge was needed by the indexer. Mr. Mills said that assigning class numbers was ultimately a clerical job, a matter of matching features in documents against a pattern of subject descriptions provided by the system. Dr. Artandi did not agree. Mr. Mills admitted that in some subjects more subject knowledge was necessary than in others. But there often came a point when it was basically just a match-

ing process. Dr. Artandi said 'subject knowledge' did not necessarily imply a master's degree in the subject and that the need for it depended partly on the desired level of analysis; one entry for a book might be simple, but ten for a short article might not be. But she did not see how an indexer could assign documents to classes if she were ignorant of the subject of the documents. Dr. Richmond said her experience was that one could - and had to - but the indexer had to know the classification thoroughly.

Other speakers agreed that the ideal was a librarian-indexer who was also a subject specialist. But the difficulty in recruiting such persons, Dr. Wooster said, was how to afford them in the first place and how to keep them once one had them.

Dr. Tauber said this combination was obviously ideal, but a real contribution of librarians to the organization of information is just this ability to work well in strange fields. At Columbia a cataloger might assign LC class numbers in subjects from A to Z, and they could do this because they worked systematically. Another speaker remarked that the ADI asked the authors of conference papers to assign six keywords to their papers, for a permuted index. But the area editors had to re-edit. Mr. Mills said that the subject specialist could be a menace in indexing. If his bias exactly coincided with that of the organization, well and good, but the likelihood was that it was a specialization in one direction only, whereas the organization might have many, as well as developing interests which demanded a wider view. He said Dr. Richmond and Dr. Tauber had reminded us how indexing in strange fields was a perfectly normal thing at book level. On the whole, UDC can be manipulated efficiently at all levels by indexers without specialized knowledge.

Dr. Wooster referred to the Weinberg report (Science, Government, and Information. A report of the President's Science Advisory Committee. The White House, 1963), which suggested that authors should assign their own twenty or so keywords. But when he heard of the fantastic figure of four minutes being adequate, often, to assign UDC numbers, he asked if it would not be more sensible to get journals to assign UDC numbers at source?

Is the UDC a True General Classification?

Dr. Wooster quoted De Grolier's assertion in his book (op. cit.) that UDC is really a collection of specialized classi-

fications, not a unified system, and more a system of nomenclature than a classification. De Grolier's daunting list of the different places at which special provision for "Measurement" had been made was an indication of the tendency to develop special little expansions.

Mr. Rigby quoted figures for the distribution of classes in UDC. Of the 130,000 or so in the full edition, 64,000 (56 per cent) were in Class 6 Technology and 35,000 in Class 5 Pure science; only 1,000 were in Class 4 Philology. This suggested a disproportion in the development of UDC. Mr. Mills pointed out that a more even balance between these and the social sciences and humanities was seen in the 2nd full edition (in French). Also, that the Common Auxiliaries of Place, Time and Race were very important facets in these other areas - much more so than in 5 and 6 - and that they had already been developed in considerable detail. The concentration on 5 and 6 was partly a matter of deploying the limited resources of UDC to develop those areas in which the need for precise detail was most urgent. If these resources were improved, the UDC would be better placed to remedy the lack of balance.

Regarding Dr. Wooster's examples from De Grolier, Mr. Mills said that the list of appearances of "Measurement" in UDC showed how inconsistent UDC sometimes was in its analysis and presentation of classes. The implication of such a list was that a concept like "Measurement" should feature once and for all in a common auxiliary, with a resulting economy in the printing of schedules (the original historic reason advanced by Dewey for his "divide like ..." devices which were the predecessor of the UDC Auxiliaries), in consistency, and in mnemonic notation. A number of UDC committees were urging the production of more such general auxiliaries, e.g., one for Materials.

On the international quality called for in a truly general scheme, Dr. Richmond, referring to the Western bias in UDC, cited the delta class Δ(delta) Spiritual experience and Mysticism in the Colon classification as an example of the sort of subject area which tended to be neglected in UDC because it did not fit in very well with a Western framework.

Mr. Custer referred to the mutual indebtedness of the DC and UDC as general classifications, and said that DC had learned from UDC in such matters as synthesis, the importance of citation order and greater flexibility. He stressed the nature of UDC as an aspect classification. It followed Dewey here and

it is surprising how many users fail to realize this fundamental feature; e.g., that there is simply no place for 'copper' or for 'United States' - only for aspects of these, such as copper ores, or history of U.S. Regarding Mr. Mills' strictures on the separation of Pure and Applied science in UDC (following DC), Mr. Custer said he disagreed. It is quite consistent with the 'aspect' principle and it is quite workable on the whole. Many technologies are based on a number of different sciences and collocation with all of them is impossible. For the same reason, the proposals now being made to move Class 4 (Linguistics) to Class 8 (Literature) so as to release a complete main class into which could be collocated sciences and technologies together (e.g., Nuclear engineering) are contrary to the principle of UDC.

Mr. Rigby mentioned the use of the Point of View numbers in the recent Russian Intermediate Edition (in which about 55,000 classes were enumerated) as an example of how flexible UDC can be in adjusting to radically different approaches. This edition prefaces all appropriate class numbers by a Point of View number representing Marxist or non-Marxist treatment of the subject. Mr. Mills said this use of the Point of View number was exactly analogous to the 'Systems' device used by Ranganathan in his Colon Classification. There, in classes like Economics, Education, Psychology, and so on, the primary facet is the System from which the subject is treated; e.g., SM97 represents Psychology (S) - Psychoanalytical system (M97). All psychoanalytical literature now files together, as sharing a basic approach. Such a device seems to be a necessary one for a general and international system.

Replying to Mr. Custer, Mr. Mills agreed on the UDC's debt to Dewey. The latter's insight into the mechanics of library classification had been extraordinary: there was very little, from facet analysis and notational synthesis to chain indexing and retroactive notation which could not be traced, in an incipient form at least, in the DC. Mr. Mills said all existing general schemes except the Brown Classification (now practically moribund) suffer the curious, elementary defect pointed out by Mr. Custer - that there is simply no place for comprehensive treatments of concepts distributed throughout many classes. Within a class, provision is invariably found (e.g., within Pathology, a place for Biopsy in general as well as for Biopsy of a particular pathological condition); but there is no comprehensive place for distributed concepts such as Water, Petroleum, U.S., Child, Metal. UDC occasionally provides an explicit instruction as to where to put such docu-

ments, e.g., one covering Forestry, Timber and Timber technology is placed under Forestry in 63 on the score that the 'comprehensive' number should go with the production of a material rather than its processing.

Mr. Mills agreed that a consistent system for collocating every technology with its science is impossible. But there are some cases where separation leads to much irritation over the ambiguities of overlapping classes (e.g., 54 Chemistry and 66 Chemical Technology - although some indexers consider it workable).

UDC and Machines

Dr. Richmond said that although superficially UDC notation is suitable for computerization, it does not really need all the calculating facilities of the computer. What is needed is a super-collator, with many accumulators and a large store capacity.

Mr. Rigby said that Meteorological Abstracts began using UDC in 1949. At first he hated it, he said, but as is the case in some situations, he had learned to appreciate its advantages. Now, using an IBM 1401 computer, printouts of the titles were obtained regularly, listed in UDC order and with a certain number of references included. To this had been added the production of cumulated and selective lists; e.g., the Bibliography on Meteorological Satellites (1952-1962) contains some 1,000 abstracts with Author and Title and alphabetical subject indexes as well as a UDC index. The sorting of this took a 7090. They now have 35,000 cards punched, in 15 languages, for classes 52 Astronomy and 55 Geology.

The U.S. National Committee on the FID is concerned to see the UDC in good shape so that if it is introduced into the U.S., it will be available - and not only vintage 1943-63. To this end they are exploring, with the aid of a grant from N.S.F., the problems of producing UDC schedules, as well as UDC indexes. They hope to tape the entire 120-130,000 classes of the UDC and to use machines to control not merely the production and constant updating of single language schedules, but also the multi-language editions (involving the comparison of abridged editions in Swedish, Dutch, German, English, Finnish, Japanese, etc.) and of interest-profile schedules (excerpt schedules). The biggest item in the initial cost is the programing - the cost of key punching is a relatively minor one.

Mr. Mills said that the use of computer printout facilities described by Mr. Rigby was undoubtedly the most helpful use of these machines in information retrieval at the moment. Implicit in what Mr. Rigby is doing is the great convenience of the printed book form display of UDC indexes. For most requests the human scanning of such an ordered index, with its extraordinary ability to pinpoint particular classes very quickly and to alter the direction of the search at a second's notice if what was being found suggested such a change, is still the simplest and quickest way by far of retrieving the relevant references. When an exhaustive request is received, as is answered by the Bibliography on Meteorological Satellites, a conventional search can still locate them quickly enough, but the great convenience of getting the answers directly in the form of the printed bibliography is undoubted. Regarding the production of UDC schedules, he was delighted to think that there was a prospect at long last of a full edition being available in English. Perhaps it would act as a spur to the British to hurry up and complete their edition before they were overtaken by events. The real significance of the developments described by Mr. Rigby was not that a most obstinate problem might be solved by machines as such, but that after many years of operating on a level of chicken-feed or peanuts (as Dr. Wooster referred to it) substantial resources might now be marshalling behind UDC.

Mr. Hoegberg mentioned another way of keeping the UDC index and schedules in book form, yet up to date. At FMC Corporation, additions and amendments were made to a card index and this was photographed with a sequential camera.

Mrs. Helen Brownson (National Science Foundation) wondered whether, in the event of getting the entire UDC schedules onto tape, this would afford facilities for further research on UDC or on general problems of classification. Mr. Rigby said a computer could do a number of things as a complement to producing schedules on tape. For example, it could produce an A/Z index to the first word in any UDC definition, e.g., if 551.593 is Optical phenomena, the computer could pick up all the subsequent terms, whatever the language. It cannot do what the experts can do, that is, read into a concept something that is not in the vocabulary. But it can turn out an index. Also, it can index any word following a period. In doing these jobs, it can calculate the frequency with which a term (e.g., 'temperature') appears, and the frequency of use of various headings. These can be compared with other systems.

Royal Dutch Shell is putting the full German edition onto tape; so clearly, it was thought to be worth doing, for its aid in translation, study and revision.

Transferring to tape also assists editing by showing up errors and omissions. For example, one could feed in an up-to-date glossary of terms in a given field and run the tape against this to show what is missing in the UDC.

Mr. Mills thought that information on frequency of occurrence of terms and categories and their distribution might be useful, in the same way that Mr. Rigby's comparison of glossaries would be. It might disclose situations in which relations not explicit in the UDC ought to be made explicit. Mr. Rigby's example of Temperature was a case in point mentioned. It would only be picked up if it had been explicitly included in the UDC heading. But in UDC 621.7 (Workshop practice), for example, which is largely about Metals, the term Metals does not occur explicitly and would be missed by a computer.

Mr. Rigby said that he had a very large file indeed of English words on tape. Comparison of all these with UDC vocabulary might be a $100,000 project, and he could not say whether UDC would like it; but we would at least have the English language well nailed down by them.

Use of UDC

Dr. Tauber noted that general libraries tend not to use UDC, even in their specialised divisions. In the U.S. there has been extensive reclassification; but as a rule libraries turn to the Library of Congress scheme for greater depth. Mr. Mills suggested that the link with the DC and the copyright relations agreed between the two systems had probably held up the spread of UDC and he hoped something would be done about this. Libraries using various editions of the DC have found classification increasingly costly and there are clearly advantages in the centralized classification of the sort possible with the UDC. But as a system for shelf arrangement the notation seemed to offer difficulties.

Mr. Mills said that American libraries, throughout this century (since Dewey lost the fight for classified catalogs to the new Library of Congress card service), had looked to the alphabetical subject catalog for indexing analysis of materials, and classification had become for them only a method of shelf arrangement. This was not true of Europe in general, nor

Britain in particular. We should not neglect the assistance shelf arrangement gives in retrieval; it does a great deal of donkey-work at the self-service level. But UDC has little to offer here. In its collocation it is generally inferior to Bliss and in some ways to the Library of Congress too.

Dr. Tauber thought it a mistake to assume that a library must have only one classification. Dr. Shaw suggested obtaining the benefits of the centralized cataloging of Congress cards, with ready made class numbers for shelving, and use UDC for detailed analytical indexing. Mr. Mills agreed. Classification is not an end in itself. We should choose those schemes which best fit our needs and if this calls for a mixture and we can make up this mixture economically, then we should certainly use it. We might add to Ranganathan's five laws of library science a sixth: 'To each reader his own classification.' This might sound impracticable; but the benefits of a classification as a map of the information field to be explored does not necessarily demand physical implementation in a classified index. For the latter, we might have a relatively 'neutral', all-things-to-all-men system (and UDC would fit this bill?) and have tables of equivalents leading from a great variety of special 'profile' classifications to the neutral one. Perhaps computer facilities might prove helpful in such an arrangement.

Dr. Shaw said it is easy to be alarmed and put off by the sight of the notational complexities of UDC. But the great batteries of auxiliary devices are never firing together; in practice users quickly adapt themselves. As to Dr. Shaw's suggestion, Mr. Mills agreed. He added that although American libraries have favored the alphabetical catalog for their detailed analysis, it has never really been all that detailed. The principle of specific entry has been advanced by Cutter with some pretty hefty reservations, and these have led to the neglect of the basic principle. Mr. Mills said he always thought of the extraordinary example dug up by Mostecky in which a special law collection had over a thousand entries under the general heading 'International law,' most of which were on quite precise subclasses of that subject. In this respect UDC seems to have an edge on the alphabetical subject catalog. It is also a contributory factor, probably, to the speed and thoroughness with which advocates of machine information retrieval have invaded what has always been the province of librarians.

Dr. Tauber wondered whether UDC might help in the development of encyclopedias. His experience in the production of detailed indexes to these, making sure that a host of

detailed connections were provided in the see also reference structure, suggested that UDC might prove quite a help in getting at the more specific areas. Mr. Mills said that alphabetical arrangement has its own elaborate pattern of associations; it is not unlike the Brown classification in which all the aspects of a 'concrete' are collected together, but without these concretes being systematically arranged. In both cases a term like Petroleum, for example, draws together a large number of aspects - scientific and technical, commercial, social. Nevertheless, the 'distributed relatives' of the alphabetic file need to be linked in some way just as those in UDC do. The logical basis for such syndesis is a systematic map of associations, and the UDC can act in this capacity. Moreover, if an alphabetic catalog attempts to develop real depth in analysis it will require decidedly more coherent and stringent rules for citation order in subject headings than are provided by, say, the Library of Congress list. One way of securing such rules would be to produce subject headings from a UDC index in the way chain index entries are produced.

Dr. Wooster confessed to having approached UDC originally with the traditional prejudices of the documentalist against decimal classification. One of the problems of the latter is that there is one unique place for an item and much of the travail comes in finding this one best number. But in this world there are very few 'one best things'. His ideas on UDC changed, however, on visiting IDAMI, a documentation institute in Milan, run by Paola Terzi, in which a million items, perhaps, are indexed by some four and a half million cards. Terzi uses UDC as he (Wooster) would use subject headings; he assigns to each document a series of UDC numbers and places an entry for it under each of these numbers. This, together with the production of abstracts, is done remarkably inexpensively. Since seeing that it is possible to use UDC without having to fight for the one best item, he has taken a fresh look at it.

Now, reflecting on the effort put into the development of thesauri in recent years, he wonders if a similar effort had been put into developing the UDC instead, we might not be further ahead in controlling our information than we are? Mrs. Brownson asked whether the special language of the UDC and its structure represent a language resource which has not been exploited in the development of the thesaurus as a method of displaying relations. Mr. Mills thought this likely; for any given term, UDC generally provides a relatively full hierarchy from which the searcher can select those classes he thinks

likely to be relevant. But a thesaurus, as a rule, provides only a selection of terms to jog the memory of the searcher; it is much less thorough in this sense. It is true that a thesaurus establishes connections (by references) which in the UDC can only be arrived at indirectly, via the A/Z index. But UDC can show the connection and can easily make the connections as direct as in the thesaurus (by using cross-references in the schedules, or classified index).

UDC and Languages

Dr. Artandi remarked on the heavy dependence of UDC on natural language which seems to be implied by Mr. Mills' emphasis on the need for a full A/Z index. What is the quality of the A/Z indexes in the various languages and do they influence the quality of the indexing? Mr. Mills said that the extensive international cooperation in the preparation of schedules and in their maintenance should lead to the terms represented by a given UDC class number in different national editions being as near as possible synonymous. However, in the social sciences, at least, nuances of language and usage have produced a certain number of discrepancies. Barbara Kyle's paper (op. cit.) gives examples of this.

Dr. Artandi doubted the claim, expressed by some, that UDC is independent of language because it is a notational system (a 'decimal classification'). Mr. Mills agreed. UDC is not a notational system, if this expression implies that the class definitions, subject descriptions, in the UDC are in some way dependent on the notation. He thought the real problem here is how, using the relatively imprecise terms of the natural language, we can provide precise pathways to the classes we have established. For example, in one widely used English encyclopedia there are separate entries for Social anthropology and Ethnology, each having a lengthy (and different) description. In another equally widely used one there is a see reference from Ethnology to Social anthropology. A classification can avoid confusion in such a case by taking certain precautions. Scope notes in the schedule to define the exact meaning recognized by the system, provision of subclasses which reinforce this definition and do not conflict with it; entries in the A/Z index which lead directly to the correct class whatever term is consulted; e.g.,

Social anthropology	39
Social anthropology: Races	572.9
Ethnology	572.9

When, having established a class with some degree of precis-

ion, we assign a class number to it, this number is a convenient shorthand form whereby we can refer to this complex of information comprehended by the class. The class number is the same, whatever natural language is used, and it is this greater air of neutrality perhaps which leads people to think of the notation as a fundamental determinant of the system. *It is* not. It is just an appendage - an important one, undoubtedly, but only an appendage - which shows in a quickly recognizable form the position of each class. But it is the meaning of the class which determines the position, not the notation. The class 'London' follows 'England' in UDC because of the containment relation between them as concepts not because London is (421) and England (42).

As to different language editions, Dr. Artandi suspects further difficulties. Mr. Mills said he was sure she is right. "At the Dorking conference in 1957 there was a long argument about the terms 'codification' and 'classification' and whether the first (French) term was really better, as comprehending our subject more accurately than the latter. But this is still only an aggravation of the basic problem: that the natural language is used more loosely than we would like it to be used when searching for information. By forcing documentalists to 'define by enumeration' (which is what a classification does) the UDC performs a very useful function, I am sure, in establishing some regularity and predictability in our use of terms," Mr. Mills said.

Dr. Theodore C. Hines (Columbia University) said classification is in a sense a linguistic problem, that the schedule does depend on language, not on notation. But this is a new idea to many Americans who have always tended to think of classification simply as a shelf notation. Looking at the classified catalog (but not when reading the literature) what struck him was the need for a host of alphabetical controls to the classification scheme, to the authority file, to the classified index. Did Mr. Mills think that the classification can be any better in the long run than the quality of our understanding of the alphabetical approach? Dr. Hines wanted to know.

Mr. Mills said he was not sure that he really understood what the alphabetical approach is. If we have not in our mind a really clear definition of a particular subject class then our classification is bound to be muddled and our approaches to it through natural language that much more confused. But 'alphabetical' here is really analogous to 'notational.' The alphabet gives an ordinal value to the letters of our natural language

terms and enables us to locate these terms easily - to see that London comes between Lollards and Loneliness, and miles away from England. It is a notational device for locating these terms in an ordered file, he thought.

He agreed that the ability of the user of the A/Z index to see just what concatenation of terms was likely to be the best one by which to enter the classification was important. This was one advantage of chain indexing; it gave a predictable alphabetical approach in that anyone familiar with the basic citation order in a subject knew where to look - knew, for example, that Insects:Pests:Storage:Grain would give direct access to the class in the classified index (i.e., would give him the specific number), whereas looking under Pests..., or Storage..., or Grain would only give him part of the number, so that the rest of the route would have to be found after reading the classified index.

Another person asked whether the classified schedule could be used without consulting the A/Z index. Mr. Mills said it could. Again, it was a question of citation order. A group to which he belonged was preparing a classification of library science: this had a formula, a citation order. The library service comes first, then the library material handled, then the library operations involved, then where it happens and when. As usual, certain basic principles of order are incorporated, such as the subordination of agents to the jobs they perform. If a request is received for something on the use of computers in indexing chemical literature, then, without any reference to the A/Z index, you know it will be located under chemical literature, indexing of, use of computers. The structure of the subject is laid open by this sort of analysis. But suppose the request is for literature on the properties of a particular plastic. You know this will be under the plastic, and you may know just where the Materials facet is located in the classified index. But if the plastic is one of a hundred odd materials, its location in that array of coordinate classes may not be familiar to you, and so the A/Z index is consulted.

Dr. Artandi said the quality of the A/Z index did, then, determine the effectiveness of the search to some extent. Mr. Mills agreed; but if the A/Z index failed to recognize a precise term which was being sought, there were many other points of access to be tried. It was usually possible to get within some distance of the precise subject, but the relevance ratio inevitably suffered if a larger class had to be examined. But the ambiguities of language and common usage will always be a

central problem in information retrieval; a classification like UDC remedies them partly by referring things to systematic contexts. If the reader asks for 'Rockets' but really means 'Missiles' he will soon find this out when he finds the context is one of engines only and not vehicles, and the A/Z index often provides this sort of 'classification' by its qualifying terms.

Dr. Wooster said we could think of UDC as being an intermediate language into which we translate. We could go from an English term to its UDC number and from that to its subject description in other languages. He had been to a meeting in London where a speaker quoted UDC numbers and everybody applauded. They all knew the numbers. In France they are seriously proposing the use of UDC as an interlingua for mechanical translation, possibly as a pigeon type language. Mr. Rigby referred to a meteorological glossary which was produced in just this way; the World Meteorological Organization subscribes to UDC and 75-80 per cent of the services use it. The French circulated an alphabetical list of terms with UDC numbers attached, to act as a means of definition; the numbers have a more concrete meaning than the words. A three-language glossary emerged and this could be translated into other languages, too. If one has a large enough alphabetical index, one must have a systematic or hierarchical guide to it. If one has a large enough hierarchical system, one must have an alphabetical guide to it. Dr. Wooster did not see why there was any argument about it.

Dr. Shaw said he would call it a pigeon-toed language. He had worked with UDC for seven years, and it worked. But when searching, one could never go to just one section of this logical language and stop there. One cross-referenced it just as in an alphabetical subject catalog. The words do not have a logical, hierarchical, sequential meaning. There are two advantages of UDC, he thought, which are notational. By using class numbers, not English, there is no argument about the logical or illogical arrangement in the catalog. "Your users don't see the relationship quite as clearly, so you could get away with murder," he said. Also, it saves the administrative chore of pulling out individual cards and erasing subject headings when they change. If 'wireless' changes to 'radio' the latter is added to the A/Z index and that is all.

Dr. Wooster had previously quoted De Grolier as saying that UDC was more a system of nomenclature than a classification. Librarians who content themselves with words from documents, Dr. Wooster said, seek to avoid the problem of

concepts. But Mr. Mills' distinction (in his paper) between the analysis of ideas and the synthesis of concepts baffled him. Ideas he thought were highly personal. Mr. Mills said he had not intended to draw any hard and fast distinction here; the phrase 'analysis of ideas' was in fact a quotation from the Introduction of the English Abridged edition and neither this phrase nor 'concept' has been used with any particular sense of precision beyond trying to convey that UDC is based on an organization of the information content that documents describe, in terms of abstract classes, rather than on the physical documents as such. In this sense, it tries to go beyond the mere words used in the documents.

Mr. Rigby thought that the neglect of UDC in the U.S. was due partly to the fact that Americans, enjoying one language, did not realize sufficiently the problems raised by the use of many different languages and the usefulness of a neutral, intermediate language as an aid to retrieval in such a situation.

Development of UDC Schedules

Mr. Frank M. Marson (Library of Congress) raised the question of availability of the tools. "With half a dozen people indexing by UDC and having to work from different editions of different schedules and without the full edition complete, it was a pain in the neck," he said. He hoped something was being done about it. Mr. Rigby agreed, saying he had suffered the situation for 14 years. He said three ways to overcome this were being tried; firstly, by getting the British Standards Institution to produce an up-to-date, full English edition. Secondly, by getting out a profile-of-interest type of schedule for any area concerned. Thirdly, by the experiment he had described, of putting the whole UDC on punched cards and tapes. Ultimately, and this might be within two or three years, and with improved typographical computer printout, the whole thing can be done. On the other hand, Mr. Rigby had referred earlier to the ability of Dr. Schuchmann to produce new or special editions of the German UDC within a matter of weeks and without the benefit of machines.

Mr. Mills referred to the existence of some 'excerpt schedules' as they are called in Europe, such as the ABC (for Building, Civil Engineering and Architecture) and one for Forestry, and said one for Metallurgy was likely to be on the way. The Germans had one for the Paints industry. He added that users of the UDC in the U.S. should not forget the possibility of obtaining type-script draft schedules of the full English edi-

tion by writing to the British Standards Institution. Some of these drafts are in substantially the same form as they will be when finally published. Mr. Mills, referring to Mr. Rigby's praise of the Russian intermediate edition as being the most up-to-date one available, said that other national committees are planning such editions too.

On the 'intellectual' aspects of developing the schedules, Dr. Richmond thought that UDC should be more enterprising in inserting new interdisciplinary fields, like brain research and space science, directly into the schedule, rather than specifying them by complicated faceting procedure. She also referred to the difficulties of recognizing classes before they actually appeared in the literature. The Library of Congress, waiting on literary warrant, does not try to project into the future. But this must be true also of the logical classifications. Nothing can be classified until it is recognized and described. And since minds differ, the world looks different to people in different cultures, so UDC will have to make concessions to non-Western ideas if it is to be a truly international system.

Mr. Mills said that a common complaint about classifications is that they must always be behind the times, have no powers of anticipation. He thought this criticism was probably overrated. He quoted the experience of D. J. Foskett who prepared a faceted classification for packaging. This included a Materials facet and an Operations facet. In the latter Extrusion appeared since there was an obvious literary warrant for the extrusion of metals, etc. A short time after the classification was put into operation a new process was developed for the extrusion of paper. There had been no literary warrant for this at the time the schedule was made, but the class number was waiting for it, a synthesis of the number for paper and the number for extrusion. The analysis of a subject into categories reflected relatively fundamental and stable features of those subjects and so long as the relatively elementary concepts were scheduled, what they might combine to form could always be accommodated, just as new chemical compounds were readily accommodated, in the system of descriptive formulae already available. Nevertheless, the notion of literary warrant is a very valuable one, since it provides us with an automatic control on the exuberance of our imagination - for the human mind is capable of infinite classification and hair splitting. Literary warrant suggests to us where we might stop. As for new syntheses, they are undoubtedly a problem. To borrow an example from Barbara Kyle, today we are content to synthesize a class number for Teaching-Machines. Tomorrow, the subject

has blossomed (for which any teacher must be deeply grateful) and is developing particular kinds of such machines. At this point it becomes convenient to do what Dr. Richmond asks and provide it with a decently simple class number. As to its location, this will often be just where it has developed. But the problems of notation here are rather tricky and all we can be sure of is that it can rarely be done if the notation is to be kept hierarchical.

Specificity in UDC

Dr. Artandi asked how specific can one get in UDC; for example, can the indexing get down to the level of a single organic compound? Mr. Mills replied that maximum specificity was a fundamental aim of UDC and in most subject fields could go as far as almost anybody wanted. In chemistry, the development of the apostrophe device made the specification of elaborate compounds easier than it had been, but naturally the symbols began to get cumbersome. There was evidence to suggest that a point might be reached here when the weakness of a pre-coordinate system compared with a post-coordinate system became significant. Dr. Artandi did not agree that a post-coordinate system would be necessarily stronger on this. Mr. Mills said he did not think this point was reached half as quickly or as frequently as the advocates of post-coordinate systems had suggested.

Mr. Rigby thought the usefulness of the UDC declined when you started abridging it. Specificity is one of its strong points. Mr. Mills agreed, and said we should never forget that it was this feature of an indexing system which determined the top limits one can reach in relevance. Money might be saved by economizing here at the input stage and classifying relatively broadly. But the price is paid in more noise when searching. Dr. Wooster said that if there are many documents in a particular class one must go deep. If there are a few, why bother? Mr. Mills agreed; in most UDC libraries one found deep indexing, using the fullest possible schedules, in the area of special interest. In marginal fields, where holdings were few, the Abridged edition was quite sufficient.

Performance of UDC

Mr. Jose A. Cordero (Lederle Laboratories, American Cyanamid) said that we continued to discuss the system as such, but the indications are that usually we cannot get a proper answer in 20-25 per cent of the cases, and when we analyze why,

we run into human factors in the indexing and searching. Should we not be doing more research in the human factor area rather than bothering about our system, which tends to operate at a high efficiency?

Mr. Mills said he agreed that the system as such was less important than we have generally thought - perhaps very much less. But it is not unconnected with the question of human error. If the indexer finds himself in a particular area, a systematic map or schedule of that area can obviously act as a memory-jogger, minimizing a chance of something being missed, and aiding decision. Also, there are likely to be considerable differences between systems as to their convenience for particular kinds of collections, particular types of users and in particular situations, and these questions have certainly not received any final answer.

The seriousness of the problem of human error is undeniable. When the detailed analysis of the reasons for not finding material in the Cranfield investigation first appeared, he, like any other teacher of cataloging, was amazed at some of the examples of the errors in indexing and searching. Yet there was plenty of evidence to show that the Cranfield indexers were very good indexers. So what might research into human factors disclose - that we are all prone to error? Mr. Cordero replied that work has been done on how to compensate for certain types of human error, on how many times a particular thing had to be done to achieve a certain degree of accuracy. Statistical studies have been made in many fields in which large variables of human error and physical factors entered. By statistical design and analysis, methods can be sought which give whatever particular percentage accuracy you want. He thought this could be done in relation to humans indexing. He thought the figure of 75 per cent recall showed a poor performance. Mr. Mills said any figure for recall alone was quite inadequate. To achieve 75 per cent only meant that this is what was found when a certain standard of relevance was insisted on. If demands are less stringent and one is prepared to sift through more material, recall could always be improved. Mr. Cordero had said, referring to the 'inverse ratio', that it seems that whatever refinements we make in our system they will not make much difference. But in the Cranfield Western Reserve University test the figures for failures due to errors in the indexing language as such (into which category UDC falls, of course) were almost double those reported in the first project (moving from 7-8 per cent to 13-14 per cent). If we examined other systems this figure might show further variations. The Cran-

field investigation had been into operating efficiency. Other factors entering into overall economic efficiency have yet to be measured. Meanwhile some system is clearly necessary for any organization and information store and our further study of particular systems seems well worth while.

Mr. Rigby said his experience certainly bore out the figure of 75 per cent recall. This suggests we use several systems, as has been suggested. If we add alphabetical subject heading it might go up to 85 per cent. If we add an author index it might go up a little more and the same for a geographical index. For really exhaustive coverage we might add citations and be approaching 100 per cent. Mr. Mills said it was dangerous to refer only to recall. One hundred per cent was always achievable, independently of the system, if we are prepared to accept much more noise. If what we want in a given situation is the cream of the relevant material, something good on a subject, quickly, then the system is very important, for only an indexing language which allows high specificity will allow this high relevance. Every organization should attempt to decide some conscious policy as to the amount of noise it can tolerate for a particular level of recall. But the two factors must be considered together.

Regarding Mr. Rigby's other point, he fully agreed. He had been talking to Dr. Kessler of the Massachusetts Institute of Technology not long ago and he was investigating almost exactly this; i.e., operating half a dozen quite different indexes to a given collection in order to see just what retrieval power they could generate in aggregate.

APPENDIX 1
DESCRIPTION OF UDC INSTALLATIONS

Installation 1

Research laboratories of a large industrial concern. Has used UDC for 30 years.

Type of material covered:
Books, journal articles, abstracts, etc. (shelved by UDC)
Periodicals, reports, translations (not shelved by UDC)
Major subject areas: Electrical and mechanical engineering, Metallurgy (including physical metallurgy), Physics
Secondary subject areas: Mathematics, Chemistry, Nuclear engineering, Workshop practice
Marginal subject areas: Economics, Factory and industrial management (including Welfare, Education, Training)

Amount of material covered:
9, 000 books, plus 300 added annually
95, 000 journal articles, abstracts, etc., plus 5, 000 annually
8, 650 reports, plus 300 annually
4, 750 translations, plus 380 annually

Files:
UDC index for all categories
A/Z subject index to BS 1000A:1961 and to the separate sections of BS 1000
Author index for books and journal articles
Title index for periodicals
Accessions register, chronologically by acquisitions
Reports are filed by series number
Translations are filed by series number, with additional A/Z index by source reference

Equipment: 3x5 cards

Classified index entries - ratio to document items:

Books	1.25	per	item	+	1.1	others	(e.g.	author)
Journal articles etc.	2.1	"	"		1.1	"	"	"
Reports	2.0	"	"		1.0	"	"	"
Translations	1.7	"	"		2.0	"	"	"

Number and types of request made of the system:
10,000 questions are put to the collection each year
85 per cent are for 'something' on a fairly definite subject
10 per cent are for 'something' on a more specific subject
5 per cent are for everything on the subject in the library - i.e., demand exhaustive search

Costs:
3,400 man hours (professional) annually
Indexing staff: 1.8 persons
Clerical staff: 1 person part-time (approximately half-time)
Materials: 30£ per annum

Indexing and searching time:
Indexing: Classification by UDC takes on average 4 1/4 minutes per item for books and periodical articles; 7 minutes for reports; 9 minutes for translations
Searching: 18 minutes on average. Of this, some 7 minutes are taken in locating the items in the catalog

Cost per search: not available

Use method:
Most requests are answered by the journal articles file
18 per cent of requests are answered by direct consultation of UDC shelves
Average number of concepts demanded in a search is 2.6
Reference is not always made to the A/Z index first. The rule is to check precise classification in the schedules first.

Installation 2

A large research establishment. Has used UDC for 17 years.

Type of material covered:
Books, periodicals, periodical articles and abstracts, reports
Major subject areas: Nuclear science and technology
Secondary: Almost the whole of pure and applied science
Marginal: Economics, management

Amount of material covered:
14,000 books plus 1,300 annually
13,800 periodical volumes, plus 1,700 annually
30,000 separate articles, etc. plus 1,600 annually
250,000 reports plus 37,000 annually (but heavily weeded annually)

Files:
UDC indexes are kept for all categories except those reports which are covered by Nuclear Science Abstracts
Author indexes to all material
A/Z subject index separately compiled. A new one was begun some five years ago and now totals 6, 000 entries.
Report number index

Equipment: 3x5 cards

Classified index entries - ratio to document items (estimates only, but fairly reliable):

Books	2 per item	+ 2	others (e.g. author)
Journals	1 " "	" 1-2	" " "
Articles, abstracts etc.	2 " "	" 2	" " "
Reports	2 1/2 - 3 " "	" 4-5	" " "

Number and types of requests made of the system (covers enquiries addressed to Information Section, but omits those addressed to Reading Room counter):
2, 000 questions annually
Less than 5 per cent are for 'everything' on the subject - i.e., demand exhaustive search

Costs: not available

Indexing and searching time:
Indexing: Classification by UDC takes on average 7 minutes per item for books; 5 minutes for a periodical; 10 minutes for an article; 15-20 minutes for a report (including abstract)
Searching: About 60 minutes on average

Costs per search: not available

Use method:
Between 600 and 700 questions are answered via UDC files annually. Abstract journals are used usually to retrieve journal articles
Average number of concepts demanded in a search: between 1 1/2 and 3
Reference is always first made to A/Z subject index unless the concept is so well known as to have its number remembered

Installation 3

A government library. Has used UDC for 19 years.

It processes and distributes books and pamphlets to 18 regional sub-libraries as part of its work

Type of material covered:
Books (shelved by UDC); periodicals; periodical articles; reports; trade catalogs; photographs
Major subject areas: Architecture, Building, Engineering, Ancient monuments
Secondary: Archeology, Pure science, Management, Labor, Legislation
Marginal: Sculpture, Painting

Amount of material covered:
10,000 books + 400 annually (i.e., individual titles); 540 periodicals + 540 annually; 5,000 periodical articles etc. + 250 annually; 60,000 reports + 3,000 annually; 8,000 trade catalogs + 1,200 annually; 250,000 photographs + 20,000 annually.

Files:
UDC indexes for books, periodical articles and pamphlets, etc., and reports
A/Z subject index separately made
Author index for books, periodical articles and reports
Name index to periodical articles
Accessions register, chronologically, for books
A fortnightly bulletin of abstracts of selected periodical articles is published, arranged by UDC and consolidated annually
Alphabetico-classed subject index to photographs (of buildings, mainly)

Equipment: 4x6 cards

Classified index entries - ratio to document items:
1.8 entries per item + 1.5 for others, e.g., author

Number and type of requests made of the system:
Some 14,000 questions are put to the library each year and some 15,000 to the regional collections
Some 4,000 are answered via the UDC files in each case
25 per cent of all requests are subject ones
About 2 per cent only demand exhaustive search for everything on the subject

Costs:
Indexing staff: 3 professional, 2 clerical assistants
2 typists, 1 photo printer (half-time)

Indexing and searching time:
Indexing: an overall average for classifying is about 2 1/2 minutes per item. Maintenance of UDC takes about 3 days annually
Searching: 45 minutes for a major enquiry (500 annually), 5 minutes for a minor enquiry (14,000 annually); of this time, some 90 per cent is taken in locating the reference in the index and ten per cent in subsequently obtaining the documents

Cost per search: not available

Use method:
Reference is first made to the A/Z subject index
About 50 per cent of requests are answered by pamphlets, etc., 35 per cent by periodicals and 15 per cent by the books on the shelves. Direct reference to shelves accounts for about 5 per cent of answers.

Installation 4

Industrial company library - technical information unit.
Has used UDC for 15 years. Operates a 'current awareness' service (as well as retrospective searches), sending photocopies of abstracts to various specialists on subjects of continuing interest to them

Type of material covered:
Abstracts of periodical articles
Subject area: Physics and engineering

Amount of material covered:
Approaching 500,000 abstracts, with 25,000 added annually; average length, 120 words

Files:
UDC index
A/Z subject index separately compiled
No other files

Equipment: 3x5 cards

Classified index entries - ratio to document items:
Two per item

Number and types of requests made of the system:
About 1,000 questions are asked annually. Most of these de-

mand a thorough search.

Cósts:
One graduate indexer, two clerical assistants, three typists, one photographic operator
1,000 entries are prepared each week

Indexing and searching time:
Indexing: varies from seconds (the indexer knowing the UDC number by heart) to 15 minutes. Average about 3 minutes per item.
Searching: varies widely

Cost per search: not available

Use method:
Reference is first made to the A/Z subject index only when UDC numbers are not known
Average number of concepts demanded per search: 3

APPENDIX 2
GLOSSARY

Auxiliary: in UDC, a set of classes provided with a distinctive notational indicator (e.g., hyphen, brackets) enabling them to appear (individually) as subclasses of other classes at specified places in the system. Their appearance may be restricted to a particular class (e.g., - 4 represents shape only in classes 62 and 66/69) or may be unrestricted (e.g., (73) U.S.A.), giving rise to Special and Common Auxiliaries respectively.

Category: a concept of 'high generality and wide application' which characterizes a set of classes, e.g., Place. Category is sometimes used almost synonymously with Facet; but the latter, if distinguished from Category, refers to concepts of a somewhat lesser degree of generality; e.g., within a fundamental Place Category we may distinguish facets of Political Place, Physical place, Orientation (North, South, etc.).

Chain: a ranked sequence of classes in which each class is subordinated to the preceding one. These classes need not belong to the same Hierarchy - i.e., need not be in a genus/species relation. For example, Grain - Storage of Grain - Diseases and pests in storage of grain. Hence, may be called a 'pseudo-hierarchy'.

Citation order: in a pre-coordinate system, the order in which the individual elements of a compound class are cited when assigning a subject description; e.g., in UDC, a class Agriculture - Grain - Storage - Diseases reflects a citation order within the class Agriculture of Crop, Operation, Process. Same as 'facet formula'.

Classified catalog: one consisting of three distinct files: (i) a classified file, or index of entries for individual documents; (ii) an A/Z subject index of see references from names of classes, terms, to class numbers; (iii) an author-title index of entries for individual documents. The last two files may be interfiled. (Cf. Dictionary Catalog in which subject document entries, subject references, and author

and title entries are filed in one sequence.)

Cyclic order: in a pre-coordinate system, restricted permutation of the elements of a compound class (with a given initial citation order) in which the additional citation orders follow a clockwise direction; e.g., beginning with abcd, the permutations bcda, cdab, dabc are derived.

Distributed relatives: a term used by E. Savage to denote those classes in a pre-coordinate system which, although related, are distributed by subordination of other classes; e.g., in UDC Metal is subordinated to (and so distributed under) Chemistry, Mineralogy, Geology, Mining engineering, Metallurgy, etc.

Exhaustivity of indexing: the degree to which all the concepts dealt with in a document are recognized in the indexing, whatever the generic level of this recognition. If a document deals with a dozen separable themes, each capable of an independent existence, fully exhaustive indexing would provide entries for all of them.

Facet: the total subclasses produced when a class is divided by a single train of characteristics; e.g., division of the class Psychology by the different characteristics reflecting Person gives such classes as Male, Female, Child, Adult, English, French, etc.

Facet indicator: a distinctive notational element used to introduce any class within a particular facet; e.g., in Class 621 Mechanical engineering, any class number commencing with - 4 represents a class from the Shape facet.

General: one class is more general than another if it entirely includes that class; e.g., Storage of agricultural produce is more general than Storage of grain. It is not more general, however, than Grain crops, say.

Hierarchy: a ranked sequence of genera and species in which a genus precedes its species; e.g.,

633 Field crops
633.1 Cereal
633.11 Wheat

N.B. 'Hierarchy' is not always used in this strict sense, but with reference to any ranked sequence, when it is virtually indistinguishable from 'chain'.

Multiple entry: in a classified index, the making of a separate entry under each major element of a compound class whether this represents the overall theme of the document or one of the distinct, separable themes within the document; the notationally separable elements are usually treated as the major elements in practice; e.g., 633.1:632.7 Field crops - Grain Wheat - Pests - Insect would be entered also under 632.7:633.1 Pests - Insect - Field crops - Grain - Wheat.

Permutation: in UDC, the making of multiple entries for a compound subject by varying the citation order of its elements (see Cyclic order).

Post-coordination: coordination of terms (classes) at the search stage. At the indexing stage, subject descriptions are usually simply conjunction of separate, single terms, or descriptors (e.g., Wheat, Pests, etc.). Access is the same for each term.

Pre-coordination: Coordination of terms (classes) at the indexing stage, implying the subordination of some elements in a compound subject description to other elements. Access to elements other than the first cited one is less direct, e.g., in UDC, Wheat - Storage - Pests implies subordination and distribution of the second and third elements to varying degrees.

Pre-coordination can also refer to the pre-coordination of terms in an enumerative classification schedule, in which some compound subject classes are given ready made class numbers (as distinct from the provision of relatively elementary constituent terms only, for subsequent coordination by synthesis; e.g., in UDC 669.162.2 Blast furnaces for pig iron production is a pre-coordinated (enumerated) class number. 669.7.04' Furnaces for light metals is a synthetic number made by the indexer.

Preferred order: the citation order followed in a particular situation.

Recall ratio: the fraction of those documents which are known to be relevant to a question (and which should have been found) which are actually found. If R is the number of relevant documents recalled and C is the total number of relevant documents in a collection, then R/C x 100 gives the recall ratio.

Relevance ratio: the fraction of documents which are both re-

called and which are relevant to the question, to the total number recalled. If R is the number of relevant documents recalled and L is the total number of documents recalled, then R/L x 100 gives the relevance ratio.

Single entry: in a classified index, making a single entry only for a compound class, whether this represents the overall theme of the document or a distinct, separable theme within the document. The location of this single entry is determined by the preferred order of citation and access to the distributed relatives is normally via the A/Z subject index.

Specificity: the degree to which the terms assigned in a description match exactly, in hierarchical status (generic level) the classes or concepts they are intended to describe; e.g., a document on oxyacetylene welding would not be matched in specificity by indexing it by gas welding. Complete specificity is achieved only when the subject description is coextensive with the information it represents.

Synthesis: in UDC, refers to the production of a class number for a compound subject by joining the symbols of two or more simple or more elementary classes according to prescribed rules; e.g., 616-076 Biopsy (Pathology), 616.5 Skin diseases, 616.5-076 Biopsy of skin diseases. Synthesis implies a prior analysis of the subject to produce these more elementary constituent classes - hence, analytico-synthetic classification.

APPENDIX 3
EXAMPLES OF ABSTRACTING AND INDEXING JOURNALS USING UDC

Japan Science Reviews: Mechanical and Electrical Engineering

629.12(52)"1958"
Shipbuilding - Japan - 1958
629.12:621.039.578
Shipbuilding - Nuclear power - Propulsion
629.12.011:620.197.5
Shipbuilding - Ship hulls - Protection - Electrical and electrolytic
629.12.011.7:624.04:681.142.004
Shipbuilding - Ship hulls - Structural members - Stress diagrams - Calculation by computer - Operation point of view
629.12.011.7:621.791.019
Shipbuilding - Ship hulls - Welding - Defects
629.12.011.7-752:629.123.56
Shipbuilding - Ship hulls - Protection against damage - by Vibration - Tankers
629.12.011.72:539.384:624.075.4
Shipbuilding - Ship hulls - Deck girders, etc. - Deformation - by Vertical flexion - Structural design - Buckling elements
629.12.014.6:532.582.32:623.823
Shipbuilding - Ship steering gear - Rudders - Hydrodynamics - Resistance - Submerged bodies - Destroyers
629.12.066:621.3.014.3:621.316.174
Shipbuilding - Ship electrical system - Current - Short circuit - Distribution network

Science Abstracts: Section B - Electrical Engineering Abstracts

621.313
Electrical machines
621.313:621.791
Electrical machines - Welding techniques for
621.313.13
Electrical machines - Electric motors
621.313.13:621.316.36
Electrical machines - Electric motors - Distribution and control - Switchgear - Mechanical protection

621.313.13:621.316.925.43
Electrical machines - Electric motors - Distribution and control - Relay protection - Overcurrent relays
621.313.2
Electrical machines - D-c machines
621.313.2:621.333
Electrical machines - D-c machines - for traction
621.313.2:621-52:621.316.7
Electrical machines - D-c machines - Automatic controls - Regulation
621.313.3-8:621.316.722
Electrical machines - A-c machines - Variously driven - Regulation - of voltage
621.313.322-82
Electrical machines - A-c machines - Synchronous generators - Hydrogenerators
621.313.322-82:621.316.722
Electrical machines - A-c machines - Synchronous generators - Regulation - of Voltage
621.313.322-82:621.316.925
Electrical machines - A-c machines - Synchronous generators - Protection - Relay

Ministry of Public Building and Works Library Bulletin (fortnightly) cumulated annually as Consolidated Building References to articles in periodicals

69.022.5:721.013
Building construction - Structural parts of building - Partitions - Design - Modular
69.024.5:624.073
Building construction - Roofs - Folded plate construction - Civil engineering - Structural elements - Plates
69.028.3:697.97
Building construction - Louvres - Ventilation - Temperature conditioning
69.03"324"
Building construction - Conditions - Winter
69.059.22:69.057.1
Building construction - Site organization - Collapse of buildings - Construction by industrialized system - assembly of prefabricated units
693.542:69.024.5
Building construction - Site construction - Plain - Batching and mixing - Concreting in situ - Roofs - Folded plate construction

693.97:620.178.3
Building construction - Steel frame - Vibration and fatigue tests

697.7:621.47:627.1
Building construction - Heating - Solar - Solar heat machines - Schools

APPENDIX 4
INDEXING AND ABSTRACTING SERVICES USING UDC

Preliminary checklist taken from "A guide to the world's abstracting and indexing services in science and technology." Washington, National Federation of Science Abstracting and Indexing Services, 1963.

(Title of service is followed by Country, Year started, Number of items per annum, and Major subject.)
* indicates subject classification with UDC numbers provided.
Several forestry abstracting publications using the Oxford system are excluded.

*AEG Mitteilungen
Germany - 1911 - 150 - electrical engineering

ASLIB Booklist
U.K. - 1935 - 750 - general

Abstract & Book Title Index Card Service
U.K. (Iron & Steel Institute) - 1962 - 11,000 - iron & steel

Abstracts of Current Publications
U.K. (Ministry of Power) - 1924 - 2,000 - mining

Abstracts of Photographic Science & Engineering Literature
U.S. - 1962 - 4,500 - photography

Acta Tropica "Bibliographie"
Switzerland - 1944 - 1,000 - tropical agriculture & medicine

*Annales de l'Institut Technique du Bâtiment et des Travaux Publics
France - 1948 - 3,000 - building

Apicultural Abstracts
U.K. - 1950 - 800 - apiculture

Associated Electrical Industries (Manchester) Ltd.
U.K. - 1926 - 3,000 - electrical engineering

Research Laboratory Technical News Bulletin
U.K. - 1926 - 3,000 - electrical engineering

Atomdokumentation Ser. S.
Sweden - ? - 2,500 - nuclear physics

*Der Bauingenieur
Germany - 1920 - 150 - building

*Die Bergbauwissenschaften
Germany - 1954 - 1,500 - mining
*Berichte der Deutschen Keramischen Gesellschaft e. V.
Germany - 1924 - 1,200 - ceramics
Bibliografía Brasileira de Botanica
Brazil - 1956 - 900 - botany
Bibliografía Brasileira de Matemática e Física
Brazil - 1955 - 3,000 - mathematics & physics
Bibliografía Brasileira de Química
Brazil - 1957 - 1,200 - chemistry
Bibliografía Brasileira de Zoología
Brazil - 1956 - 1,200 - zoology
Bibliografía Cientifica da Junta de Investigações do Ultramar
Portugal - 1960 - 400-1,500 - general
Bibliografía Elettrotecnica; Rassegna mensile della stampa tecnica italiana e straniera
Italy - 1947 - 6,000 - electronics
Bibliografia Italiana di Elettrotecnica. Electrotechnical Italian Bibliography
Italy - 1943 - 600 - electrical engineering
Bibliografia Italiana di Idraulica
Italy - 1950 - 500 - hydraulics
Bibliographica Medica Helvetica
Switzerland - 1943 - 10,000 - medicine
*Bibliography of Scientific Publications of South and South East Asia
India - 1955 - 7,000 - general
*Bibliography on Snow, Ice, and Permafrost with Abstracts
U.S. Army - 1951 - 1,000 - glaciology
Boletim Analítico
Portugal - 1959 - 400 - physical sciences
Boletim Mensal de Informação
Portugal - 1949 - 3,000 - civil engineering
Boletín Bibliográfico
Argentina - 1934 - 4,000 - agriculture
*Building Science Abstracts
U.K. - 1926 - 2,000 - building technology
*Bulletin de Documentation de l'Union Internationale des Chemins de Fer
France - 1947 - 4,000 - railroads
*Bulletin Mensuel de Documentation
France - 1945 - 5,000 - automobile engineering
Bull. Mens. de Doc.: Maandelijks Documentatie Bulletin
Belgium - 1947 - 10,000 - general
*Bulletin Technique de la Suisse Romande
Switzerland - 1874 - 350 - general

Bygglitteratur: Building Abstract Service
Scandinavia - 1946 - 300 - building technology
CSIR Research Review
South Africa - 1951 - 950 - general
*Cahiers du Centre Scientifique et Technique du Bâtiment
France - 1948 - 250 - building
Canadian Building Abstracts
Canada - 1960 - 200 - building
*Chemiker-Zeitung, Chemische Apparatur
Germany - 1877 - 2,200 - chemistry
*Cimjegyzék a Bel-és Külföldi Folyóiratokban Megjelent Vizügyi Vonatkozású Közleményekről
Hungary - 1954 - 3,000 - hydrology
*Csepeli Müszaki Folyóirat Szemle
Hungary - 1959 - 1,200 - metals
*Deutsche Eisenbahn Technik
Germany - 1953 - 300 - railways
*Documentation Bibliographique
France - 1948 - 1,300 - cement
Documentation du Bâtiment
Switzerland - 1952 - 300 - building
Dokumentációs Szemle
Hungary - ? - ? - metallurgy
Dokumentation Wasser (DW)
Germany - 1960 - 2,500 - water
*Dokumentationsdienst Faserstoffe und Textiltechnik (card service)
Germany - ? - ? - textiles
*Dokumentesyon Kenkyu
Japan - 1950 - 400 - information retrieval
*Draht-Welt
Germany - 1908 - 300 - wire
Dyna: Revista de la Asociación Nacional de Ingenieros Industriales
Spain - 1935 - 2,000 - technology
Electrical Engineering Abstracts
U.K. - 1898 - 6,500 - electrical engineering, etc.
Electronic Technology
U.K. - 1923 - 4,000 - electronics
*Elektrotechnický Obzor
Czechoslovakia - 1912 - 130 - electronics
*Epitésügyi Dokumentációs Tajékoztató
Hungary - 1958 - 1,000 - construction
*FOGRA-Literaturdienst (card service)
Germany - 1955 - 600 - printing
Fichas Técnicas
Spain - 1948 - 1,500 - iron, steel

Fiches Documentaires. Civil Engineering (card service)
Switzerland - 1950 - 300 - steel structures
Fiches Documentaires. Electrical Engineering
Switzerland - 1932 - 2,080 - electrical engineering
Fiches Documentaires. Textiles
Switzerland - 1955 - 2,000 - textiles
*Figyelökartonszolgálat
Hungary - 1955 - 250,000 - general
Figyelöszolgálat
Hungary - 1957 - 2,500 - auto engineering
Galvanotechnik
Germany - 1902 - 700 - metal finishing
Die Gartenbauwissenschaft
Germany - 1928 - 600 - horticulture
*Giesserei
Germany - 1914 - 250 plus 2,500 refs. - foundries
*Glastechnische Berichte
Germany - 1928 - 2,000 - glass
Glasteknisk Tidskrift
Sweden - 1946 - 500 - ceramics
*Heizung, Lüftung, Haustechnik
Germany - 1950 - 500 - heating
*Hungarian Technical Abstracts
Hungary - 1949 - 4,000 - various
*INSDOC List of Current Scientific Literature
India - 1954 - 48,000 - general
*IRE Proceedings
U.K./U.S. - 1946 - 4,000 - radio
ITC International Bibliography for Photogrammetry
Netherlands - 1958 - 1,000 - aerial surveying, photogrammetry
Index Aeronauticus
U.K. - 1945 - 3,500 - aeronautics
Index Translationum
UNESCO - 1948 - 31,000 - general
Indice de Revistas Científicas y Técnicas
Spain - 1953 - 40,000 - chemical & technical
Indonesian Abstracts
Indonesia - 1958 - 120 - science
*Informação Bibliografica
Portugal - 1959 - 2,000 - agriculture
*L'Ingegnere
Italy - 1927 - 1,000 - engineering
Japan Science Review: Mechanical & Electrical Engineering
Japan - 1954 - 4,000 - engineering
*Japan Science Review: Medical Sciences
Japan - 1954 - 12,000 - medical sciences

Japan Science Review: Mining & Metallurgy
Japan - 1957 - 2,000 - mining & metallurgy
Journal of the British Institution of Radio Engineers
U.K. - 1939 - 200 - communications
*Journal of the British Shipbuilding Research Association
U.K. - 1946 - 2,000 - shipbuilding
*Kagaku Gijutsu Bunken Sokuho (6 parts)
Japan - 1958 - 119,000 - various
*Kenchiku Zasshi
Japan - 1898 - 100 + 4,500 refs. - building
*Kishocho Tosho Geppo
Japan - 1955 - 7,200 - meteorology
Klassifisert Oversikt Over Norsk Bygglitteratur
Norway - ? - 300 - building
*Kurzausztige aus dem Schrifttum für das Eisenbahnwesen
Germany - 1953 - 3,000 - railways
Landbouwdocumentatie
Netherlands - 1945 - 7,000 - agriculture
Library Bulletin
U.K. (Ministry of Works) - 1944 - 3,300 - building
*Library Bulletin of the Heating and Ventilating Research Association
U.K. - 1960 - 500 - heating
Light and Lighting
U.K. - 1908 - 150 - lighting
Lodní Stavitelství
Czechoslovakia - ? - 200 - ship building
*MTW: Mathematik-Technik-Wirtschaft
Austria - 1954 - 200 - computers
*Magyar Agrárirodalmi Szemle
Hungary - 1952 - 500 - agriculture
Magyar Folyóiratok Repertóriuma
Hungary - 1946 - 7,000 - general
*Magyar Müszaki Lapszemle
Hungary - 1949 - 4,000 - various technical
Magyar Nemzeti Bibliográfia
Hungary - 1945 - 2,000 - general
Materialprüfung
Germany - 1959 - 300 - materials testing
*Die Medizin der Sowjetunion und der Volksdemokratien im Referat
East Germany - 1954 - 6,700 - medicine
*Mekanförbundets Litteraturöversikt
Sweden - 1949 - 1,200 - machinery
Mémoires ICF
France - 1848 - 200 - civil engineering

Memorie e Atti del Centro di Studi per l'Ingegneria Agraria
Italy - 1946 - 100 - agricultural engineering
*Meteorological and Geophysical Abstracts
U.S. - 1950 - 11,000 - meteorology, etc.
Monthly Bibliography of Accessions (U.K. Meteorological Office)
U.K. - 1919 - 7,000 - meteorology
*Müszaki Folyóiratok Cikkeinek Kovonatai
Hungary - 1954 - 4,000 - communications
Müszaki Irodalmi Tajékoztató
Hungary - 1959 - ? - technology
*Müszaki Lapszemle. Bányászat
Hungary - 1949 - 3,000 - mining
*Müszaki Lapszemle. Elektrotechnika
Hungary - 1949 - 4,500 - electrical engineering
*Müszaki Lapszemle. Élemiszeripar
Hungary - 1949 - 2,600 - food
*Müszaki Lapszemle. Energia
Hungary - 1949 - 3,000 - energy
*Müszaki Lapszemle. Épitöipar
Hungary - 1949 - 3,800 - building
(7 other parts of Müszaki Lapszemle)
Hungary - 1949 - 28,000 - various
NBO Abstracts
India - 1956 - 1,300 - building
*NTZ Nachtrichtentechnische Zeitschrift
Germany - 1948 - 300 - telecommunication
*Nachrichtentechnik
Germany - 1951 - 300 - telecommunication
*Nederlandse Technische-Wetenschappelijke Literatuur
Netherlands - 1953 - 2,500 - general
*Neue Hütte
Germany - 1946 - 100 + refs. - mining
*Nichidai Igaku Zasshi
Japan - 1937 - 120 - medicine
*Nouveaux Livres Scientifiques et Industriels
France - 1908 - 600 - general
Österreichische Dokumentation für Bauwesen und Wohnungswirtschaft
Austria - 1951 - 800 - building
*Österreichische Dokumentation auf den Gebieten des Bauwesens und der Architektur
Austria - 1951 - 150 - building
Országos Müszaki Könyvtár Uj Külföldi Beszerzéseinek Yegjzéke
Hungary - 1952 - 3,000 - science

Philippine Abstracts
Philippines - 1960 - 550 - science
Photographic Abstracts
U.K. - 1921 - 2,000 - photography
Physics Abstracts
U.K. - 1898 - 15,000 - physics, etc.
Portuguese Civil Engineering Literature
Portugal - 1952 - 300 - civil engineering
*Přehled Textilní Literatury (cards)
Czechoslovakia - 1961 - 1,000 - textiles
*Přehledy Potravinářské Literatury
Czechoslovakia - 1960 - 200 - food
Railway Engineering Abstracts
U.K. - 1946 - 800 - railway engineering
*Referate-Kartei der Galvanotechnik (cards)
Germany - 1960 - 1,200 - metal finishing
*Referaten-Praktikum für die Ernährungsindustrie
Germany - 1954 - 350 - food
*Regelungstechnik
Germany - 1953 - 1,000 - automation
Resumos Bibliográficos
Brazil - 1960 - 150 - veterinary medicine
Revista de Ciencias Veterinarias
Portugal - 1902 - 1,000 - veterinary medicine
Revista de la Asociación Odontológica Argentina
Argentina - 1898 - 150 - dentistry
*Revue des Matériaux de Construction et de Travaux Publics
France - 1905 - 300 - civil engineering
*Revue Générale de l'Électricité
France - 1917 - 1,300 - electricity
Rivista di Meteorologia Aeronautica
Italy - 1937 - 500 - meteorology
*Schnellinformationen für die Kohlenindustrie der Deutschen Demokratischen Republik
Germany - 1960 - 1,500 - coal
Seimitsu Kikai
Japan - 1933 - 120 - precision mechanics
*Shikizai Kyokaishi
Japan - 1927 - 400 - paint
*Silicates Industriels
Belgium - 1934 - 2,000 - ceramics
Svensk Byggliteratur
Sweden - 1946 - 1,500 - building
*Svenska Tidskrifts Artiklar
Sweden - 1952 - 6,000 - general
Svetslitteratur
Sweden - 1932 - 1,200 - welding

*Szakirodalmi Tájékoztató
Hungary - ? - 2,500 - roads & railroads
Tajékoztató a Hazai és Külföldi Müszaki Irodalom Legújabb Közleményeiröl
Hungary - 1956 - 6,000 - technology
Technical News Bulletin (A.E.I.)
U.K. - 1927 - 3,000 - electrical engineering
*Techniques et Sciences Municipales
France - 1905 - 400 - public health engineering
Technische Mitteilungen P.T.T.
Switzerland - 1923 - 125 - telecommunications
*Technische Überwachung
Germany - 1960 - 300 - management
*Technisches Zentralblatt Abteilung Elektrotechnik
Germany - 1951 - 10,000 - electrical engineering
*Technisches Zentralblatt Abteilung Maschinenwesen
Germany - 1952 - 9,500 - mechanical engineering
Técnica; Revista de Engenharia dos Alunos do Instituto Superior Técnico
Portugal - 1926 - 1,000 - engineering
Teknillisen Kemian Aikakauslehti
Finland - 1944 - 10,000 - chemistry
Tetsudo Gijutsu Bunken Shoroku
Japan - 1959 - 4,800 - railroads
*Tonindustrie-Zeitung und Keramische Rundschau
Germany - 1949 - 1,200 + refs. - ceramics
*Tropical Abstracts
Netherlands - 1946 - 3,300 - tropical agriculture
Vegyiterv Dokumentációs Tájékoztató
Hungary - 1960 - ? - industrial chemistry
Vejteknisk Litteratur-Indeks (cards)
Denmark - 1950 - 300 - roads
*Verres et Réfractaires
France - 1947 - 900 - glass
*Wasserwirtschaft-Wassertechnik
Germany - 1951 - 250 - water
*World Fisheries Abstracts
FAO/UN - 1950 - 600 - fisheries
Zeitschrift für die Gesamte Textil Industrie
Germany - 1897 - 350 - textiles
Zement-Kalk-Gips (also has card service)
Germany - 1948 - 750 - cement