

## INFORMATION SYSTEMS AND SERVICES IN SCIENCE AND TECHNOLOGY

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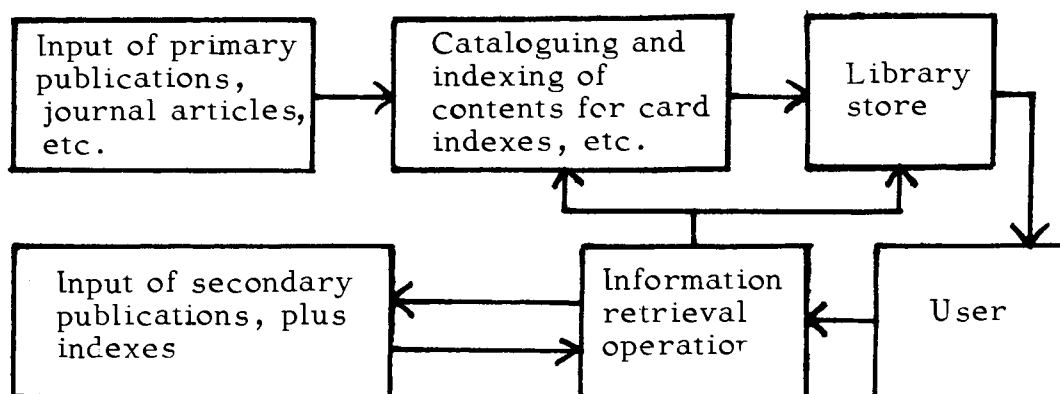
### Introduction

The main information need of scientists is to know what research is going on, who is doing it and where and what results have been obtained. They also need much factual and numerical data and information about methods, materials, new products, information sources, etc. The world fund of formal published scientific information in all active disciplines and technologies is very large and growing continuously. Access to this information is mainly through various institutional facilities. Research managers, administrators and policy makers equally need access to information for research planning, the assessments of priorities and budgets and in policy making, but this is of a qualitatively different kind to that needed by practising scientists.

For scientists, to be well informed requires knowledge of what information exists and how to get it. This is mainly a matter of access to published literature taken by libraries attached to research institutes, universities, etc. where they work.

### The Library information system

Functional components In all countries libraries are the principal first-line repositories of information for scientists. Their basic function is to obtain, catalogue and store documents and to make them accessible to users on demand. In addition, libraries will normally undertake to obtain loan copies or photocopies of documents held elsewhere. A generalized scheme for the library function is as follows:



In this scheme, the user can have either direct access to library stocks on the shelves or can use subject or author catalogues and top of indexes to identify items which can then be retrieved from stocks. The information retrieval operation may be done by the user himself or by information personnel working on his behalf. The secondary information literature may also be used to identify documents needed and which can be obtained from library stocks or outside sources.

Library contents The usual classes of literature held by a science library will include the following:

1. Journals, conference proceedings, bulletins, monographs, etc. containing original research reports.
2. Books, textbooks, research reviews and digests, scientific reference books, data files, etc.
3. Dictionaries, glossaries, guidebooks, etc. for general reference.
4. For some libraries, patents and/or standards literature.
5. Secondary information journals, reviews, digests.

Publications in classes 1 to 4 will generally be given notice in the library catalogue. Class 5 is the so-called secondary literature which typically consists of journals containing collected titles of articles or titles plus abstracts or other extracts from the primary literature. This can therefore be regarded as condensed information about the contents of primary publications and which at the same time gives sufficient details to enable the original documents to be identified and located. Such publications provide a key to literature not taken by the library and so greatly extend its literature coverage. The indexes in secondary publications perform the same role for the literature they cover as library catalogues do for the library contents.

Library catalogues The catalogue or index has a key role in enabling the library contents to be noted and retrieved. This is usually done by means of subject keywords and authors' names. In some very large libraries the cataloguing arrangements may be complex and computerized, but in most smaller libraries manual indexes are usual. At their simplest, these indexes may consist simply of individual cards. Each new document entering the system is indexed by subject and author and new cards carrying the bibliographic description or accession number are made out and added to the cards already in the system. Because each entry needs two or more new cards, such indexes rapidly become physically unwieldy. A measure of compression can be achieved by using various forms of edge- or centre-punched cards in which the same index card may carry a number of different document descriptions or accession numbers. Alternatively a card may be made out for each document or accessions number, which is then edge- or centre-punched for an index keyword or keywords.

A variant of the former is the so-called feature or optical coincidence card index. In this system every keyword in the index has its corresponding feature card. Each card which is edge notched carries a fixed number of positions (usually up to 10,000) which can be located by horizontal and vertical coordination and on which each coordinate position corresponds to a document accessions number. When a new document (book, research paper, memorandum, etc.) enters the library, it is first indexed and given an accessions number. If the keyword chosen has already been used in the system, its corresponding feature card is extracted and a hole punched at the coordinate position corresponding to the accession number of the new document. If the index keyword is new, then a new feature card is made out for the keyword, punched at the appropriate coordinate and added to the cards already in the system.

When using a single card for retrieval, the card corresponding to the chosen keyword can be taken from the index and placed over a light source. The coordinates at which light shines through the card can then be identified and their respective accession numbers found and used to retrieve the corresponding documents from store or file. Alternatively, more than one feature card can be aligned together in a stack and similarly placed over a light source. The coordinates at which light shines through the stack correspond to those documents carrying all the index terms chosen for retrieval. By this method index entries can be coordinated so that retrieval is achieved with chosen keyword combinations.

The choice of cataloguing system depends on the size of library or amount of material to be dealt with. The feature card system can be used to index the same number of documents as there are coordinate positions on the cards; when the number of documents exceeds this number, then a new set of index cards must be started. In time, this could involve the sequential searching of a number of feature card sets. In practice, it becomes difficult to use more than about five sets of a feature card index carrying 10,000 coordinates; however, where it is wished to retrieve material going back over a relatively limited period of time this may be less of a problem.

Where feature card systems involve substantial numbers of keywords, users may find it difficult to decide which is the correct keyword to use for retrieval. In this situation it will be necessary to provide both users and those responsible for document indexing with a list of the main operative keyword synonyms, related or alternative terms with cross-references linking them to the preferred operative keywords\*.

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\* A good account of a feature card system and its associated controlled index or thesaurus is given in the following reference: Posnett, N W The Land Resources Division and its feature card system. Quart. Bull. IAALD, 1975, 20, No.1, 23-33.

Photo- and microcopying Reprographic facilities are nowadays available in many libraries. Xerography is in common use for direct copying of documents for internal and external use and is a valuable means of providing document copies on request without the need to send the originals. Microcopying is also in use as a means of rapid, inexpensive document transfer through the mail and can offer a way of reducing the volume of library storage needed. Microfiche (commonly 90 pages per fiche) is more popular than microfilm, mainly because it is more convenient and file storage of microfiche is easier. However, the equipment needed to produce microfiche masters is expensive; copying masters is appreciably less costly and microfiche readers themselves are relatively inexpensive.

Microfiche is likely to become increasingly important as a medium for document transfer in international and multinational documentation and information systems. However, scientists themselves generally dislike having to use microfiche and its acceptability as an alternative to maintaining library stocks in hard copy form is likely to be limited, in practice.

#### In-house provision of scientific information

Information gathering habits of scientists There are variously reckoned to be 30-35,000 scientific journals in the world today, though in the face of this very large number (and ignoring the additional very large amount of non-conventional literature) it has also been said that 95% of the really important literature is published in only about 10% of them. Typically, scientists may read on average only 10-12 journals regularly, perhaps 8 or 9 specifically on their subject and the rest general science journals such as Nature or Science. Outside their own reading, many scientists rely heavily on informal contacts at work, conferences and symposia, on abstract journals, etc. So-called invisible colleges (e.g. groups of scientists within and outside their own country who share a professional research interest and who correspond, exchange reprints, etc.) are also considered important by some scientists, though such groupings tend to be rather haphazard and unsystematic as information sources.

Library information services Generally, libraries will take as much of the relevant primary literature as demand requires and budgets allow and take secondary literature to supplement their coverage. Outside scientists' own literature scanning, therefore, efficient library services thus depend on effective ways of identifying wanted documents and effective means of getting documents that are not already taken by the library. This depends on a good inter-library loan system, backed up by knowledge of how and where to get documents outside the library network, e.g. in other countries.

A valuable and rapid method of alerting library users to new literature is to list it for, say, weekly circulation. Such lists will not necessarily include research articles in journals which the scientists concerned will see anyway, but will concentrate on incoming books, reviews, reference books, conference proceedings and other non-conventional literature, etc.

In-house information personnel There is an increasing trend in many organizations to appoint information officers specifically to process and prepare information for users. This can work very well where such personnel are in close touch with those they serve; in large organizations this can save much of the time many scientists spend searching the literature and maintaining their own card indexes.

Such personnel may compile lists of bibliographic references, find and assemble hard data and generally deal with specific enquiries for technical information. Clearly, good knowledge of information sources and of scientific information work generally is important; in many cases good subject knowledge will also be necessary.

Some research organizations in developed countries have large centralized information departments based on the library and which use computerized methods of processing information. Computers are expensive, but hardware and software costs are falling and equipment is improving all the time. Their use as information processing aids is likely to increase considerably over the next decade.

Where national documentation and information centres exist, these are likely to play an increasing role as intermediaries in abstracting primary literature and in searching secondary literature on behalf of users. Also, literature search services such as those specifically provided in agriculture by such services as the Commonwealth Agricultural Bureaux can provide useful back-up for national or local information sources.

Formulation of enquiries Where information personnel have to do scientific enquiry work, a common problem is to identify exactly what the enquirer wants. Within the same organization, this is not too difficult - the problems arise when enquiries come from outside. Proper formulation of enquiries involves both the seeker and the provider of information. It is useful to itemize some common difficulties, especially with complex enquiries involving comparison and assessment of information. Here are some questions for those answering enquiries:

1. Does the enquirer want as much information as possible, or only an introduction for which a few key documents or a recent review will do?
2. How far back should the enquiry go? (In many subject areas, anything over 10 years old may be of little value).
3. How quickly is the information needed?

In answering enquiries, simple facts and figures can generally be found in textbooks. Enquiries of the kind "all information on . . . ." often turn out to be much less sweeping in scope on being referred back to the enquirer.

It can be very useful in dealing with enquiries to draw up a standard form to answer some of these points in advance.

## Secondary information sources and services

Today no scientists can hope to keep up with the literature published in his subject by his own efforts. Fortunately, he has no need to be informed about more than a fraction of it and the problem is therefore one of selection. The so-called information explosion was first felt in the developed countries. In response to the need for a means of identifying and selecting wanted from unwanted literature, there have now grown up secondary documentation and information services in all disciplines and technologies of any significance. A new discipline of information science has itself recently evolved and the number of its practitioners grows. These services are mostly staffed by information specialists whose principal job it is to prepare notices (article titles, or titles plus abstracts) of the contents of journal articles or other primary publications, and to issue these, usually plus indexes, at intervals to users. The indexes make it possible to identify and retrieve particular primary documents and the information given in the abstracts enables users to decide whether or not they need to see the original document.

There are now hundreds of secondary information services in existence. Some are very large and sophisticated, others are small. Many are national, some are multinational and some are international. All the very large services now use computers to enable them to deal with the enormous amount of information they have to process. Nearly all these continue to issue printed journals and all produce their output on magnetic tape as well. This enables users with the necessary computer facilities to print out all or to select parts of the contents according to need.

### Secondary information services

Examples of the more important among these services are the following:

Biological Abstracts, issued by the Biosis service (about 120,000 abstracts per year).

Chemical Abstracts, produced by Chemical Abstracts Service (over 160,000 abstracts per year).

These are major commercial services serving particular scientific disciplines.

Examples of large nationally based services covering a wide range of disciplines are the Referativnyi Zhurnal series of abstract journals produced in the USSR by VINITI (over 900,000 abstracts per year) and the Bulletin Signaletique journal series produced in France.

Examples of large recently created international services are the Agrindex and Atomindex title services.

An example of a large multinational service is the Commonwealth Agricultural Bureaux (CAB) which issues 130,000 abstracts per year in its journal series.

Up to several months or more may often elapse between the publication of a scientific article in a primary journal and the appearance of its corresponding abstract in a secondary publication. To meet the need for rapid notice of new literature, so-called current awareness services such as Current Contents and Chemical Condensates are available. These publications issue lists of article titles, Current Contents in the form of copied primary journal contents pages and Chemical Condensates as repackaged title lists. In both cases, the objective is to reduce to a minimum the interval between primary and secondary publication.

Special outputs Some secondary documentation and information services repackage the material in their data bases into so-called SDI (Selective Dissemination of Information) outputs covering small subject areas. The CAB for example, repackages its main abstract output into regularly issued outputs covering such narrow fields as plant growth regulating substances, irrigation and drainage, etc. The UK INSPEC service, which covers physics, electronics and computers, provides a similar service covering particular subsections of the main subject sections. The Chemical Abstracts Service, for example, also provides output covering, say, a single chemical to customers' requirements. Both the Excerpta Medica and CAB services provide retrospective retrieval services on demand, in the case of CAB in the form of one-off annotated bibliographies which cover the literature published over a longer or shorter time interval.

All the large services use highly sophisticated computer aided processing techniques and, unfortunately, many are very costly to use.

Data analysis and referral centres There are a number of document analysis centres in existence in which the data or factual information in primary journals is analyzed and made available in condensed form to users. These services are generally staffed by scientific specialists and their output is numerical or factual data, provided in response to direct enquiry. An example is the US National Oceanographic Research Centre. Initiatives are being made to set up an Environmental Referral Service. Other services, such as the National Referral Centre for Science and Technology in the USA, provide information about sources of information.

#### International and national agencies and systems concerned with scientific information

Of the following organizations, INIS and AGRIS also publish secondary information, but all are important as referral agencies for service and aid in scientific information matters.

AGLINET (Worldwide Network of Agricultural Libraries)  
Like AGRIS, this is based on FAO and consists of a network (at present) of 10 collaborating agricultural libraries. The system is seen as complementary to AGRIS and its aim is to coordinate library resources and exchange internationally.

International Nuclear Information Service (INIS)  
(International Atomic Energy Agency, INIS Section, PO Box 590, 4-1011, Vienna, Austria). This was the first fully international information system and deals with information on nuclear science and atomic energy. It produces Atomindex. Governments of 22 countries collaborate.

Information System for Development Science (DEV SIS)  
(Information Science Division, International Development Research Centre, Box 8500, Ottawa, Canada K1G 3H9). Modelled on the INIS and AGRIS Systems. This is a projected international information system for economic and social development, particularly for the Third World and is still in the planning stage. Its function will be to coordinate the collection and evaluation of published and unpublished information on development policy, planning, finance and trade, the social and economic effects of development programmes and related aspects.

International Council for Scientific Unions (ICSU)  
(17 Rue Mirabeau, 75016 Paris). A non-governmental international organization consisting of a number of scientific unions, sections and committees coordinating various scientific activities on an international basis. An important component of ICSU is its Abstracting Board which exists to improve the quality of scientific information and its distribution among scientists. Represented on its Board are major secondary documentation services and publishers of scientific journals.

International Federation for Documentation (FID) (7 Hofweg, the Hague, Netherlands). The principal non-governmental international organization concerned with the study and coordination of documentation and information. FID collaborates with various other international bodies, convenes conferences and organizes study and research programmes. A special committee (FID/DC) exists to survey documentation needs in developing countries and promote documentation activities.

International Information System for the Agricultural Science and Technology (AGRIS) (AGRIS Coordinating Centre, FAO, Via delle Terme di Caracalla, 00100 Rome, Italy). Similar to INIS in being a system in which cooperating countries or regional centres (over 60 in all) collect and record information on the literature published within their geographical area. This information is sent to FAO, Rome, where it is coordinated and prepared for publication. The subject

coverage includes all aspects of agriculture and related subjects. The present output is Agrindex, a monthly title service, in printed form or magnetic tape. Parallel abstract outputs covering major subject areas in agriculture are planned for the future.

ISORID (Information System on Research in Documentation)  
Set up in 1972 by UNESCO to collect, organize, analyze and disseminate information on research activities in documentation, libraries and archives and to keep a register of research projects on information and documentation.

UNESCO (United Nations Education, Science and Culture Organization) (Place de Fontenoy, Paris 7, France).  
This is an agency of the United Nations with responsibility, among other things, for fostering and developing efficient information services in member countries. UNESCO organizes meetings, arranges for consultancy work and the training of information personnel and has been instrumental in setting up documentation centres in various countries.

UNIDO (United Nations Industrial Development Organization)  
(Felderhaus, 2 Rathausplatz, PO Box 707, Vienna 1010, Austria) Set up as a clearing house to provide help to developing countries in industrialization, with emphasis on medium and small industries unable to provide their own R&D. Includes help to providing industrial information facilities.

UNISIST (United Nations Information System in Science and Technology) This is a programme, not a service, established jointly by UNESCO and ICSU (International Council of Scientific Unions). Its aims are to coordinate and promote trends towards international cooperation in documentation and information. Research projects coordinated by UNISIST and funded by UNDP (United Nations Development Programme) are under way at regional and national level in a number of countries. Many study projects covering various areas of UNISIST interest are also in progress.

In addition to these international agencies, various developed countries also provide aid in documentation and information matters. Prominent among these countries is Canada, which funds the International Development Research Centre (IDRC) (PO Box 85), Ottawa. This organization exists primarily to help developing countries acquire the knowledge they need to improve their social and economic conditions. This it does by awarding grants for appropriate research and for strengthening the information services within these countries. Other countries include the UK (via the British Council, 65 Davies St. London W1Y 2AA), the Federal Republic of Germany (the German Foundation for International Development, 53 Bonn 1, Endenicher Strasse 41) and various others.