ELEMENTS OF SCIENTIFIC COMMUNICATION

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Introduction

The theme of this Workshop is effective communication in the context of science and technology. By communication is meant the whole process of producing, transferring and receiving information by means of the written or spoken word or by pictorial illustration.

The importance of scientific information as a major resource essential to progress at all levels of science and technology is now universally acknowledged. But just as scientists and technologists need access to information from their colleagues and elsewhere, both within and outside their subject specialities, so also do they need to be able to communicate the results of their own work to other scientists generally and to contribute to the flow and exchange of information within their own group or organization.

In most countries scientific and technological activities operate on various interrelated levels and in some developed countries may present an extremely complex picture. Basically, however, the communities involved may include scientists in academic institutions for whom the emphasis is on the search for fundamental knowledge with no particular end use in view. Many other scientists work in governmental and industrial research organizations and for them the emphasis may be on applied research aimed at obtaining knowledge of direct or indirect practical value. Technologists, who are mainly concerned with processes, techniques, development and similar work, will usually have strictly practical and tangible objectives in view.

In addition to those actually conducting research and development work are research managers and administrators, information personnel and many others with scientific or administrative support roles or who may be involved in interpreting and disseminating information, whether on a crop variety, a laboratory technique or industrial process, among end users. Each of these groups within the total scientific community has its own particular information needs and patterns, depending on its functions and interests. Among scientists proper, the chief need is to communicate the results of their research and be informed about the results of work done by other scientists. In addition scientists, technologists, research managers and administrators, information officers and other may all from time

to time be called on to write reports of various kinds, policy documents, present and argue cases at meetings, organize work demonstrations and communicate with the general public.

Communication among the scientific community therefore goes on at many levels, involves exchange between many different types of information, uses various formal and informal media and may have limited or wide circulation.

Every type of information to be communicated has to be presented in terms the audience or recipients can understand. For example, there is little point in presenting non-scientists with the full details of a scientific paper or with material that assumes background knowledge they do not possess - it must be interpreted into language and terms they can grasp.

All modes of communication, whether oral or written, whether among scientists or non-scientists, to live audiences or not, have their own potentialities and limitations, advantages and disadvantages. They also have their own principles, techniques and rules that must be taken into account if communication is to be effective.

Formal and informal modes of communication

Within the overall communication process, a primary distinction can be made between formal and informal modes.

1. Formal modes. Being formal, these modes employ forms prescribed by custom and practice and follow established rules set by the community to which they apply. In the scientific community the most important communication need is to report the results of research done. This is usually done in formal scientific papers written for publication in established scientific journals, books or other publications. When published, such reports become permanent records that can be examined at any time. Similarly, many forms of internal reports, memoranda, extension literature, etc. also constitute formal publication in prescribed forms. Elements of formal communication in science and technology are set out in Figure 1.

   In common with most people, scientists often have difficulty in communicating effectively by means of the formal written or spoken word. To organize and prepare material for publication is often an arduous, time-consuming business and many scientists have problems in expressing themselves clearly. Some scientists, of course, achieve proficiency with experience and others are fortunate enough to have an innate ability to write or speak well. For others, however, the problem remains. It needs to be stressed, however, that much of the art of effective communication can be defined and can be learned.

2. Informal modes. As in any human community, much communication and information exchange goes on by

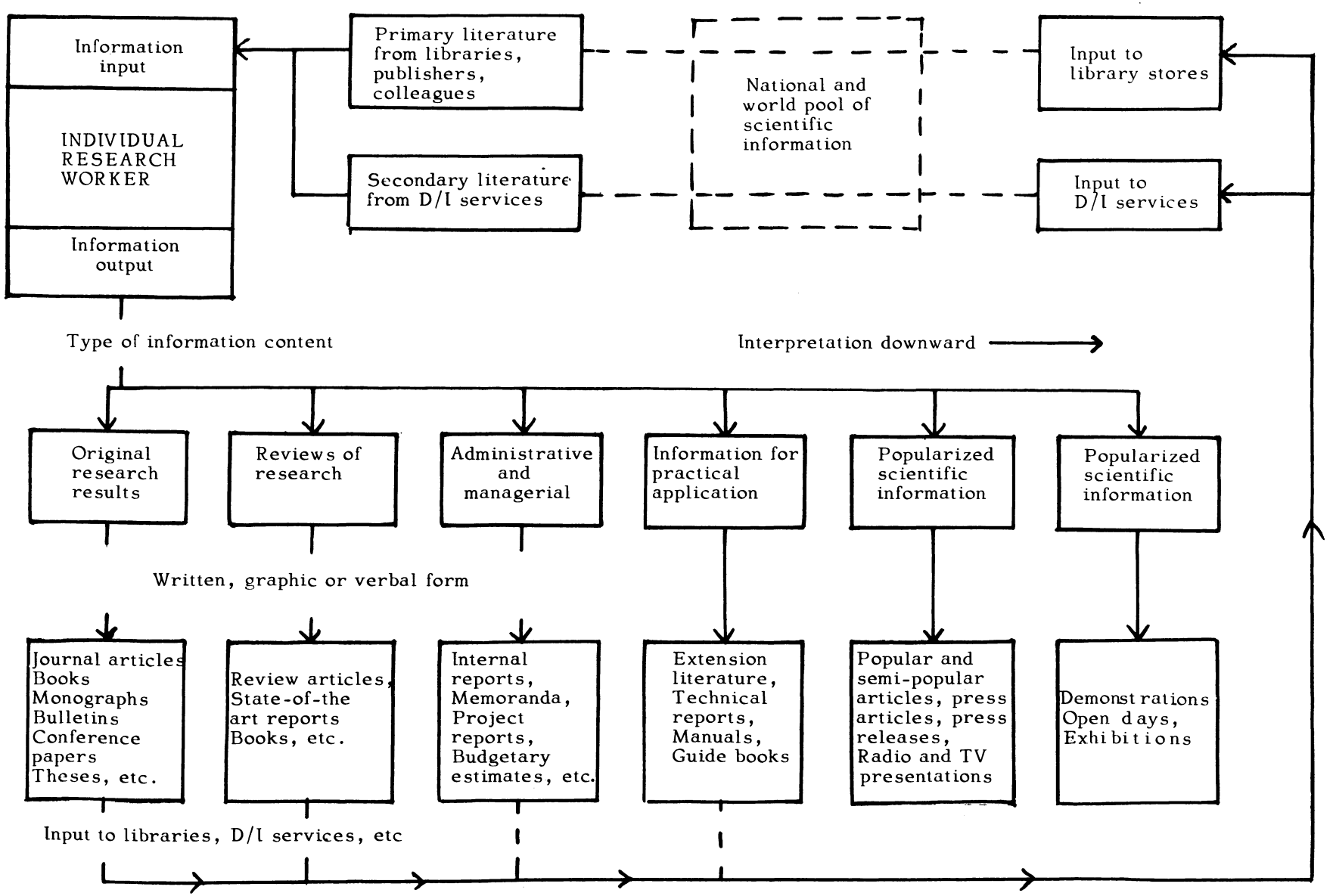


Fig. 1 Formal elements of the communications cycle in science and technology

informal person-to-person contact in the course of daily work, but because it is informal and of necessity unregulated, its significance is hard to quantify. However, all studies of the information gathering habits of scientists have stressed the importance of this mode. Much research and development work is carried on as a group activity, as indeed is the work of any research organization as a whole, and as in any group activity, its efficiency depends greatly on free, effective and positive informal communication among the personnel concerned. At one level, such communication can be regarded as belonging to the realm of sociology, but where inter-personal relationships between individuals or groups are poor or where there are other personal or organizational obstacles to free transfer of information, then both morale and research efficiency will certainly suffer.

Meetings, seminars, conferences and symposia

These have been included at this point because they share elements of both formal and informal modes of communication. Within organizations, meetings and seminars are variants of one another, seminars being meetings held specifically to discuss or review given topics and at which participants may present formal or semi-formal written or spoken material. Meetings proper are generally less formal than seminars and their content of informal communication among participants is correspondingly greater. Meetings can take up much valuable staff time to little purpose unless they are well organized and conducted, but at best are extremely important means of information exchange within organizations and groups.

In contrast to meetings and seminars, conferences and symposia are more formal affairs which bring together individuals from a much wider area to discuss or review a specific scientific subject or subjects. It is usual for formal written or spoken material to be presented on these occasions, often in the form of progress reports or short research papers which may subsequently be published in book form for wider circulation. Often as important as the formal side of conferences is the informal communication among professional colleagues that is such a prominent and essential feature of such occasions and which makes possible the exchange of views and information among individuals who may otherwise meet only infrequently.

Communication of information - the outward flow

It is useful first to consider in more detail the audiences with which scientists and others will communicate and the forms which that communication may take. It must also of course be remembered that transfer of information by informal person-to-person contact can take place with any of the audiences encountered.

1. Practising scientists will expect to write up the results of their work for publication and circulation outside their

group or organization. This will normally take the form of journal articles, bulletins, monographs, scientific conference papers, books, etc. They may also write reviews of research. Their audience here will mainly be other scientists and information services.

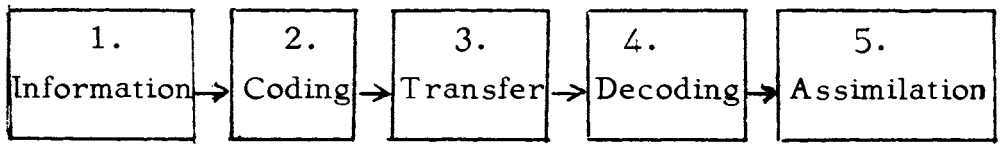
2. Within their own organization scientists will participate in the communication flow among scientific colleagues, research managers, policy makers, etc. Communication may take the form of internal reports, memoranda, policy documents, etc. They may also have to present and argue cases involving policy and decision making, budgets, etc. Most of this flow will be internal, but may at times extend outside the organization.

3. Scientists must communicate their research results and experience to technologists in industry or public services or to extension personnel responsible for advising farmers and others. They may at times have to communicate directly with end users in talks, lectures, literature, etc. without benefit of such intermediaries.

4. Finally, scientists, research managers and information officers may have to communicate with the general public and other lay audiences such as non-professional groups, schools, societies, the press, etc.

Scientists writing original research articles are usually writing for other scientists and their presentation will reflect their scientific training and analytical approach. As scientific information is progressively interpreted downwards to audiences with less and less scientific background, so must the presentation change accordingly.

The basic sequence common to all visual and auditory communication, whether scientific or not, can be summarized as follows:



1. Start of sequence. Information present in the mind of the person wishing to impart it.

2. Coding the information in terms of words or pictorial illustrations.

3. Transfer by means of the printed or spoken word, or by pictorial illustrations or audiovisual means.

4. Reception and decoding of the printed or spoken word to extract the meaning.

5. End of sequence. Analysis of the information and committal to memory or other record, i.e. written notes, etc.

Because this sequence is a human process, faults that hinder communication or distort the message can be introduced at any stage. The following are examples:

Stage 1. The originator may have given insufficient thought to matching his material to the target audience. He may lack the time or ability to organize his material to best advantage.

Stage 2. The originator may make a poor choice of words, grammar or other modes of expression to convey his information. The graphics used may be inadequate.

Stage 3. The medium used to transfer the message may be inadequate, defective or inappropriate. Printed material may be difficult or uncongenial to read. With verbal delivery, sound quality, acoustics, voice projection, intonation, etc. may be unsatisfactory. A stuffy auditorium and a dull speaker may send the audience to sleep or at least make them inattentive.

Stage 4. The recipient may misunderstand words or lack the scientific background to understand concepts, assumptions, scientific jargon, etc. if these are not properly explained. In some cases there may be language difficulties.

Stage 5. Where the presentation has been uninteresting and the information content not clear or readily understandable, recall of the information content may be poor and short-lived.

These examples of obstacles to communication differ with the medium used. For effective communication it is necessary not only to know what faults to avoid but what positive methods there are to aid reception and comprehension for each medium and how to use them.

The sequence of communication starts in the producer's mind and, obviously, he or she should have something worthwhile to express. But once the decision to communicate has been made and with it the decision of how best to match message, medium and audience, then all possible art and artifice must be employed to give maximum impact and comprehension.

For the communication of original research results, the medium of communication may be more or less self-evident and other questions, such as which journal to place it in, may be more important.! For communication to administrators, technologists and non-scientists, the best choice of medium and style of presentation may be less obvious, since the communicator may have to simplify and interpret his information to a greater extent and keep his audience much more actively in mind.

Communicators need to know the potentialities and limitations of the different media and thus need guidance on how to present their material to different audiences and what aids

and techniques, graphic or historic, they can use.

In some contexts, particularly commerce and politics, the term "public relations" has dubious overtones. Nevertheless, communication with the public and with persons in public and political life can be highly important. Scientists, research managers, administrators and information officers may all at times become involved in the public relations aspect of communication. They therefore need to know how best to present the case for their group or organization and to ensure that when opportunities arise to describe work or achievements, this is done to maximum effect. They need to know, for example, how the same statement made in print in a newspaper can differ in impact and interpretation from that made orally over the radio. Also, what points in a public statement may be liable to be picked out for emphasis in a newspaper report and possibly misinterpreted or distorted. Understanding of techniques and approaches for dealing with the press, press releases, radio and television interviews and talks and also the use of graphics and the various methods or presenting visual material are all important and will be singled out for further attention in this Workshop.

Communication of information - the inward flow

Scientists and technologists are both producers and consumers of information. They must communicate the results of their work if it is to add to the total sum of world knowledge or make its contribution to scientific and technological progress in their own national community. In publishing their work, therefore, scientists contribute to the world pool of information; at the same time, they need access to this same pool of information if they are to keep abreast of progress made elsewhere in their own or related subject fields.

In this sense scientists are part of a circular flow of information among the scientific community generally. For those engaged in fundamental research with no particular applied objective in mind, this circular flow of scientific information is the major concern. For those involved in applied science this same circular flow is also of major importance, but so also is the largely one-way flow of information to technologists, extension workers and others who need to apply it to practical use. In this case there may also be feedback of other levels of information on such aspects as the usefulness of the scientific knowledge originally provided, the need for new or further research, modifications to existing programmes, etc. Figure 2.

Without access to the results of other scientists' work as published in scientific journals, to textbooks and other reference sources, etc. no scientist can do effective research for long. The problem for scientists is to find out what information they need and where and how to get it. As has been said, scientists receive a great deal of their information input from informal personal contact at work, at meetings, conferences, etc.

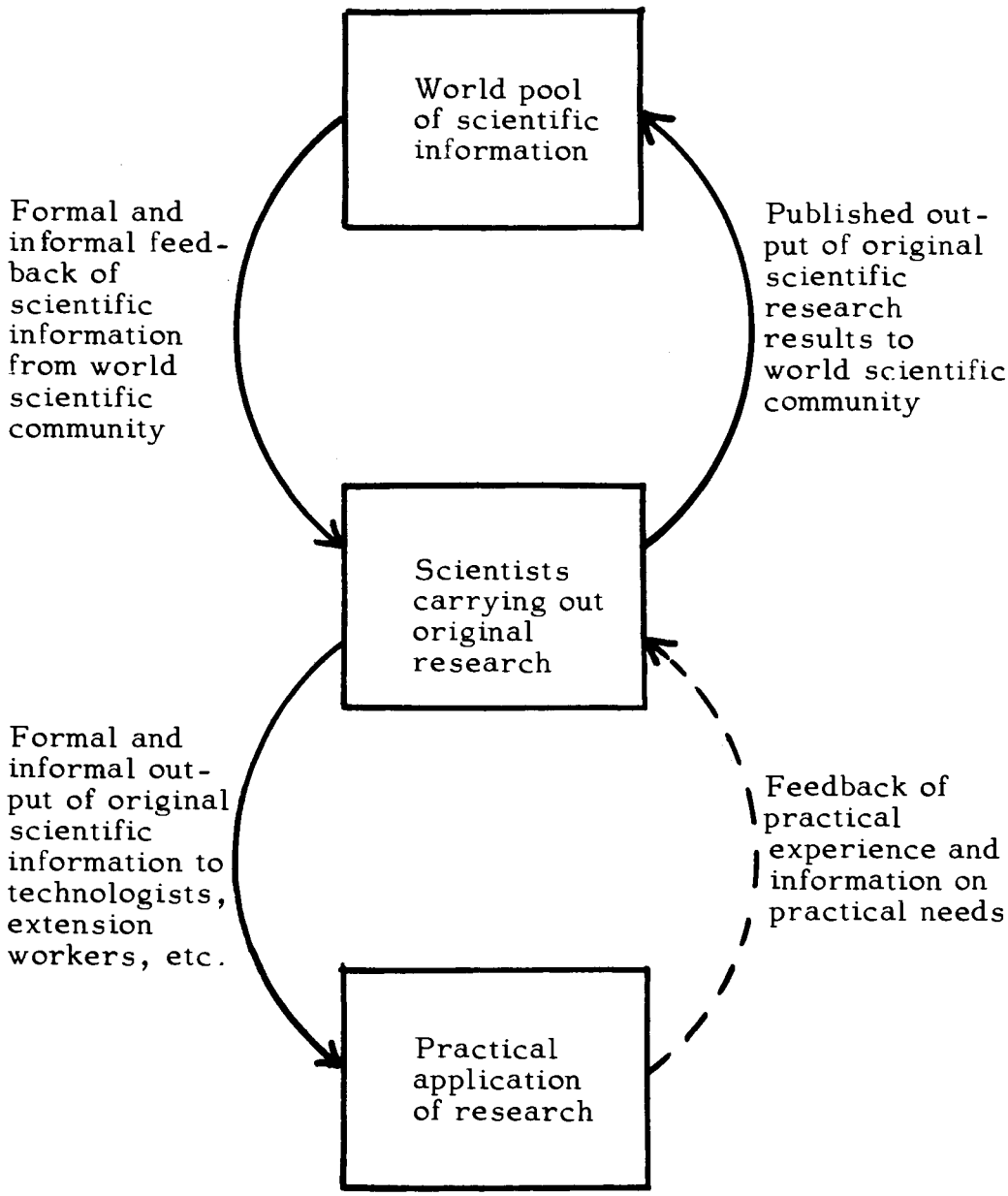


Fig. 2 Flow and feedback within scientific information

Most research or academic organizations will have libraries containing the more important publications relevant to their subject area. However, most scientists generally have only limited amounts of time to devote to scanning the literature.

To keep abreast of developments reported in the literature they do not normally see or which their library may not receive the library may take one or more of the so-called secondary documentation services in which abstracts or other notices of research articles are presented in a form in which they, or someone on their behalf, can scan and extract items of interest. The library resources can then be used to obtain the original article or a copy of it.

These secondary services thus enable libraries to increase greatly their effective literature coverage and they are now a prominent and established feature of the documentation scene in all scientific disciplines and technologies.

At one time, scientists did most of their own literature scanning and searching and generally maintained their own private card or other index files to the literature. Many still do so, but there is now an increasing trend towards the appointment of information officers to carry out part of this function on their behalf and generally to act as a middleman between the information source and the scientist.

In many developed countries there exist large national libraries and library networks covering virtually all areas of science and technology. Similarly, there has been a tremendous growth of documentation and information services, some using sophisticated computerized processing and publishing methods, designed to meet the information needs of particular scientific communities. These developments have been paralleled in recent years by initiatives towards the establishment of international information systems, such as AGRIS to cover agriculture, UNIDO industrial development, etc. These services have been designed with the needs of developing countries especially in mind. In addition, there are various international agencies, such as UNESCO, that actively promote and aid the development of scientific information services in these countries. Many developing countries are actively seeking to develop and improve their own national information and documentation services and to provide their scientific communities with better access to the common world pool of scientific information. The development and organization of national information systems will therefore also be dealt with in this Workshop.

A glossary of a few terms commonly used in the field of scientific information is appended.

GLOSSARY OF TERMS

Annotated bibliography. A list of titles of documents relevant to a specific, usually narrow subject area, with each title supplemented by annotations in the form of abstracts or other brief notes giving details of the contents of the documents.

Bibliographic information. Information about documents, typically details of their titles, authors' names, year volume and page numbers and other relevant information enabling the documents to be identified and retrieved.

Data base. In the information and documentation context, the whole store of bibliographic material, typically titles plus abstracts plus index entries, or other referral data, assembled by a documentation and information service.

Document. Any permanent record carrying information, usually in written form, but which may be on film, magnetic tape or other medium.

Documentation. That which has to do with documents, especially their arrangement for retrieval and presentation and the process of handling them for this purpose.

Documentation centre. An organization that (a) selects, acquires, stores and retrieves documents, (b) announces, abstracts, extracts and indexes the contents of documents, (c) disseminates documents or information about documents or their contents, (d) organizes and coordinates information services and facilities.

Documentation and information (D/I). A compound term denoting the whole process of recording documents and condensing, indexing and processing of their information content for presentation.

Extension service. Body of professional people who, working under or in cooperation with the government, provides technical advice to specific groups of users on a non-remunerative basis (government officials, technical experts from universities, etc.) Extension officers may also be called liaison/advisory officers, or information officers.

Information. The factual, numerical or other content of knowledge convened, typically by a document, but which may also be conveyed verbally, visually, etc.

Liaison/advisory service. See Extension Service.

Library. An organization which collects, stores and makes available for use books, periodicals and similar materials.

National information system. A system in which the various national documentation and information and referral services and resources of a country are linked and coordinated so as to maximize their value and availability to users.

Primary publication or document. The original publication or document in which new information or new interpretations of existing information is published in full.

Referral centre. A centre or unit providing hard data or other factual information on specific subjects rather than abstracts or other bibliographic information, or indicating sources (persons, institutions, publications, etc.) where such information can be obtained.

Repackaging. The rearrangement of bibliographic material (usually titles plus abstracts) that has already been published as a main output by a secondary information service into new, generally narrow, subject profiles or arrangements to meet the needs of special user groups.

Secondary publications. Publications in which secondary information, typically in the form of titles plus abstracts, derived from primary documents are published in order to inform users about the existence and contents of the documents; they may also include similarly derived catalogues, reviews, surveys, etc.

SDI (Selective Dissemination of Information). Type of regularly issued, repackaged secondary output consisting of regularly updated sets of references (usually documents titles, with or without abstracts) on a specific, narrow subject profile.

Retrospective retrieval. Type of one-off repackaged secondary output consisting of a single set of references (usually document titles with or without abstracts) on a specific, narrow subject profile and derived from literature published over a greater or lesser time span.

Thesaurus. A keyword list or index in which only controlled keywords are used. Such a list may specify which are permitted keywords and which are non-permitted keyword synonyms or related terms, with cross-references from non-permitted to permitted keywords. The keywords may also be arranged in a logical structure of main and subordinate or broader and narrower terms.