NEW TRENDS IN SCIENTIFIC COMMUNICATION

K. BHATTACHARYYA

IASLIC

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NEW TRENDS IN SCIENTIFIC COMMUNICATION

K. BHATTACHARYYA

(With a Foreword by Dr. S. R. Ranganathan)

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To

Prof. J. D. Bernal, F.R.S.,

who
infected the author with the
germ of the idea elaborated
in this monograph

FOREWORD

In the past, research was largely stimulated by the inner urge in a few stray individuals. But today a new social stimulus is promoting research. This stimulus is due to the rate of increase in population having become greater than the rate of production of natural and near-natural commodities essential for human existence—food, clothing, shelter, and transport. There is an urgent necessity, therefore, to produce artificial commodities out of directly-non-consumable raw materials. Consequently, research has to be planned and organised consciously on a large scale. Research has to be done by large teams of workers.

This change has two results. Firstly, research out-put has to be promptly fed into research teams in order to prevent dissipation of research potential due to unintended and unwanted repetition of work. Secondly, the rate of research out-put has increased many-fold.

This is producing a crisis in the physical embodiment of publication, selection, acquisition, organisation, storage and service of research out-put to research workers. This crisis has been engaging attention since World-War II. To resolve the crisis, re-thinking has become necessary in respect of each of the above six factors involved in the communication of the results of research from the producer to the consumer.

Sri Bhattacharyya gives in this monograph his own views of the way in which the crisis may be met. His approach is characterised by clear analysis and bold thinking. Problems posed are really challenging. The solution suggested might not be the only possible one.

There might even be doubts about the practicability of the solution. He is careful to state that nearly a generation will be required for his solution to mature. Perhops, one might feel that maturity may not be reached even after thirty years, unless a change takes place in the emotional make-up of man in respect of personal, zonal, national and regional barriers and the development of vested interests of various kinds at various levels.

These difficulties will not take away, however, from the value of the monograph. To start re-thinking about the crisis in scientific communication is by itself of value. It is hoped that this monograph will stimulate further thought and action.

September 17, 1962 **S. R. Ranganathan**

Documentation Research and
Training Centre,
Malleswaram, Bangalore-3.

PREFACE

Man has sometimes been defined as a tool-making animal. Whether anthropologists and sociologists will accept this as a complete definition of man is doubtful; however, what is incontrovertible is that tools are an index of human ingenuity, that they change with times and that the progress of civilization has invariably yielded better and more refined tools. To the Stone Age man, his implements were vital for survival; to the modern man they are nothing but museum pieces. Conversely, Faraday's original experiments on electricity merely served to amuse or at best excite the curiosity of the audience gathered at the Royal Institution's evening lectures; yet, within less than a century, electricity replaced steam as the main source of power for the industry and the household, revolutionizing the entire economy, and now in the second half of the twentieth century, comes nuclear energy to usher in a new era.

All this may appear almost a truism to the scientists. But its implications are not always obvious to them in domains outside their own field of activity. This brings us to the main point of this book, which is simply this: the men of science have been much too preoccupied with **their research in the laboratories** to devote much thought to **the tools used for the processing of scientific information.** Thus, a scientist using the most uptodate apparatus in his laboratory, uses uncritically and without demur virtually the same primitive tools of communication, fashioned by his predecessors several centuries ago. These tools, centering around the scientific periodicals as their main axis, served the cause of science well, in the good old days, but today when they are visi-

bly cracking under a massive load of ominously growing scientific information, there in neither sense nor science in clinging to these worn out tools.

This has been lately felt by many scientists, documentalists and information workers. But the task of evolving alternative tools of scientific communication has been considerably hampered, not simply because of inertia, prejudice and vested interest of which, to be sure, there is plenty, but also due to the fact that the problem has not been adequately faced as yet by those who feel the need of a change. It should be realised that despite its numerous defects, the existing information tools possess a comprehensive structure and a certain internal coherence. As against this, there have been up till now only fragmentary suggestions by various individuals on different aspects of scientific communication. What is required, however, is a comprehensive, integrated scheme that could be counterposed to the existing system.

Unesco showed its awareness of this problem, when it initiated in 1956 a 5-year study programme on this subject. But only two reports have been submitted under this programme (both published in the Unesco Bulletin for Libraries). The first report by H. Coblans (1957) deals mainly with mechanization of documentation work, while the second one by Phelps and Herlin (1960) gives an exhaustive summary of the views of the advocates and critics of the existing tools, giving their own affirmative vote for journals in the last page.

The present monograph is of a much broader scope ; it embraces the entire field of scientific communication, deals with the fundamental issues involved in this controversy and works out an integrated, alternative scheme which will be able to replace the existing system over a period. The form of publication of research

results, the organisational structure and techniques of abstracting, the classification and indexing system— these are the four main pillars on which the efficiency of the communication system depends. The author proposes radical changes in the existing practices regarding all of them.

The first part of the monograph deals with the problem of reduction of the growing volume of reading materials and of the form of original research publications and their mode of distribution. The highlight of this part, however, is the author's own scheme embodying a 4-stage plan of gradual transition from the existing to the final stage when periodicals will be completely replaced by reprints of research papers. The right of selection, scrutiny and editing is to be exercised by the scientists and their societies, while production is to be partly and bibliographical control to be entirely centralized. The need of careful planning and gradual transition has been insisted upon throughout. The main criticisms of the advocates of periodicals against this system e.g. impracticability, loss of scientific freedom, high costs etc. — have also been carefully examined and answered.

In the second and concluding part of this monograph, the author examines the impact the change-over from the existing periodical system to the reprint system will have on the various elements of the communication system e.g. abstracting, classification, indexing, reviews, language barrier, mechanization of documentation work, photo-reproduction of documents and library service. It is shown that each of these elements has got its own specific problems, even as they interact closely with each other. In each case, only the fundamental aspects of the problems have been discussed, with special reference to those posed by the change-over and the directions along which their solution may be sought have also been indicated.

Discerning readers will notice certain expressions in this book in the future tense which should have occurred in the past tense, on the basis of the date of publication of this book. This is due to the fact that the writing of the manuscript started in mid—1960 and ended in the last quarter of 1961. The first part appeared in IASLIC Bulletin, March 1961, and a brief synopsis of the complete monograph was presented at a symposium held during the Fourth General Meeting of IASLIC, February 14—17, 1962, at the Central Fuel Research Institute, Jealgora, Dhanbad. It was not possible to revise the manuscript before sending it to press. Thus, the prediction that "Chemical Abstracts" will one day be compelled to bring out sectional abstracts was made at a time when the decision of the publisher to bring out a separate Biochemical Section of Chemical Abstracts was not yet known. CA's subsequent circular to this effect confirmed the author's main line of reasoning.

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The author is deeply indebted to Dr. S. R. Ranganathan for kindly writing the Foreword to this monograph despite his ailing health and numerous preoccupations. The author would be failing in his duty if he does not acknowledge his debt of gratitude to Shri A. K. Mukherjee, Chief Librarian, Jadavpur University and Vice-President, IASLIC, but for whose untiring efforts and constant encouragement this work would have been well nigh impossible. IASLIC and its indefatigable Secretary Shri G. B. Ghosh deserve the author's sincere thanks for the seriousness with which they undertook the publication of this monograph inspite of their heavy publication programme. Thanks are also due to Dr. P. Mookerjee, Reader in Physical Chemistry, Indian Association for the Cultivation of Science, for helpful discussion.

September 19, 1962 K. Bhattacharyya

Indian Association for the
Cultivation of Science,
Calcutta.

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PART I

NEW TRENDS IN SCIENTIFIC COMMUNICATION

(PART I)

0.1. THE EXPANDING UNIVERSE

The world of science is currently facing a problem which, both in dimension and depth, is even more acute than what the demographers menacingly term, "The Population Explosion". While world population is increasing at less than 2 per cent per annum, scientific publications are increasing annually by about 5-10 per cent (1). In 1950, the number of scientific periodicals alone were calculated at about 50,000 by the compilers of the "World List of Scientific Periodicals". By 1960, this number must have exceeded 60,000. But this number, formidable as it is, does not give a full idea of the dimension of the ever growing volume of reading material, because the number of articles as well as pages per each periodical per year have also increased many times in the last few decades, as shown below in the case of four internationally recognized periodicals :

	No. of pages per year	
	1920	1959
Physical Review	1,157	6,837
Physics Abstracts	751	1,758
Journal of Amer. Chem. Soc.	2,716	6,601
Chemical Abstracts	4,365*	23,114

(*Fig. for 1922)

When to this problem of volume, is added the further problem created by multiplicity of languages in which research papers are published, the complexity and magnitude of the problem threaten to overwhelm us. The same problem confronts scientists, bibliographers and librarians at different points. While the volume of reading material has shot up to astronomical heights, the scientist's personal capacity to read has remained more or less constant, with the result that he is fast losing the confidence that he knows all about his subject that is being currently done throughout the world. Faced with the " runaway spiral " of bibliography, the bibliographers confess that with best of efforts perhaps no more than 33 per cent of the published material could be covered in the existing abstracting periodicals (2). Lastly, the harassed librarian finds it an increasingly absurd job trying to adjust his limited budget with the growing number of books and periodicals even in his

own narrow field. There is no scope for contenting oneself with the idea that all significant research results are mentioned in the "standard" abstracting services. Numerous cases may be mentioned to destroy this complacency. It has been shown that due to inadequate documentation, Mendel's original work (about his theory of heredity) remained unknown for thirtyfive years. (3). Dr. A. Prins of the Dutch Patent office calculated that from a large collection of patent applications 65 per cent were refused and a further 31 per cent limited because the inventions were already wholly or partly known (4). With complete documentation, such lapses and wastage could have been prevented. Thus, the case for evaluating the existing bibliographical methods and adopting improved methods for redressing the present situation is incontrovertible.

0.2. ON THE THRESHOLD OF A NEW AGE ?

This situation has been summed up by an authoritative body as follows :

"We are entering a new age in the communication of information and knowledge which will require methods as different from those of today as our present techniques are from those of the Middle Ages. There is need for a revolution in thinking on this subject, owing to several causes.....The question is large and complex. It is difficult and even dangerous to seek to solve individual minor problems without giving due attention to the problem as a whole" (5). Such an effort was made by the Royal Society of London when it organized, in 1946, the Empire Scientific Conference and then in 1948, a full fledged conference on Scientific Information. The Reports of these two conferences still represent the most comprehensive thinking on this problem in all its aspects

and must be studied for any serious discussion on the subject. Subsequently, the FID, the IFLA and the ISO (Technical Comittee on Documentation) held a number of meetings on different aspects of this problem. The most important in this connection is the decision, taken by the Bureau of the Unesco International Advisory Committee on Bibliography at its meeting held in May 1956, in Paris, to launch a 5-year plan "for an initial study on the nature and extent of present methods of communicating recorded knowledge and on possibilities of improvement through new techniques" (6). The first phase of this programme is to terminate in 1961 or 1962, by a large meeting in, perhaps, India. Under this plan two project reports have been submitted up till now,—the first one in 1957 by H. Coblans (7) and the other in 1960 by R. H. Phelps and J. P. Herlin (8).

1. THE BASIC AIMS

As the subject is vast and complex, it is necessary at the very outset to have a clear conception of the basic aims we want to achieve in setting up an efficient scientific communication system. In our opinion, these aims are as follows :

(1) Standardization of the form of original publications and their mode of distribution;

(2) Making scientific information as speedily available as possible to the research workers;

(3) Ensuring complete coverage, both in regard to countries and subjects;

(4) Reduction of the volume of reading materials

by the elimination of unimportant and sub-standard papers, without impairing efficiency.

The present part deals with the first and the last items mentioned above, while the related problems of reviews, abstracting, indexing, classification, translation and mechanisation of documentation services will be treated in Part II of this series.

2. HOW TO REDUCE THE READING LOAD ?

It is possible to reduce appreciably the current volume of reading materials without any drastic change in the system of research publications. It involves the elimination of repetitive, trivial or inconsequential works. Specific proposals to this effect were made at a meeting held at the Ciba Foundation, London, in 1960 (9).

It is often found that the same material is published more than once; for example, first as a part of the proceedings or transactions of the Institute where the author is working, then as a paper read at a conference and finally as an article in a periodical. As a result, the abstractor often finds himself abstracting the same work twice or thrice. This practice should be discouraged.

However, the author is not always responsibile for this. The authorities of many universities and research institutes insist that those attending conferences must contribute a paper in order to get the travelling and other expenses. Dr. G. E. W. Wolstenholme (Director, Ciba Foundation) informed that fortunately, some of the more enlightened grant giving bodies no longer insisted on this. This lead should be followed by others.

While the author publishes his paper in a standard

periodical for the sake of his better recognition, a modified version of the same work may appear in his institute's organ for other reasons. Many institutes and university faculties start their organs with the primary object of getting other valuable periodicals in exchange. This was the opinion of Dr. B. M. Crowther (Editor, Physics Abstracts). He also thought that nowadays many of the conference proceedings had very little value. In his opinion, the practice of publishing conference proceedings may as well be discontinued. Conference may be held to discuss recently published works, but without the publication of further papers.

In some circles, particularly in countries with less developed scientific traditions, there is a tendency to estimate a man's scientific standing and to reward him according to the quantity rather than the quality of his research publications. This gives rise to lot of dross which inflates the volume of reading material. There is no easy solution to this problem, except by raising the quality of scientific administration itself.

Another method of reducing the reading load is by improving the standard of refereeing to check reduplication.

The rapid increase in the number of scientific periodicals is also partly due to the competition among the business publishers who bring out new periodicals (either without a tangible demand or without guarantee of a steady supply of research papers of good standard) in order to boost up their prestige in the intellectual world. This was admitted at the above meeting by Mr. R. W. David, President, Publishers' Association (U.K.). That's why editors of so many periodicals find it hard to get good manuscripts to keep them going (D. Richter), which lowers the standard of the journal.

To attract subscribers, the initial volumes are produced at a high level. Subsequently, the quality deteriorates very fast. According to one opinion (C.C.N. Vass, Hony. Secy., International Abstract of Biological Sciences), sometimes the Vol. 1 of a new periodical appears to be the only volume worth buying.

Many bibliographers feel that the publication of research results, in non-periodical forms, should be gradually stopped.

Given cooperation on all hands, many of the above suggestions can be worked upon ; taken together, they provide the framework of a policy aimed at limiting, in a planned manner, the unplanned growth of reading materials.

3. PERIODICALS Vs. REPRINTS

The existing disordered state of bibliography and its uncontrolled, haphazard proliferaton have driven many reputed scientists, documentalists and librarians to the conclusion that the situation cannot be remedied by maintaining the present system of publication of research results through the medium of periodicals. The individual scientist feels that he needs only a small fraction of papers appearing in innumerable periodicals which he cannot read. The librarian faces the acute problem of budget and space of acquiring a collection of periodicals, only a small portion of which is needed by his clientele. The abstractor/bibliographer does not possess any sure key to complete documentation even in his specific field ; for him centralization of bibliographical control is essential. All this has led them to propose, with numerous variations though, a system whose basic principle consists in replacing the periodicals with

reprints of individual papers, treating the latter as the primary unit of publication. On the other hand, the advocates of periodicals have assailed this scheme from various angles (8).

PROGRAMME FOR A BIBLIOGRAPHIC REVOLUTION

We are firmly convinced that reprint publications would prove to be superior to the existing system. We give below the outline of a 4-stage programme of gradual transition from the existing periodical system to the final phase of the reprint system. This programme, while incorporating the positive features of the proposals put forward by some of the proponents of the scheme, contains the author's own views as well, particularly those intended to meet the objections of the critics of the scheme.

4.0. OUTLINE OF THE PROGRAMME

To make it easier for the readers to follow the scheme clearly, we give below a synopsis of the headings under which the scheme is elaborated. In subsequent discussions, only the index numbers of the different headings and sub-headings will be used to avoid repetition.

0. Preliminary Phase of Study & Planning.

0.1 Drawing up detailed plans for each phase within the framework of a broad, long term "Perspective Plan".

0.2 Compilation of a complete world list of scientific periodicals.

0.3 Compilation of a complete world directory of scientific societies, institutions, etc.

0.4 Exhaustive study of the present periodical system with particular reference to the facilities provided by the existing periodicals, the subject fields covered by them and their present modes of publication.

0.5 Setting up international standards in abstracting, classification, indexing, cataloguing, publishing and storage of materials.

1. Limitation of the Number of Periodicals.

2. Different Forms of Research Publications under the Scheme :

2.1 Periodicals

2.2 Reprints

2.3 Auxiliary Publications e.g. photoreproduction.

3. **The Individual Scientist :** His position under the scheme :

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3.2 As a reader

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- 5.1.2 National Documentation Centre (N.D.C.)
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- 5.2.3 Administrative Wing

5.3 Functions of Z.D.C., N.D.C. & I.D.C. in their dual role as collector and distributor of information.

- 5.3.1 Collection of abstracts, reports and periodicals
- 5.3.2 Compilation of lists of preview abstracts
- 5.3.3 Classification, indexing and publication of reprints; preparation of catalogue cards for reprints.
- 5.3.4 Distribution of lists of abstracts, reprints and cards.
- 5.3.5 Functions of the I.D.C.

5.3.6 Coordination between the Z.D.C., N.D.C. & I.D.C.

6. Users of Information

6.1 Their relation with the learned societies etc.

6.2 Their relation with the Z.D.C., N.D.C., & I.D.C. re : acquisition of reports and remittance for them.

7. Duration of each Phase of the Scheme

4.1 DETAILS OF THE SCHEME

4.1. 0. The Preliminary Phase

0.1 The existing periodical system has faithfully served the scientific communty for the last 3-4 centuries. It would, therefore, be thoughtless to demolish it without careful, detailed planning of all aspects, even minor ones, of the problem. The final goal aimed at should be clear and the targets for the successive phases must be so fixed as would lead to the final goal without any major difficulty. For this the following steps are essential.

0.2 Compilation of a complete world list of scientific periodicals and their grouping under subjects, countries and sponsoring societies/publishers.

0.3 Compilation of a complete directory of learned societies, institutions, universities

and their faculties, documentation centres and special libraries all over the world and their grouping under specific subjects. From this directory a scientist and a librarian will be readily able to find out which institutions in the world are engaged in research in his own field or which documentation centeres/libraries can provide specialized service or information on his own subjects.

0.4. 1. Before changing over a periodical to the reprint system, the different facilities provided by it should be minutely considered. Besides carrying research reports, periodicals very often offer other services under different sections—e.g. specialised abstract lists, lists of patents, review articles, calendar of events and year books in special subjects, news service regarding notice of important conferences etc. and their reports, significant developments in that field, research facilities in different countries etc. There is no justification for encumbering research publications with these extraneous materials; yet they are essential to the scientists and often constitute valuable reference tools for the librarian/information workers. Before dismantling an existing periodical, care should be taken to see that abstracts, yearbooks, directories, patent inventories etc.—are available in that field to compensate for the loss of these services. One can then buy them separately as reference volumes, if desired.

0.4. 2. A list of periodicals, clearly indicating the subject fields covered by them, would be essential to planning the next phase. Periodicals that cover the entire field of science or knowledge—such as 'Comptes Rendus' of the French Academy of Science or 'Doklady' of the Academy of Sciences USSR—are burdensome for scientists and needlessly expensive for librarians. They should be the first targets for the change-over.

0.4. 3. Then the varying modes of publication of research papers by various societies in different countries should be studied. Some societies already publish their papers as separates (to which Vol. nos. are given) —e.g. Philosophical Transactions of the Royal Society of London or "Matematisk-Fysiske-Meddelelser' of the Danish Royal Scientific Society. Their list should be separate from those that are published as traditional periodicals. This survey should clearly indicate the extent of work to be undertaken, as well as the progress already achieved towards the reprint system.

0.5 For the processing of countless reprints, in place of periodicals, a high degree of standardization in every aspect of documentation work—e.g. classification, indexing, cataloguing, storage of reprints etc. will be required. This work must precede the replacement of periodicals by reprints. Otherwise there will be all round chaos.

6. The preliminary phase will cover **five** years.

4.1.1. The First Phase.

1. Periodicals, published by commercial firms, are to be discontinued in this phase. In the Soviet Union and other centrally planned countries, this is already the case.

   Simultaneously, the number of journals published by different learned societies are to be voluntarily limited by them so that in each subject there may be only a limited number of periodicals. Subject specialization of journals will be encouraged. Of course, the degree of specialization of a periodical will depend on whether the volume of research activity in that subject in that country justifies the publication of a separate periodical on it.

4.1 Societies publishing periodicals under clause (1) will remain in sole charge of their publications, including finances. They are only to send two copies of their periodicals as well as those of preview abstracts of accepted papers to the Z.D.C./N.D.C/I.D.C.

4.2 Those organs that cover wide subject fields —e.g. Proceedings of the American Academy of Arts and Sciences—would cease publication **as periodicals.** They will still retain their full control over the selection and editing of papers submitted to them. At no stage will this right of learned societies be affected in any way. However, the

selected papers will be published as reprints by the Zonal or National Documentation Centre as the case may be. Any financial loss which may result due to this change-over to the reprint form of publication will not have to be borne, therefore, by the societies themselves. The society which sponsors the publication of a paper may treat it as an individual issue of their organ and, if they want, may bind them from time to time into a suitable number of volumes. This will leave the academic status of the existing societies intact in relation to their publications. Two copies of preview abstract of every paper, immediately after its acceptance, shall be sent to the Z.D.C./ N.D.C./I.D.C.

5.1 During this phase, documentation centres will be established in every country, including Z.D.C.s in big countries like the USA, India, USSR etc. An International Documentation Centre is also to be established at this stage.

5.2 The basic unit will be the N.D.C. in a small country and Z.D.C.s in a big country.

The Z.D.C./N.D.C. will have the following wings :

5.2.1 Publication Wing : in charge of publication and printing of reports, lists of abstracts, and photo-reproduction.

5.2.2 Technical Wing : in charge of compilation of list of abstracts, classification and indexing of reprints, preparation of catalogue cards for reprints.

5.2.3 Administrative Wing : in charge of distribution of preview abstract lists, reprints, and catalogue cards to subscribers and also accounts.

5.3 The Z.D.C./N.D.C./I.D.C. will receive, according to the law of compulsory deposit of periodicals/reprints, two copies each of these materials published in the area under its jurisdiction, as well as preview abstracts of accepted papers from the sponsoring societies operating in its area.

The Z.D.C./N.D.C. will compile a fortnightly list, N.D.C. (big country) a monthly list, and the I.D.C. a bi-monthly list of preview abstracts in each subject. The N.D.C. list and the I.D.C. list will be compiled on the basis of the Z.D.C. list and the N.D.C. list respectively, transmitted by the lower d.c.s. to the higher d.c.s. regularly and speedily.

These lists of abstracts in different subjects will be sent to subscribers who have registered their names with the Centres and also their subject interests.

At this stage reprints will be distributed and order received usually by the Z.D.Cs/N.D.C. alone. I.D.C. will neither publish reprints nor accept any order for supplying them.

In addition to publishing reprints, abstracts etc.,

the Z.D.C./N.D.C. will classify the reprints and catalogue their abstracts on cards giving author and subject entries. These cards will be sent along with the reprints to the subscribers who have communicated their requiremens on receiving the preview abstracts. This will save, for the individual libraries, the time required for processing these innumerable reprints. The cost of the cards will be included in the cost of the reprints. The Z.D.C./N.D.C. will also supply photocopies of any reprint or periodical article published in its area.

The function of the I.D.C. will be, primarily, to bring out regularly a bi-monthly international list of abstracts in every major branch of science. It will also lay down standards in abstracting, classification, indexing etc., and constantly carry out researches in these fields to keep pace with the rapid progress in the various sciences. It will also coordinate the activities of the various national D.C.s.

All payments for reprints, abstracts etc., shall be made to the Z.D.C./N.D.C. through some standard international coupons to get over foreign exchange difficulties.

6.1 During this phase, subscribers should normally operate through the Z.D.C./N.D.C. However, those who are interested in getting the publications of a particular learned society may get their list of preview abstracts directly from the Society ; if they so desire, they may purchase their complete set of papers and bind them as periodical volumes instead of purchasing separate reprins. All orders and remittances shall, however, be sent to the Z.D.C./N.D.C. alone.

6.2. Subscribers are to register their names with

and notify their subject interests to the Z.D.C./N.D.C. This will entitle them to receive, for a small charge, the Z.D.C./N.D.C.'s fortnightly or the N.D.C's monthly list of preview abstracts in his subject. On receipt of the list, the subscriber is to make his selection and communicate it to the D.C.s. by mentioning the document number shown against each abstract. Payments will be adjusted annually against the total number of reprints taken by a subscriber from a Z.D.C./N.D.C. Wherever a Z.D.C. exists, it will handle orders and publication.

7. The first phase will spread over **ten years.**

4.1.2. The Second Phase

1. Periodicals dealing with a highly specialized subject (for which there is a clearly defined, exclusive demand in the whole world) will not be affected in this phase. All other periodicals will be gradually shifted to the reprint form of publication.

2. The individual scientist will submit his paper to a society for acceptance, instead of submitting it to the editor for publication in a periodical, as at present.

3. In every country, there will be societies, institutions etc., recognized by the country's highest scientific body (such as the National Academy of Sciences in the U.S.A. or the Academy of Sciences in the U.S.S.R.). These recognized scientific bodies alone will be entitled to sanction a paper for publication. This procedure will ensure the quality of published papers and guarantee academic freedom.

4. Publication, processing and distribution of reprints will remain as before in the hands of the N.D.C.

and for a big country, in the hand of the Z.D.C., to avoid top heavy administration at the centre.

However, the distribution of the abstract lists and the receipt of orders will be concentrated in the N.D.C. for all countries, big or small. The N.D.C. will accept orders only from societies, Z.D.C.s and other N.D.C.s ; as a special case, they may accept orders from eminent scientists of those countries where no N.D.C. has been yet formed.

5. During this phase, the N.D.C. and the I.D.C. will issue fortnightly and monthly abstract lists respectively in each subject to the subscribers. This increased frequency will be made possible due to experience gained by the D.C.s and expansion in their staff.

6. Same as before, with the only difference that transactions will now be with the N.D.C.s This will be more convenient for the subscribers who will be able to deal with a limited number of N.D.C.s, instead of innumerable Z.D.C.s, all over the globe.

7. The second phase will also last **ten years.**

4.1.3. The Final Phase

1. During this phase, each of the remaining highly specialized periodicals will be carefully examined to see if it is necessary to change them over to the reprint form. At any rate, their number will be further reduced by bringing out one international periodical in one, highly specialized, subject. (The practice of bringing out international organs with their editorial boards composed of eminent scientists of different countries is increasingly gaining ground in the post—Second World

War period). The existence of more than one periodical in a highly restricted field, due to national rivalries, has to be eliminated. In that case scientists, bibligraphers and librarians will not find it unmanageable or too costly to handle them even in their traditional form.

2. Thus, the pattern of publication emerging in the final phase will be as follows :

2.1. Survival of a handful of periodicals, published internationally in highly specialized subjects.

2.2. The dominant form of publication will be the reprints. The overwhelming portion of today's periodicals will be converted to the reprint system by the beginning of this phase.

2.3. In addition to the existence of the above forms, auxiliary publications, mainly, microfilms, microcards, paper photocopies etc., will play a vital part in supplementing the other services, particularly in relation to the supply of copies of articles in periodicals, old periodical volumes, reprints whose initial stock is exhausted etc., etc.

3. The relation of the individual scientific worker with his professional societies will remain unchanged. No administrator will intervene there and suggest what is or is not fit for publication.

His position as the author of a paper and as an user of information will, however, improve enormously. Through the publication of preview abstracts at short intervals, his work will be comunicated speedily to other parts of the world, just as he will be able to learn similarly about other's works quickly. This high level of efficiency will be achieved because of the centralization of publication and distribution of all research results.

4. The academic freedom of the societies will remain uninterfered with as before.

5. Where the Z.D.C.s, exist, they will be in charge of publication and processing of the reports as well as their despatch to the different N.D.C.s of the world and the I.D.C. as well. The Z.D.C. will compile a weekly list of preview abstracts for its internal use and also for transmission to the N.D.C.

The transations between two countries will take place between their respective N.D.C.s as regards their exchange of publication lists, lists of requirements, remittances etc.

The N.D.C. will circulate a weekly list of preview abstracts among other N.D.C.s of the world. All abstract lists will be distributed by air mail to speed up transmission of information.

Lists of preview abstracts and copies of reports will be printed by traditional means or photoreproduced, depending upon the volume of demand for them. This will mainly depend on the degree of specialization of the subject. It will be one of the primary tasks of a Z.D.C./N.D.C. to keep an exact record of the subject interests of the different laboratories, societies and institutions operating in its area. It is on the basis of this record that an N.D.C. will communicate its requirements to other N.D.C.s and, in its turn, will satisfy their demands. With the help of statisticians and computing machines at its disposal, it would not be at all difficult for an N.D.C. to find out, at an instant, the number of copies of reports required, in a particular field, to satify the world demand. Reprints will be printed or photocopied accordingly. Renowned scientific periodicals, having a

world market and mass circulation, run their affairs, in fact, along such lines.

Every N.D.C. will have a research wing. Problems relating to publication, abstracting, classification and indexing of papers, cataloguing of abstracts and photo-reproduction methods—which will arise in course of work will be noted and examined; measures for improving the existing methods and techniques will be studied here. The reports of such studies will be sent by the N.D.C.s to the I.D.C.

In addition to bringing out a fortnightly international list of preview abstracts in each subject, the I.D.C.'s research wing will examine the study reports of the various N.D.C.s. and lay down international standards to be followed by all N.D.C.s.

6. All subscribers inside a country shall communicate their subject interests and their requirements of abstract lists and reprints to their national D.C.s. and they will receive their supplies as well through them. Due to increased experience, greater skill and adequate staff at their disposal, gained over 20 years, it is expected this procedure will not involve much red tape in acquiring and transmitting reports to subscribers.

7. This phase, which is mainly devoted to consolidation of the work started in the earlier phases, will be completed within five years.

The entire scheme, starting with the preliminary phase and ending in this phase will, therefore, take 30 years to complete.

5. ANSWERING THE CRITICS

5.1. The Scientists' Benefit :

The above scheme would be highly useful to all concerned—scientists, bibliographers and librarians alike. The scientist will get only his desired papers and be rid of unwanted burden of reading materials. He will get to know others' work and be able to communicate his own work more speedily. Thus, the risk of duplication of work will be avoided and complete coverage of his subject throughout the world ensured.

5.2. Loss of Scientific Freedom ?

The scheme should allay the fears often expressed by many reputed scientists that the institution of a highly centralized organisation would threaten freedom of science (10). As has been repeatedly mentioned before, the right of selecting, sponsoring and editing a paper will be in the hands of the scientists themselves, operating through numerous societies, institutions etc. If a paper is rejected by one body, the author shall have the right to resubmit the same paper to another, recognized scientific body. This should serve as a safeguard against arbitrary decisions.

5.3. Hindrance to Cross-fertilization of Knowledge ?

Another criticism made by some scientists is that the replacement of periodicals by reprints will lead to intense specialization. This will hinder cross-fertilization of knowledge which is essential to scientific progress (11). In our scheme this need will be satisfied by the publication of two types of reviews in various subjects—e.g. reviews for specialists and reviews for

general scientific readers. This point will be discussed in greater detail in Part II.

5.4. A Master-key to Complete Documentation :

The bibliographer will perhaps benefit most from the above system. He will not be faced with the problem of covering an ever expanding field of an uncertain and impossible number of periodicals and at the same time keeping track of informations that appear in various forms—e.g. in books, periodicals, technical reports, notes, monographs, conference proceedings, etc. Under the new system, his work will become well-defined, limited and standardized. For example, a bibliographer working at the Z.D.C. level in a particular subject—say, Physics or Chemistry—will have to compile a list of abstracts, in that subject, of papers sponsored and published only in that Z.D.C.'s area. Thus, no report published in that area can escape his attention; simultaneouly, the number of papers to be handled by him will be reduced to manageable figures. Similarly the N.D.C. and I.D.C. bibliographers will compile their lists of abstracts in specific subjects on the basis of a limited number of Z.D.C. and N.D.C. lists respectively.

5.5. The Librarians' Headaches :

The librarian's insoluble problem of space and budget will be, without doubt, much nearer solution ; although his other labours may somewhat increase. But these need not pose such insuperable difficulties as visualized by Phelps and Herlin. According to them, "Bibliographical control would not be improved, for the task of receiving, recording, indexing, and servicing hundreds of thousands of separate pieces, especially by larger libraries would be even more difficult. Staffs of libraries would have to

be enlarged to a point where financial support could not be obtained even if it were possible to recruit qualified personnel. Our own experience in the Engineering Societies Library with preprints of our societies shows that the man-hours required to receive and prepare separates for use are many times the number of man-hours required to handle the same number of papers received as papers in periodicals." Their verdict on the reprint system, given at the end of their project report, is "that a system of separates distribution is not a practical solution to problems of scientific communication" (12). The above authors approach the problem primarily from the viewpoint of librarians and seek a solution within the limitation of the resources available to individual institutes and libraries. There can obviously be no solution on this basis. First, it has to be recognized that the techniques of library science are meant to serve the interests of the readers, in this case, the scientists ; thus, if the existing library methods fail to satisfy the need of the scientists for an efficient scientific information service, the only correct approach is not to ignore their demands but to carry out suitable modifications in the methodology of library administration. Secondly, the authors did not consider the variant that reprints may be classified, indexed and catalogued by a central agency. This provision, included in our scheme, will save much of the time and labour of the library staff. It is admitted that the problem of selecting desired reprints and their storage will impose heavier burdens on and pose new problems for the library. But none of them is insuperable. To cope with some of these problems, greater collaboration between the library and research staff will be required. To get rid of the trouble of selecting each reprint separately, a library may issue a standing instruction to the N.D.C. to send it all the reports appearing anywhere in the world in its own sub-

jects, its subject interests being already communicated to the N.D.C. in detail. Lastly, any action contemplated will have to be taken collectively—first on the zonal, then on the national and finally, on the international level.

5.6. High Cost of the Reprint System ?

Much has been said about the high cost of reprint publication (13). It has been stated that two British publishers and one American publisher abandoned their scheme of reprint distribution, in place of periodicals, after trying it for sometime, precisely on this ground. But this argument about costs sounds queer. Why should the question of "economy" be considered only from the publishers' viewpoint ? Has there been any survey of the huge wastage of money incurred by thousands of libraries in every country over unwanted literatures included in periodicals ? Does the society as a whole gain from a system of publication in which the bulk of the consumers has to go on sacrificing in order to make it "economic" for a handful of publishers ? If the system of reprint publication is found to be more useful to the scientists than the present periodical system, as has been shown to be so in our preceding discussion, then its costs should be borne by society as a whole, that is, mainly by the state. Since nowadays most of the scientific research is financed, in every country, by the state, directly or indirectly through grants, it will only signify a rearrangement of financial accounting, rather than an additional heavy burden for the exchequer. The cumulative saving of all the libraries, under the reprint system, should add up to a substantial sum which may suffice to subsidize the scheme. At any rate, we feel that financial considerations should

not hold up progress, if the scheme is otherwise found desirable and technically feasible.

6. FUTURE OUTLOOK FOR THE SCHEME

The replacement of periodicals by reprints raises many complex and inter-related problems in the field of classification, abstracting, indexing and filing of reprints (these will be discussed in Part II of this paper). Any false step should be avoided. As reiterated so many times throughout this article, much thought will have to be given to plan carefully the different phases, to lay down international standards, and, what would be more difficult, to enforce them in all countries. It is in this spirit that the Unesco has initiated a series of studies on this problem.

Unfortunately, those who criticise the reprint system and stand for the continuation of the periodical system do not realise that they have also a duty to suggest alternative measures for removing the present chaos in the field of scientific bibliography.

It is quite conceivable that the scheme will not find ready acceptance in the near future due to inertia, prejudice and even vested interests of commercial publishers and the authorities of the existing periodicals. Different elements of this scheme are already in operation for many years in various countries and they have not given rise to any complication. It is only when these elements are sought to be woven into a harmonious pattern and to be made universally applicable that we suddenly find ourselves confronted with a formidable opposition. But we are convinced that the compulsion of necessity, coupled with the intrinsic value of the

scheme, will finally make its underlying principles universally accepted.

7. NEED OF AN INDIAN SYMPOSIUM

The Five-year plan of initial studies and planning on this subject, adopted by the Unesco in 1956, will end in 1961-62. Unesco has invited all interested bodies to deliberate on these problems and send to the Unesco the proceedings of these deliberations, with recommendations, if any. These will be considered by Unesco's Library and Documentation Division. It would be fitting if the next symposium of the Iaslic is organized on this vital problem. Scientists should be particularly invited to participate in this symposium. The proceedings of the symposium together with its recommendations should be sent to Unesco.

The present series of papers is intended to stimulate discussion on the subject and to provide a basis for it.

PART II

PART I I

The main objective of an ideal scientific communication system is to ensure, on the one hand, complete documentation in a given subject and elimination of all superfluous materials and on the other hand, the availability of the benefits of such a comprehensive documentation to its users with maximum economy of time.

0.1. Elements of an Efficient Communication System.

The factors on which the efficiency of a scientific communication system depends are varied, complex and inter-related. The most important elements of the system are as follows :

1. Form of publication of the results of original research;
2. Abstracting;
3. Classification;
4. Subject indexing;
5. Cataloguing;
6. Periodical Reviews;
7. Language Barrier Elimination;
8. Mechanization of Documentation Services;
9. Photographic Reproduction of Documents;
10. Library Services.

The extent of benefit which the scientists are likely to derive ultimately from a communication system would be determined not so much by individual perfection of one or two of the above mentioned factors, but by a balanced and harmonious blending of all of them. A high degree of standardization in abstracting and indexing techniques may bring very little improvement to the users, if, for example, the linguistic barrier goes

workers results of research being done in their particular fields throughout the world, does it justify bringing out another set of abstracts of the same papers for general scientists ? What interest can a worker in Electrochemistry have in reading the abstracts of papers dealing with, say, natural terpenes ? The needs of scientists for keeping themselves generally informed of major developments in related fields can be adequately met by means of periodical reviews of work done in these fields. Abstracts are not the appropriate media to stimulate cross fertilization of knowledge. Looked at from this angle, that is, on the basis of the assumption that abstracts are meant only for specialists, the validity of publishing a single abstracting journal—like the "Chemical Abstracts"—covering such a broad subject as "Chemistry" can be seriously questioned; at least the broad divisions of chemistry—e.g. Physical, Analytical, Inorganic, Organic etc.—may be published separately. In fact, "Chemical Abstracts" is becoming increasingly so unwieldy and costly that we should not be surprised to see it split up into various sections in the near future. The Bureau of British Abstracts have long since realised the necessity of such sectionalization of its abstracting services.

The only legitimate fear which a scientist, working in a field with overlapping subject interests, may have about such sectionalization is that he is likely to miss some papers pertaining to his field as a result of specialization. However, this criticism is not unanswerable. In the last few decades, the traditional boundary between physics, chemistry and biology has broken down; that has not led anybody to suggest the publication of a single abstracting journal covering all the above subjects. Modern scientific developments have led to two, apparently contradictory, tendencies—intense specialization on the

one hand and integration of various sciences on the other. The only possible remedy in such a situation is for the abstractors to provide adequate cross references in their respective sectional abstracts (through co-ordination among various sections working under a centralized abstracting agency) and for the scientists to subscribe to those sectional abstracts in which they may have marked overlapping interests.

1.1.2. Multiple Abstracting

This brings us to the topic of multiple abstracting of papers. Some papers, depending upon their hybrid subject matter, may have to be abstracted separately for different groups of scientists having different subject interests. As a result, abstracts of the same paper may appear differently in abstracting journals devoted to different subjects. Dr. C. H. Desch related his own experience at the 1948 Royal Society Scientific Information Conference that in abstracting the same paper for the Iron & Steel Institute and for Metallurgical Abstracts he had frequently found it necessary to write two separate and distinct abstracts (4). Multiple abstracting is essential if complete documentation is to be achieved and it can occur efficiently only through a system of cooperative abstracting among different groups of abstractors specializing in different subjects and collaborating with each other closely.

1.1.3. Transmission through Various Media

Whatever abstracting service is ultimately introduced in a particular subject, should be made available, to be really useful and effective, to the international scientific community. For this, editions in at least 5 languages—English, German, French, Russian and one

universal language, Esperanto or Interlingua (preferably, the latter owing to its greater application in the field of scientific communication)—would be necessary.

The scope of abstracts, as conceived by us, is thus defined as follows : it would be informative, specialized, capable of satisfying the diverse needs of various categories of scientists and universally intelligible, so far as their medium of communication is concerned.

1.2. Quality :

At present, there are considerable disparities in the level of efficiency in abstracting. While the quality of abstracting has to be improved in general, certain aspects of the abstracting operation need greater standardization. It should also be carefully considered as to which factors are amenable to standardization and which are not. Technically, there are three relevant factors—e.g. the character of abstracts, their length and the references given.

1.2.1. Character :

In general, abstracts ought to be factual rather than critical in their method of treatment ; they should give a clear indication of the **new findings** of the author relevant to the interests of the abstract users.

1.2.2. Length :

It is highly doubtful if the length of an abstract can be standardized. The length will depend primarily on the subject matter of the paper and the categories of users for whom it is meant.

1.2.3. References :

The system of giving references in papers should be thoroughly standardized. It is desirable that the references should be complete. It would, perhaps, be more helpful if the abstract mentions, besides the usual periodical reference or the document number, the address of the Institution wherefrom the paper originated, as well as the Zonal or National Documentation Centre from which the document may be ordered. The abbreviations used for titles of periodicals should conform to certain international standards, such as that in the "World List of Scientific Periodicals".

1.3. Forms of Publication :

Abstracts may be used (a) in the form of a regular journal printed on both sides of the paper, (b) in a journal printed only on one side and (b) finally in the form of cards. All the above forms are in use and sometime the same abstracting service is available in more than one form. Each form has its own advantages and disadvantages.

1.3.1. Journals printed on both sides possess the advantage of the book form in its easy manoevrability. For a single issue or even for an annual volume it is quite handy, although in the latter case, abstracts on the same subject will lie scattered in different places throughout the volume, causing considerable inconvenience and wastage of time to the user. When abstracts of several years are to be consulted, its disadvantages become obvious, necessitating the publication of cumulative indexes to these abstracts after a certain period, say, 5-10 years (e.g. Decennial Index to Chemical Abstracts). Subscribers to the original abstracting journal

have to purchase separately these highly expensive indexes. As against the apparent economy of purchasing the abstracts in journals printed on both sides, must be set off these extra heavy costs of cumulative indexes. Furthermore, for literature search covering several decades of scientific work in a particular field, one may have to go through numerous cumulative indexes too, making it a very cumbersome job. Besides, even the provision of a cumulative index cannot do away with the necessity of digging out the abstracts themselves that lie scattered in numerous separate volumes and issues of the same journal.

1.3.2. Journals printed on one side seek to combine the advantage of the book form with the flexibility of the card form. Each issue may be handled as easily as any bound volume; however, later on the separate abstracts are to be cut out and pasted on cards and then filed according to the classification scheme used. Since a single issue of the abstracting journal, appearing once or twice a month, contains thousands of entries, the time and cost involved in the above work would be enormous. The libraries attached to small or medium-sized institutions cannot afford that.

1.3.3. Abstracts on cards take more time to handle than an equal number of abstracts printed in one place in a journal. However, as a single abstract is printed on one card, its flexibility is maximum. All abstracts on cards on a particular subject, whether they had been published one year, five years, or even thirty years ago, automatically come together, thereby saving much time and labour of the searcher. However, the efficiency of this system presupposes the use of a well-formulated, flexible and yet stable, indexing system. For example, the abstracts of all papers published in the last 10 years on the subject of "The use of nuclear

magnetic resonance spectroscopy in organic chemistry" can come together only if the same notation had been used throughout these 10 years to indicate this concept; otherwise the cards will be scattered. There should also be adequate cross references to the same abstract, for which a good subject indexing is necessary. Obviously, this job cannot be left to the individual resources of the library staff. Subject classification as well as subject index cards will have to be centrally provided ("Physics Abstracts" has been using, for many years, U.D.C. notations to designate each separate abstract). Of course, the card form appears more expensive than the journal form in the short run, but may not be necessarily so in the long run, when the cost of the cumulative indexes which are an essential adjunct to the journal form are taken into account. At any rate, it is much more flexible, ultimately convenient to and economizes the time of the research workers.

1.4 Role of the Abstractor

Abstracts of original research papers can be and, in fact, are actually made by both authors and other abstractors. In view of the need for multiple abstracting of many papers, abstracting by the author alone cannot suffice.

1.4.1. Author's Abstract

There has been much debate on the virtues and vices of the author's own summary. There can be no doubt that if the author's summaries are given in accordance with certain specified standards, they could be used with profit. Since they accompany the original papers, they can be directly utilized, increasing the speed of publication and reducing the cost of the abstracting

services. However, to perform his duty as an abstractor efficiently, the author needs some training in the art of abstracting; this training as well as that in the art of scientific paper writing should be made an essential part of a scientist's formal schooling. Such training can be facilitated by the formulation of international standards on the composition of scientific communications and on the preparation of their abstracts.

1.4.2. Qualifications Required of other Abstractors

However useful or efficient the abstracts, prepared by the authors, may be, they provide no substitute, as has already been stated, for multiple abstracts of the same papers required by readers with different subject interests.

For persons, other than authors, engaged in abstracting of research publications, the following qualifications are essential : (i) General scientific background, (ii) Special acquaintance with the field covered, (iii) Knowledge of languages, (iv) Knowledge of the techniques of abstracting and experience gained under actual working conditions.

1.4.2.1. Part-time Abstractors

The quality of abstracting is much improved when scientists, engaged in active research, do the abstracting themselves. The Royal Society Scientific Information Conference (1948) reminded the scientists that "they have a professional duty and interest in participating in the work of abstracting" (5). In fact, the best known abstracting services of the world—such as the "Chemical Abstract" in the USA or the Referativnii Zhurnal of the USSR—do utilize the services of a large number of active researchers on a part-time basis.

1.4.2.2. Full-time Abstractors

However, in addition to these hosts of innumerable, part-time scientist-abstractors, there is always a core of professional, full-time abstractors working at the main abstracting centre. As the practice obtains at present, not all of them come to abstracting via the laboratories. They include many who are science students who have learnt their job 'in service'. While many of them discharge their duties efficiently, it cannot be gainsaid that the quality of service would have been much more raised if they had combined their technical skill, gained through experience, with a research background. In this connection, the suggestions of Sir David Rivett (Chairman, C.S.I.R.O., Australia) at the 1946 Royal Society Empire Scientific Conference deserve serious consideration (6). He proposed recruiting personnel from the research laboratories whose flair for original research had diminished. If service conditions donot vary much between scientists working in the laboratories and those at the abstracting centres, a section of them may very well be persuaded to shift their activities to the latter, especially if they are given leading positions among the full-time professionals by virtue of their research experience in the subjects in question.

1.5. Abstracting Agencies & Their Organisation

Qualitatively as well as historically, abstracting has been most developed in the chemical sciences and in the anglo-saxon countries. To-day, abstracting activities are most conspicuous in the USA, France, the USSR and the U.K. and they embrace virtually all fields of knowledge. However, there are marked variations in the method of organisation of the abstracting services in these countries. They can be divided into two categories :

while, in France and in the USSR, all science abstracting is handled by a single, centralized agency offering separate abstracting services in different subjects, the anglo-saxon countries follow the decentralized system wherein there are different abstracting journals, devoted to different subjects, each functioning independently of the other. Both the groups of countries can claim to have produced a few high class abstracting services. This does not mean, however, that their varying systems of organisation have no relevance to the question of efficiency of service. But before judging the merits and demerits of these systems, it will be perhaps better to to study their functioning in some detail.

1.5.1. Centralized Abstracting Agency

Under this heading we shall deal with two organisations : The All-Union Institute of Scientific Information (Moscow) and the Centre of Documentation of the French National Council of Scientific Research (CNRS).

1.5.1.1. All-Union Institute of Scientific Information (Moscow) (7) :

In 1952, the Presidium of the USSR Academy of Sciences decided to set up a special All-Union Institute of Scientific Information under its own auspices. Since October 1953, the Institute has been publishing an abstracting journal entitled 'Referativnii Zhurnal' which comes out, at present, in 13 separate series covering the following subject fields—(i) astronomy and geodesy; (ii) biology : (iii) biological chemistry; (iv) geography; (v) geology; (vi) geophysics; (vii) mathematics; (viii) mechanical engineering; (ix) metallurgy; (x) mechanics; (xi) physics; (xii) chemistry; (xiii) electrical engineering. Each issue of every series runs to something between 128 and 560 pages; and there

are either 12 or 24 issues a year. In 1958 alone, the 13 series together comprised 206,048 pages and 559,700 items. Thus the series of abstracting journals issued by the Institute constitutes a comprehensive scientific reference publication, covering scientific works published all over the world.

The Institute handles, at present, material in 64 languages from 92 countries of the world. In 1958 alone, it dealt with over 15,000 different soviet and foreign periodicals. It exchanges scientific publications with 1,075 foreign organisations in 63 countries; the Institute is a member of the International Federation of Documentation (FID) and participates in the work of the Abstracting Board of the International Council of Scientific Unions (ICSU).

For the purpose of abstracting papers, the Institute employs a large staff of highly qualified specialists, including academicians and corresponding members of the USSR Academy of Sciences and doctors and 'candidates' (post-graduate research students) of science.

It is also significant that owing to its vast experience in bibliographical and translation work, and its intimate knowledge of the latest developments in the various sciences, the Institute has been able to offer many useful auxiliary services to the soviet scientists and engineers, services which we cannot get from the abstracting agencies in the USA or U.K. These auxiliary services include the publication of (i) a series of monographs on specialized topics, summing up developments in these subjects for the use of research workers and specialists, (ii) various kinds of comprehensive bibliographical reference works on specified subjects, listing soviet and foreign works, with detailed annotations, and (iii) terminological and lexicographical work. Another of

the Institute's activities is a service providing photostat copies, microfilms and translations of any article abstracted in its journal; in 1958 alone, some 318,000 photostat copies of articles and micro-films were supplied.

1.5.1.2. The Documentation Centre of the CNRS :

Another notable example of a centralised abstracting agency is provided by the Centre de Documentation du Centre National de la Recherche Scientifique of France. This centre publishes an abstracting journal entitled "Bulletin Signaletique". The scope of this journal is even broader than that of its soviet counterpart, the Referativnii Zhurnal, in as much as the Bulletin Signaletique embraces, besides the natural sciences and engineering, also the social sciences and humanities. The 'Bulletin' appears in 22 separate series, each series being devoted to a specific subject or a group of subjects, as shown below : (i) Mathematics; (ii) Astronomy, Astrophysics, Geophysics; (iii) Physics. I. Generalities, mathematical physics, mechanics, acoustics, optics, heat, thermodynamics; (iv) Physics. II. Electricity ; (v) Nuclear Physics. Nucleus, Particles, Atomic Energy; (vi) Structure of Matter. Crystallography, Solids, Fluids, Atoms, Ions, Molecules; (vii) Chemistry. I. General Chemistry Physical Chemistry, Inorganic Chemistry, Analytical Chemistry, Organic Chemistry; (viii) Chemistry. II. Applied Chemistry. Metallurgy; (ix) Engineering Science ; (x) Earth Sciences I. Mineralogy, Geochemistry, Petrography; (xi) Earth Sciences II. Geology, Geophysics, Paleontology; (xii) Biophysics. Biochemistry; (xiii) Pharmacological Sciences. Toxicology ; (xiv) Microbiology. Genetics; (xv) General and Experimental Pathology; (xvi) Animal biology and physiology; (xvii)

Plant biology and physiology; (xviii) Agricultural Sciences. Zootechnics. Food and Food Industries ; (xix) Philosophy. Human Sciences , Religion, Archaelogy and and History of Art; (xx) Psychology. Pedagogy; (xxi) Sociology and Linguistics; (xxii) History of Sciences and Technology.

The 'Bulletin' in all its series is published monthly. Every year it contains on an average abstracts of more than 230,000 articles. Like the Soviet Institute of Scientific information, the French Documentation Centre also supplies paper photocopies and microfilms of articles abstracted in its "Bullentin" or of any other articles whose precise bibliographical references may be supplied to the centre. Since the coverage of information given in the "Bulletin" is international, every French research worker is thus assured of a ready access to all information in his subject produced anywhere in the world. The centre offers its invaluable service to the researchers by functioning in this capacity of a clearing house of all scientific communication of the world.

1.5.2. Multiple & Independent Abstracting Agencies

We are familiar with the system of abstracting services prevalent in the Anglo-Saxon countries—mainly the USA and the UK—where abstracts on different subjects are published in different journals, all being administered by separate, independent authorities. Some of these journals cover such a wide subject area—eg. Chemical Abstracts (USA) and British Abstracts—that they assume the character, to some extent, of a centralized abstracting service, at least in relation to the numerous subject groupings covered by them. It is also noteworthy that it is these very journals which have been found most useful, out of the innumerable abstracting journals in the field. It

should also be remembered in this connection that abstracting has reached its high watermark only in the chemical sciences, pure and applied, and that scientists working in other fields—such as mathematics, physics, biology, medicine etc.—do not depend upon their abstracting journals so much, nor have they developed this tool to such perfection as have been done by the chemists in their line. Thus, although journals like Physics Abstracts (UK), Electrical Engineering Abstracts (UK), Biological Abstracts (USA) and Mathematical Reviews (USA)—have by now established their position, their usefulness—judged by the extent of their coverage of papers and the quality of abstracting—is not at all comparable to that of, say, Chemical Abstracts. Our generally favourable estimate about the American and British system of abstracting has been unduly influenced by one or two outstanding exceptions and not by an overall study of all the available abstracting services in all the subjects in these two countries.

1.5.2.1. Duplication of Abstracting

Such a study will clearly show that the system of multiple abstracting agencies, each functioning independently of the other, suffers from serious deficiencies. One of these is the unnecessary duplication of work, by various journals, using the same papers and abstracting them for similar journals and for similar groups of research workers. We give below a few examples of some abstracting journals in English, produced in the USA or the U.K., overlapping wholly or in part the subjects covered by them.

Analytical Chemistry :

(i) Analytical Abstracts (with Analyst) (U.K.)

(ii) British Abstracts C. Analysis and Apparatus (U.K.)
(iii) Chemical Abstracts (USA)
(iv) Spectrochemical Abstracts (U.K.)

Engineering :

(i) Engineer's Digest (U.K.)
(ii) Engineering Index Service (U.S.A.)
(iii) Annotated List of Published Papers. (British Electrical & Allied Industries Research Association).
(iv) Electrical Engineering Abstracts. (Science Abstracts B) (U.K.)

Medicine :

(i) Abstracts of world Medicine (U.K.)
(ii) Abstracts of Current Medical Literature (Contained in Medical Journal of Australia)
(iii) British Abstracts A III. Physiology, Biochemistry, Anatomy.
(iv) Key to Current Medical Literature (U.K.)
(v) Bulletin of Hygiene (U.K.)

Plastics & Rubber :

(i) Abstracts of British Plastics Federation
(ii) Resins—Rubbers—Plastics (U.S.A.)
(iii) Summary of Current Literature of the British Rubber Manufacturers' Association.
(iv) Abstracts given in 'Modern Plastics' (U.S.A.)
(v) British Abstracts B II. VI. Plastics, Resins, Adhesives etc.

The above list only indicates the trend and is far

from being exhaustive ; it can be easily expanded if other subjects are also considered. The wastage of labour and time of highly skilled scientific personnel, involved in this type of needless duplication of efforts, is absolutely inexcusable. This has been clearly recognised by many of those who are actually in charge of these services in these countries. ("Both in this country and in the United States there is a great wastage of effort, for the main abstracting services,.....overlap" —Dr. L. H. Lampitt) (8).

1.5.2.2. Incomplete Documentation

Effective documentation in a subject is governed by two factors, in so far as abstracting is concerned, namely—abstracting as many papers in that subject as possible, the ideal being to procure all the papers in the world on it **(extensive documentation)** and on the other hand, to analyse throughly each available paper to bring every facet of its composite subject matter, if that be its nature, to the attention of various interested groups of workers **(intensive documentation).** Incomplete documentation may be the result of inadequacies occurring on both these fronts. Since all the abstracting journals, published in the English speaking countries, operate with a limited number of journals (which are bound to be far less than the 15,000 periodicals handled in 1958 by the Institute of Scientific Information, Moscow) they fall far short of the ideal of extensive documentation. Similarly, a paper on biology with auxiliary interest in chemistry and physics will be most probably lost to those interested in the latter two subjects, since all the journals abstracted by "Biological Abstracts" are not abstracted by "Chemical Abstracts" and very few of them, if at all, by "Physics Abstracts". Thus, although the paper is not lost to the scientific community, it does not become accessible to all who

need it ; in short, it fails to reach the ideal of intensive documentation.

1.5.2.3. Lack of Cooperation and Coordination in Abstracting :

The above deficiencies of the British and American system of abstracting can be removed if they can coordinate, according to a plan, the abstracting activities of their countless abstracting agencies. This presupposes a number of things—(i) a joint venture to abstract all the available scientific periodicals by the various abstracting agencies functioning collectively; (ii) a clear demarcation of subject areas to which each abstracting journal will confine its activities and lastly (iii) cooperative abstracting to facilitate multiple abstracting of papers, individual papers of composite nature being passed on by one abstracting journal to the others. It is yet to be proved that the above reforms can be carried out by keeping intact the present system of decentralised abstracting agencies. The mutual consultation and exchange of views between the existing abstracting agencies (in Britain and the USA), recommended by the 1948 Royal Society Scientific Information Conference, were of an extremely limited scope (9), but even these have not yet been accepted by the parties concerned, thus testifying to the validity of the doubts expressed above.

1.5.3. Centralized Versus Decentralized Abstracting Agencies :

1.5.3.1. Inherent Limitations of a Decentralised Agency

Whatever may be the historical justification of the multiple abstracting agencies that have struck deep roots in the English-speaking countries, it is quite

evident they have now outlived their period of usefulness. During an age when only a few western countries were engaged in scientific research, when the total volume of reseach output was relatively small and the number of learned scientific periodicals was somewhat manageable, these decentralised abstracting agencies, with their modest resources, could perform their duties with a certain measure of efficiency. However, the situation has radically changed today : an increasingly larger number of countries are taking to the road of economic development and scientific research; in future this trend will become more and more strengthened ; the total output of research publications in the whole world has increased at a phenomenal rate ; the number of research periodicals in which these are published is baffling for any single, decentralised agency; to make confusion worse confounded, there is multiplicity of languages in which research papers are published. It is obviously impossible, under these changed conditions, for any private, decentralized agency to carry the load with even moderate efficiency. The attempt of some big abstracting agencies, such as the 'Chemical Abstracts' to do it has not been particularly successful; at any rate, it has resulted in shifting its burden on to the backs of the ordinary subscribers who find the existing subscription rate, at least in the non-U.S. territories, simply crushing. Thus, to maintain the decentralised structure, the consumers have to be prepared to pay a disproportionate price in return for a moderate efficiency.

1.5.3.2. Advantages of a Centralised Agency :

An all-comprehensive abstracting service under a centralised agency is the answer to the challenge thrown by the explosive scientific development of the present century. Owing to the vast human, technical and financial resources which can only be available at the disposal of

such an agency (the National and International Documentation Centres in our scheme), it will have a surer access to all the sources of scientific information in the world ; due to its far larger coverage of papers and to the assembly of the various subject abstracting groups under a single organization, its efficiency in multiple abstracting of papers will be far greater ; the speed of transmission of research results to the scientist which is of vital importance to him will be much more quickened ; and due to rationalization and economy, only possible in such a big organisation, the cost per single abstract will be less under a centralized agency than under a decentralised unit; the actual cost will be even less, may be even gratuitous, because like research activities in all the modern, civilized countries, the cost of documentation, an integral part of research, must be subsidized by the welfare state. To the individual scientist, some of the auxiliary activities of such centralised agencies viz. supply of photo reproduction of papers or of their speedy translation—are of immense help.

1.5.3.3. The Roots of British Objection :

Unfortunately, the objections voiced by the English-speaking scientists to the establishment of a central abstracting service have never been argued out in detail. At the 1948 Royal Society Scientific Information Conference, "any consideration of centralized control of abstract publication was rejected" not because the system was found technically inefficient, but because the majority of the British Scientific authorities felt disinclined to interfere with the independence of the existing abstracting journals. The conference was careful to point out "that extension of facilities for mutual consultation between existsing abstracting agencies would be very desirable.....provided that any organization set up for this purpose was not of such a

type as to assume executive powers, or to be a financial burden on the abstracting organizations.....(which) are not likely to co-operate if they suspect any danger of being coerced into accepting majority decisions with which they donot agree" (10). It is likely that this conservative attitude is inevitable in the context of the British reality but it remains equally true that this "British reality" is increasingly hindering their own progress in the domain of scientific documentation, and that without changing the nature of this "reality" there can be no material improvement in the situation. To this extent, the Royal Society's recommendation fails to meet the requirement of the times and falls short of the breadth of vision and scholarship we are used to expect from this august body. Socially, the climate is not favourable in the U.K. and U.S.A. to any concept of centralized planning; France, although a close ally of Britain and America, has followed, in this sphere, a path similar to the Soviets, a contrast born probably out of the fact that France had been the cradle of European socialism (cf. Saint-Simon, Fourier etc.) and has been less averse to the idea of planning, having practised nationalization since the end of the First world war.

Even in Britain, a few highly conspicuous individuals have raised their lone voices against the policy of maintaining the status-quo. As early as 1946, Dr. L. H. Lampitt (Bureau of British Abstracts) who is more intimately associated with abstracting services in Britain than anybody else, stated at the Royal Society Empire Scientific Conference : "In this country this waste of effort is to be deplored, **but it can only be by the establishment of a central abstracting organization,** which must be imbued with imagination and energy, **that the present state of affairs can be overcome.** What are the difficulties to be surmounted ? They fall essentially into

two categories, personal and financial.....**The personal difficulties.....are partly to be ascribed to the reluctance of some bodies which already have an abstracting service to lose their identity with this important work.** This is a serious but not insuperable obstacle, it is however, very real and the amount of good will and common-sense required to resolve it is considerable.....**it will only be by convincing them that the formation of a central abstracting organization would render a valuable contribution to the scientific life of the country,** in other words would further the development of the country itself, **that they would be willing to forego the prestige and sacrifice an amount of vested interest.** The experience which has been gained by the amalgamation of the purely chemical abstracting service of the Bureau with that of the Physiological Society leaves no question of the advantages to be gained by such joint work and no one would suggest that the Physiological Society had lost anything by its far-seeing attitude" (11). (emphasis ours).

It should not also be forgotten in this connection that the unprecedented rate at which Soviet Science has advanced in the recent period has been due, to a very great extent, to the system of comprehensive, centralised and rapid documentation, established through the Institute of Scientific Information in the USSR.

1.5.4. Essentiality of Regional Organization of Abstracting

In 1958, the Soviet Institute of Scientific Information abstracted nearly 15,000 periodicals ; however the number of currently published scientific periodicals of the entire world would not be less than 60,000 as stated in Part I of this article. Even such a mighty, centralized

agency as the Soviet Institute could not process more than 25 percent of the world's total scientific periodicals. The ideal of complete documentation is, thus, still far off, and it is doubtful whether it would ever be reached by any single agency, if the present system of publishing research papers in periodicals and of abstracting them by analyzing the periodicals persists. The only reasonable and effective course to reach the ideal of complete documentation is to set up a network of zonal, national and finally international documentation centres, **operating on a pyramidal basis,** each centre having the charge of taking stock of all publications that appear in the area under its jurisdiction. From the point of view of the international flow of scientific communication, there can be no justification for France, USSR, USA and Britain to bring out abstracting journals in the same subjects and all aiming at the same international coverage (viz. Chemical Abstracts, British Abstracts, Referativnii Zhurnal : Khimiia, and Bulletin Signaletique : Chimie I-II). Under the system envisaged by us, abstracting journals of international coverage will be published only by the International Documentation Centre in 4 or 5 world languages (English, French, German, Russian, Interlingua). Since this aspect has been discussed in detail in Part I, we would not repeat it here.

However, we would like to mention here one aspect of this regional abstracting which has relevance to India. Sir Lewis Fermor F.R.S. reported, to the 1946 Royal Society Empire Scientific Conference, the publication in India, before the war, of an abstracting journal entitled "Indian Science Abstracts." It was published as an annual volume by the National Institute of Sciences of India and provided a summary of all research work done in India, whether published in Indian or foreign

periodicals (12). Unfortunately, this essential service which was stopped during the war has not been resumed yet, with the result that today nobody in India knows precisely the extent of India's total scientific output in a particular period, say, in the last 15 years since independence. Logically, this work belongs to the INSDOC which should immediately plan out the publication of such an abstracting journal.

1.6. International Efforts to Standardize Abstracting

Efforts have been and are still being made by various international bodies to lay down a code for the abstractors. International Standards Organization (ISO/TC 46 on Documentation), International Federation of Documentation (FID), International Council of Scientific Unions (ICSU Abstracting Board) and the UNESCO (Division of Libraries, Documentation and Archives)—all of them have organised numerous meetings and conferences from time to time to settle this issue. Yet no universally accepted code has yet emerged. One of the reasons for this seems to be, in the opinion of the present author, that all these efforts had been made independently and separately by these bodies. In this domain, activities should be coordinated at an international level under the joint auspices of all the interested international bodies, so that their decisions may command the necessary authority in the scientific world and may be universally accepted. The Unesco may play a vital role by bringing the ISO, the FID, the ICSU and others to a common forum for this purpose.

2. CLASSIFICATION

2.1. Aims of Classification :

The primary objective of classification is to define uniquely the location of an item of information in the library, be it a book, report, a reprint or any other material. Its chief purpose is not to show to the readers what materials on a particular subject are available in the library. This can be and, in fact, is achieved by a good subject index. The purpose of library classification is, thus, strictly utilitarian and not at all to construct a philosophical scheme. This point should be borne in mind because the association of a classification scheme with some sort of a subject grouping of materials is rather a misunderstanding, born out of the the librarian's constant preoccupation with such schemes, since all the current schemes, in one way or the other, belong to the category of subject classification. But subject classification, it should not be forgotten, is only one variant, though a very important one, of the entire field of classification.

2.2. Problems of Classification under the Reprint System :

All these considerations have direct bearing on the topics we have been discussing so long. The type of subject classification schemes we have been accustomed to using in an information system, mainly based on periodicals and books, may prove to be utterly unsuitable to an entirely different information system where what we have to deal with is not hundreds or thousands of periodicals but millions of separate papers. When this number grows, with each year, to an astronomical figure, it becomes a matter of serious doubt if any kind

of subject classification, however refined or specialized it may be, can cope with it and discharge its elementary duty of locating a paper speedily for a reader. Moreover, the place which will be assigned to a particular paper in the shelves of the library can never be made unique under any subject classification scheme, for the very simple reason that there cannot be as many subjects as there are separate papers in this world ; so the attempt is made to attach other extraneous factors—e.g. the auhor's name, the language of composition, the date of publication, the country of origin etc.—to the material and thus to find a unique location for it on the shelf. All this makes the whole subject scheme inconsistent, and what is worse, the notation becomes, as a result, too cumbrous and complex to be used easily either by the readers themselves in an open access library or by the library's subordinate staff in a closed access library. If this is the complaint heard today in very big book libraries, how much more confused is the situation likely to be in a documentation centre or worse still in a regime where the mode of research publication has been completely switched over to the reprint system ? Under such circumstances, the necessity of re-evaluating the utility of the current classification schemes in the field of documentation, especially in a situation where a limited number of periodicals may be replaced by an unlimited number of reprints, cannot be lightly brushed aside.

Yet, to achieve the practical aim of finding out in an instant a desired paper, from among a million ones, there is, perhaps, an extremely simple method of giving the paper a serial number. (According to our scheme, as outlined in Part I of this article, this document number will be assigned by the documentation centre where it will be processed and published). It is possible to prevent this number from becoming too long, if we

attach to it two other notations—the year of its publication and a symbol for the country of its origin. To facilitate the grouping of documents belonging to the broad subject divisions (e.g. mathematics, physics, chemistry etc.) in close proximity, the class numbers of these broad divisions alone may be used. However, this scheme can be operated only when national documentation centres take full charge of publishing all research papers in their respective countries and also of classifying them at the source.

2.3. Classification Vis-a-Vis Subject Indexing

All this does not mean that the labours spent on building various subject classification schemes have been useless or that in future there will be no need of them. Far from it. However, under the reprint system, their purpose will radically alter. Whereas, at present, they constitute the foundation for determining the arrangement of materials in a library, in the new set-up they will provide the philosophical basis on which the system of subject indexing will be built. A good knowledge classification scheme is an essential prerequisite to a sound indexing system. In a subject index, terms stand for concepts (i.e. subjects); therefore, the cross reference from one term to other terms really represent the relation of one concept or subject to other collateral or subordinate concepts or subjects. It is, thus, quite clear why without a clear conception about the definition of a subject, its relation with other subjects as well as with its constituent parts, it is impossible to build up a good indexing system. And it is precisely this conception that a sound knowledge classification scheme seeks to impart to us.

2.4 Classification Schemes : Their Scope and Limitations

There are various classification schemes in currency at present. Of them, the most notable are—Dewey Classification, Library of Congress, Universal Decimal Classification, Colon Classification, Bliss' Bibliographic Classification etc. For a discussion of these as well as a few other classification schemes, their special features, scope of applicability, deficiencies etc.—readers are referred to Foskett's excellent essay on classification in W. Ashworth's "Handbook of Special Librarianship" (London, Aslib, 1955) (13).

Dewey classification is suitable only for medium sized public libraries, as admitted by its editors themselves in their Introduction to the 15th edition of D. C.

Library of Congress classification scheme which had been constructed with the explicit aim of only classifying books received in that library suffers severely from the nature of its origin. It is not derived from a logical analysis of the entire field of knowledge and as such it is unsuitable for documentation purposes.

U.D.C. and Colon are the only two universal classification systems designed to meet the requirements of documentation work.

2.4.1. Universal Decimal Classification

Of all the classification systems, the U.D.C. is perhaps the most extensively used in the world today. According to a recent survey, known UDC users number between 4000—5000. Its advantages are that its schedules in science and technology are extremely exhaustive; it is sustained by an international body, the International

Federation of Documentation which, with the help of panels of experts in various subjects, strives continually to keep the scheme uptodate. Among its major drawbacks are—inadequate treatment of the humanities and social sciences; delay in incorporating newly developing subjects into its schedules (this is true, at least, in relation to its English edition); an inadequate index; frequent change of old notations; too lengthy notations for highly specialized subjects ; the cumbersome form divisions and auxiliary notations; and the still greater difficulty in the intercalation of the constituent parts of a complex notation and in arranging materials on the shelves according to this notation (e.g. the arrangement of numbers found after " ", =, :, (o), .00, (1—9) etc..). Interested readers are referred to two competent evaluations of the U.D.C. published very recently (14 & 15).

2.4.2. Colon Classification

Among the current subject classification systems, Colon Classification occupies a unique place in many respects. Its most striking feature is, perhaps, its extreme elasticity and "hospitality" towards new subjects, including even those not yet formed. Unlike other schemes it does not attempt to include in its schedules the detailed divisions and subdivisions of every subject. What it does is (a) to enumerate only a limited number of very broad subjects (using alphabetic symbols for them ; thus, B stands for Mathematics, D for Engineering, E for Chemistry, S for Psychology, T for Education and so on) ; (b) to analyse all possible divisions of a class (subject) by applying certain characteristics based on such fundamental concepts as personality (the quality determining the area of knowledge), Matter (the materials worked on, e.g., plastics, metals

etc.), Energy (mechanical, electrical engineering etc.), Space and Time (geographical and chronological division) ; and finally (c) to lay down a sure method for the classifier to build up a notation for a new subject on his own ; this method is claimed to be so precise that there is very little room for arbitrary decisions on the part of the classifier. Thus, unlike the other schemes, the uptodate-ness of the Colon Classification does not depend on the exhaustive enumeration of its subject schedules, which are to be brought uptodate from time to time by committees of experts providing official expansions of the scheme. Instead, Colon estabiishes the methodology of expansion of a class and of notation-building, a unique autonomy given to the classifer. As Mills remarks, "Once the basic rules and discipline of Colon are grasped (not a difficult matter), the scheme becomes extremely easy to apply, easier than Bliss, because more purely logical and leaving fewer decisions to the classifier" (16). Mills' statement is of particular interest because the author had spent some years using Bliss before studying Colon and had previously written in high praise of Bliss (17). Ranganathan holds that only by following the Colon's method, can bibliographic classification face the challenge of the developing field of knowledge (18).

2.5 Need of International Standardization :

The existence of numerous classification schemes in the world today is the result of historical, national and technical factors. Melvil Dewey's use of the decimal notation for use in library classification was a technical innovation of the first order. But no classification system can move ahead merely by virtue of a good notation. Owing to lack of research and the consequent inability of D. C. to keep abreast of new developments

in knowledge, D. C.'s further progress has virtually stopped and its users are today mainly confined to public libraries in the U.S.A. The library of Congress scheme is, by its very nature, nationally originated and isolated. Its adoption by many U.S. libraries is not primarily due to any intrinsic worth of this scheme, but mainly because of the obvious benefits that L. C. scheme users derive by receiving ready made catalogue cards and classifications of the books from the Library of Congress.

The Universal Decimal classification, though born in the continent, has now become truly international in character. Formed to fill up the gaps, caused by D.C.'s stagnation and rigid structures, its use has spread throughout the world, especially in research and documentation centres.

The Colon Classification, despite its Indian lineage and comparatively recent origin (1933), has already made a powerful impact on the serious thinkers abroad. Initially, the scheme might have been motivated by Dewey's failure and that of the other western classification schemes to deal adequately with the literature, history and civilization of the East. But Colon has outgrown these limitations of its origin. In comparing the U.D.C. with Colon, Foskett says, "This scheme and the U.D.C. are the only ones that set out to cope with the problems of documentation ; of the two, U.D.C. is the more developed and easily put into use, but Colon is more scientific in construction and, when complete, will provide a **method** that can very easily be applied to any collection, no matter how specialized" (original emphasis) (19). It would, however, be instructive to know how many libraries and documentation centres in the world are using this scheme. In this connection,

we may note the interesting fact that a scheme, based on Colon, is used for maintaining the technical files in the Titanium Division of the National Lead Corporation, New Jersey, U.S.A. (20).

We have also heard about Russian and Chinese classification systems, although we know very little of them.

However, one thing is certain. In an age when all cultures were of national origin and were permeated with national outlook, the evolution of nationally inspired and isolated classification systems was but natural. But in the present epoch, they have hardly any justification. The problem of classification and indexing, faced by scientists, documentalists and librarians transcend national barriers and it requires an international solution. In the interest of effcient scientific communication, they should set aside all national affiliations and agree to accept a common classification system, without which no standardization is possible. This system should be universal (in its coverage of subjects) and should incorporate the positive features of the existing schemes.

2.6. Requisites of a Good Classification Scheme

Whatever this system be, to be successful, it must possess the following features :

2.6.1. The scheme must be flexible to the extreme; it cannot survive unless it possesses the capacity to embrace the ever new developments.

2.6.2. Simultaneously, **the stability of the scheme must be maintained.** The inclusion of new terms within the the scheme must not disturb its general structure. In

relation to notations, it means that there should be as few changes as possible in old notations, although they may be further expanded. (Thus, in the old English edition of U.D.C. schedules dealing with mathematics, astronomy and physics, nuclear physics has the notation 539.152.1. whereas the abridged English edition of U.D.C. (1957) shows the notation 539.14 for the same subject ; such change of notation is undesirable).

2.6.3. Notations should not be too long or cumbersome. It is not easy to fulfil this condition. Documentation requires very close classification which in its turn tends to give rise to long notations (as in the case of U.D.C.). On the other hand, the use of long and complex notations (due to the attachment of too many auxiliary symbols representing form divisions, language, country, period, point of view etc.) seriously hampers its easy use. (It may be noted here that the French have discarded the U.D.C. at their Saclay Nuclear Research Centre for the above reasons) (21). This difficulty may be obviated if class notations are used as a means of locating a subject in the map of knowledge and not as a means of locating a document in the library. For the latter, the document number or some variant of it may be used, as stated earlier.

2.7. Some Problems of Classification

2.7.1. Classification of Special Materials

Patents, trade marks, specifications, microfilms, microcards etc. present serious problems for classifiers. It is not easy to find a classification scheme which is specialized enough to permit, say, patents to occupy a place in the general stock of the library and yet to be speedily tracked down. These are, therefore, usually

kept in a separate sequence, arranged by their number of issue. Since they are almost invariably referred to by this number, the arrangement is highly convenient; however, this has to be supplemented by providing subject indexes to the patents.

2.7.2. Notation for Organic Compounds

Another serious difficulty confronts the classifier of organic compounds. The number and complexity of structure of these compounds have defied all attempts at systematization made up till now. Even on the limited issue of nomenclature, no internationally agreed solution has yet been achieved, despite numerous efforts at various levels, national as well as international, in this direction. The notational difficulty arises from the fact that the graphical formulae representing molecular structures cannot be arranged in a linear order, classified or alphabetic. Various schemes of notation have been suggested so far. Of nine such schemes, the International Union of Chemistry chose, at its meeting in Paris in October 1951, Dyson's notation as the most promising for development as the official system (22 & 23).

3. SUBJECT INDEXING

3.1. Anarchy in the Field of Indexing

The attempt to standardize the indexing procedures makes us keenly conscious of the lack of any science or methodology in this domain. Up till now, scientific terms have been produced empirically and used indiscriminately by the scientists themselves. Sometimes different terminologies and subject headings are used to designate the same subject, just as instances of the same term designating different subjects are also not rare. The implications of this situation for information retrieval are serious enough, for it results in a situation where informations that should logically come under the same subject heading are split apart and are, thus, virtually lost to their potential users. It would probably require a linguistic revolution to put this entire domain of subject indexing and scientific terminology on a sound footing. Since the headings used in subject indexes are formulated on the basis of terms and expressions used in the relevant literatures, progress in this domain will be possible only if reforms proceed simultaneously in indexing as well as in the coining of scientific terms.

3.2. Need of a Conceptual Reorientation

A major question that faces us in indexing is whether we should classify an information under the name of the object, phenomenon or process with which it deals, or alternatively, under the name of the subject, the science, pertaining to the study of these objects, phenomena etc. Thus, should we index a book dealing with the study of Earth under "Geology" (or "Earth Sciences" as it is sometimes called these days) or simply under

"Earth" ? Similarly, how are we to index a book that studies the constitution and properties of the atomic nucleus ? Under the term "Nuclear Physics" or under "Atomic Nucleus" ? If we logically pursue this line of reasoning, we should ultimately reach a point where many of our traditional conceptual terms would vanish and become replaced by others. Thus, instead of terms like astronomy, physics, chemistry, geology, botany, zoology, we shall have such index terms as celestial bodies, energy, matter, earth, plants, animals etc. If we reject the latter and stick to our conventional terms, we cannot index a paper under such terms as "elementary particles" or "algae" because they donot represent the name of any subject but refer to the objects studied. After all, whatever system we select should be applied consistently. The plea that these are well known terms and as such their use in headings would be convenient to the research workers in their respective fields, is too empirical an answer to a highly complicated problem. If tomorrow we have such subject headings as "particology" or "algology", should we start indexing under these new terms or refuse to do so even if their use becomes very common in scientific circles then ? In indexing this is an important issue and should be solved as early as possible on a principled basis.

3.3. Objective Indexing Vs. Subjective Indexing

The present author tends to be inclined to the view that for maintaining both the stability and flexibility of the indexing system, it would be preferable to rely on the names of objects, phenomena and processes rather than names of their subjects of study, the former being much more stable than the latter. The term "atomic physics" is of recent origin, but the term "atom" dates back

to the Greek and Indian atomists of antiquity; similarly, the term "solid state physics" has been coined in the last decade, but not so the term "solids" or its further division "solids — physical properties".

By using names of objects and processes as index terms, we can go on expanding an index heading from a term of large extension to a term of great intension, without disturbing the indexing system. Thus, a paper dealing with the application of nuclear magnetic resonance spectroscopy to the study of organic molecules can be indexed as follows, "Atomic Nucleus—Magnetic Resonance Spectra—Application to Carbon Compounds", or alternatively, "Cardon Compounds—study by NMR Spectra". Depending upon the nature of the library and its users, and the degree of specialization of the collection at our disposal, we can make the indexing general or very specific as need be.

3.4. Requisites of a Sound Indexing system

3.4.1.

To function as an effective aid to comprehensive abstracting of the kind visualized under the reprint system, the techniques of subject indexing must conform to international standards. (The tangible benefits obtained by a library in following such an internationally accepted scheme even in a restricted field, are described in a recent paper by a West German librarian) (24).

3.4.2.

Like a univeral classification system, the indexing system should also be comprehensive, mapping out the entire field of knowledge with its countless divisions of

different subjects, their areas and their interrelations.

3.4.3.

Whatever scheme is ultimately chosen, must possess enough flexibility to accommodate new terms to designate newly developing subjects.

3.4.4.

Index terms should be carefully chosen and, once selected, they should be maintained on a stable basis. Frequent change of headings for the same concept or within the same subject area is harmful and it seriously vitiates the utility of indexing. A careful examination of the subject headings used by abstracting journals and of the changes in headings made by them after every few years should convince us of the necessity of avoiding these pitfalls.

4. CATALOGUING

As subject indexing has already been discussed before, what remains to be discussed in this section is the code of cataloguing relating to author and title entries.

In documentation, title entry is of no use. But author entry or main entry can play a very useful role in locating a document speedily in those cases where the name of the author is known and in such cases, a laborious search through the subject index may not always be necessary.

Fortunately, in this domain the International Federation of Library Associations (IFLA), is making commendable efforts to standardize cataloguing practices throughout the world. In view of the cooperation already accorded to its efforts from various countries, it may not be too rash to hope that in this sphere international agreement may be reached and could be enforced in the not too distant future, at any rate sooner than in the field of abstracting and subject indexing.

The International Cataloguing Conference, held in Paris in 1961, under IFLA'S auspices, aimed at reaching an international agreement on basic principles governing the choice and form of entry in the alphabetic catalogue of authors and titles. Appropriately enough, the conference directed its attention to those aspects of catologuing practices which show marked variations under different catalouging systems. Questions on which substantial agreement already exists were left out. The matters on which agreement in principle was sought to be reached were as follows (25) :

A. **Function of the main entry:** in relation to the following assumptions about the character of the catalogue : it must serve two purposes (a) to locate a particular publication by its author's name or its title as given in in the publication, (b) to bring together entries for all editions and translations of one work and all works of one author.

B. **Choice of main entry :** (i) use of author or title as main entry for works of known authorship published anonymously; (ii) choice of main entry for works of multiple authorship, with special reference to (a) different forms of multiple authorship (e.g. collaboration, separate contributions, collections), (b) use of title entry when the number of authors exceeds a certain figure (e.g. three).

C. **Personal authors :** (i) choice of one name for an author who has used or is known by several names ; (ii) adoption of one form of a name which varies in orthography or exists in different linguistic form ; (iii) part of name to be used as entry word (a) for compound names with prefixes, of European origin, (b) for non-European names.

D. **Corporate authors :** (i) Whether, and in what circumstances, entries should be made under the names of corporate bodies ; (ii) use of subordinate bodies (a) as independent entries, (b) as subheadings under the names of superior bodies; (iii) use of geographical names as entry-words for corporate bodies other than those of a territorial character (states, provinces, cities etc.).

E. **Title entries :** (i) choice of entry for anonymous

works appearing under various titles ; (ii) entry of serial publications whose titles have changed.

F. **Form headings :** use of form headings and form subheadings for certain types of publications.

Since we have not yet received the full proceedings of this highly important conference, we are not in a position to discuss its major recommendations here.

Let us hope that the IFLA will succeed in securing the co-operation of all countries in enforcing the recommendations of this conference.

5. PERIODICAL REVIEWS

Under the reprint system of publication of research reports, there will be more selective purchase and selective reading of materials and this will tend to foster still more specialization. In one sense, this is inevitable and also highly necessary ; but at the same time there can be no doubt that too much of specialization leads to relative sterility of thinking and a limiting of the creative horizon of the research workers. To counteract the harmful effects of this over-specialization, there must be compensating devices to stimulate, as we have said, cross-fertilization of knowledge. It can be shown with numerous examples of how many chemists contributed to the progress of physics and vice versa, or how the problems of biology have inspired chemists and physicists to tread new terrains of knowledge. It is incontrovertible that cross fertilization of the various sciences is one of the essential fountain heads of scientific progress in general.

An effective method of fulfilling this need of the scientists is to provide them with competent and well written reviews of progress achieved in the adjoining areas of their own subjects. Reviews, thus, play a very crucial role. Reviews are important enough already; under the reprint system this importance will increase all the more.

The question of reviews is not as simle as it appears. Above all, we must known for whom a particular review is meant, because that will determine its scope and character. There are reviews for the general public (which fall outside the purview of the present discussion) ; there may also be reviews for the general scientists,

just as there are reviews for the specialists alone. Thus, for example, the articles in 'Reviews of Modern Physics' are meant for the practioners of the trade ; those contained in 'Reports of Progress in Physics' can be read by the workers of the physical sciences, while the articles on physical subjects appearing in 'American Scientist' are meant for a still wider circle of readers, that is, for scientists in general ; in the last case, the articles starting at an elementary level finally take the readers upto a sufficiently advanced level, without using the technical jargons or mathematical tools. This is one way of defining the scope of reviews. There may by other criteria too. Some reviews cover the entire field of a broad subject (e.g. Annual Report on the Progress of Chemistry of the Chemical Society, London), some cover a major subdivision of the broad subject (e.g. Progress of Organic Chemistry, Annual Review of Physical Chemistry), while there are still others devoted to a minute division of a subject (e.g. Advances in Carbohydrate Chemistry, Progress in Semi-Conductors). And lastly, there are reviews with varying frequencies of publication, from annual or bi-annual volumes (e.g. Advances in Inorganic and Radiochemistry) to monthly issues (e.g. Physics To-day).

Considering the diverse subject backgrounds of different groups of scientists, it is perhaps appropriate that reviews of varying scope and character should appear and an attempt to standardize may be undesirable in this sphere. One can only insist on maintaining a high quality for all types of reviews. It is understood that the different varieties of reviews will require writers with different qualities. A nuclear physicist who can write competent reviews for his own specialized circle, may not be at all successful in giving a broad view of the progress of his science for a wider audience.

6. THE LANGUAGE BARRIER IN SCIENTIFIC COMMUNICATION

The language barrier constitutes, at present, a major obstacle to free flow of scientific information. The problem is complex and vast. Both short term and long term remedies will be needed to solve it. Steps should be taken at various levels to attack the problem from different angles.

6.1. Need of Highly Skilled Translators :

Considering the growing volume of scientific papers in different languages that need speedy translation to be of use to the scientists, there is a real dearth of qualified translators in the world to-day, even including the most advanced countries like the U.S.A. and the U.K. This was sharply brought home to the American scientists when in the recent past they were taken by surprise by their own ignorance of Russian achievements in various fields ; this is mainly due to the fact that the Russian scientists publish their research only in their own language and in the soviet periodicals alone which, in their original, are read only by a small section of western scientists. Recently, the western countries, particularly the U.S.A., have engaged in wholesale translation of many important Soviet journals, often with substantial state subsidies. This project and the demand for translators which it created brought to light a long standing deficiency in all these countries—an inadequate supply of really competent translators in various languages.

6.2. Requisites and Training of Technical Translators :

To tackle it effectively, there must be in every country an adequate number of technical translators.

Technical translation demands not only linguistic proficiency but subject specialization as well. To fulfil this criteria, scientific personnel should be encouraged to take to this field, which should be made sufficiently remunerative. (In India, this need is very acute indeed. The government should aim at a planned production of such personnel under the Five Year Plans, as it is doing in the case of engineers, technicians, geologists etc.). The best place to train them up is perhaps in the various abstracting agencies and according to our scheme of the reprint system, in the zonal and national documentation centres. An instructive example of this is furnished by the Institute of Scientific Information USSR. This Institute handles, at present, materials in 64 languages from 92 countries of the world and publishes separate abstracting journals in 13 different subjects. An institute of this nature automatically becomes the greatest workshop for apprenticeship and the ideal laboratory for research and experimentation on the problems of technical translation. It is, thus, natural that the Institute, in addition to its main function of bringing out the abstracting journals, also engages in terminological and lexicographical work. In 1955, on the occasion of the First Geneva Conference on the Peaceful Uses of Atomic Energy, the Institute published an English—Russian and a Russian—English dictionary of nuclear physics and engineering.

6.3. International Co-operation

Every advanced country has undertaken today a heavy project for translating current literatures. Unfortunately, much of these efforts takes place independently, without knowledge of each other's plans, programmes and activities. As a result there is considerable duplication of efforts and wastage of highly skilled

labour. In the U.S.A., Great Britain, France and Germany, separate national indexes to translations exist. But there is still no regular, periodically published, international index which is a crying need in the field of documentation. Coblans suggested that the Unesco should either publish or subsidize the publication of an international index at least once a month (26). (Here again, India lags far behind. We donot possess yet a consolidated index of all translations carried out in India. Such a work must be undertaken immediately, preferably by INSDOC. Initially it may be published as a quarterly, or even as an annual, index ; later on, the frequency may be increased to once a month.)

6.4. Machine Translation :

Another direction in which some researchers are attempting to overcome the linguistic hurdle is by employing machines for translation. The Soviet and American workers are particularly active in this field. We may mention, in this connection, the team of Allen Kent and James W. Perry at the Communication Research Centre of Western Reserve University, the M.I.T. and Rand Corporation teams in the U.S.A. and Ljapunov and Panov teams in the U.S.S.R. The U.S. scientists have taken German as their input language, while their Soviet counterparts are working on English.

6.4.1. Requirements of Machine Translation :

The results of their research are interesting but as yet they donot permit us to entertain any exaggerated optimism regarding the capability of these machines to bear even a minor part of the world's total translation load in the foreseeable future. Quite apart from their fantastic costs, the technical efficiency of these machines

is still very low; they can translate only a few, extremely elementary sentences. Researches have revealed that for the machine to operate with any degree of efficiency, it would require a new dictionary for each language and a corresponding coding system for the machine. In this dictionary, there should be only one word to express one concept. However, judged by this criteria, all living languages are impure, because in most cases a single word has more than one connotation. Only a human agency can decide which of these meanings will be appropriate in a particular context. A machine is capable of correlating one term with only one meaning; it does not possess the "intuition" to distinguish between the various shades of meanings represented by the same word. In other words, the machine can operate efficiently only if it is fed with a "pure word". Naturally, this presupposes the "manufacture" of a "pure language" and a new type of dictionary for such a language. This calls for a veritable semantic revolution, without which not much progress can be achieved along this direction. At present all the researchers are engaged in compiling such electronic language dictionaries. All this gives us an insight into the complexities and dimension of the problem.

6.4.2. Magnitude of the Problem

Moreover, for carrying out translations even with a very small range of languages—e.g. English, German, French and Russian which are the major languages of the scientific world today—a large number of machines, to be precise 12 machines, will be required.

(Machines to handle translation from :

A.	1. English to German	}	3 different machines
	2. " " French		
	3. " " Russian		
B.	1. German to English	}	3 machines
	2. " " French		
	3. " " Russian		
C.	1. French to English	}	3 machines
	2. " " German		
	3. " " Russian		
D.	1. Russian to English	}	3 machines
	2. " " French		
	3. " " German		

Thus, 12 different types of machines in all for 4 different input languages)

If the range of the input languages is increased by adding other European languages and a few advanced eastern languages (e.g. Japanese and Chinese), it will require hundreds of different types of machines ; and the development of each type of machine demands laborious research and unlimited funds, to tackle translations at an elementary level.

6.4.3. Scope of Machine Translation :

In our opinion, to obtain the maximum benefit from the translating machines, research should be concetrated upon the **four** most important languages mentioned above and upon the more, quantitatively precise sciences like mathematics, physics and chemistry where success is more likely than in such qualitative subjects as botany, zoology etc.. In view of the large number of languages in which research results are already published today and the even more numerous media through which they may tend to be communicated in the near future, as a result of the emergence of new, independent states in the world, each with its own languages and subjected to strong nationalistic pressures at home, the World of Science may soon turn into a veritable Babel's Tower. Under such circumstances, any attempt to keep the linguistic barriers intact and to solve the problem through translating machines is bound to be self-defeating.

A much more basic approach is obviously needed to tackle this problem. In the sheer interest of effective scientific communication, the scientists should refuse to submit to the irrational claims of nationalism and should accept a solution dictated by common sense, that is, a common language for the entire world of science. The use of such a language whose purpose is strictly utilitarian and which will be, so to speak, a trade language of only the scientific community, need not at all clash with the legitimate needs of the different, developing nations in imparting education to their citizens in their own mother tongue ; in any society, the bulk of the population will receive their education in their own language; however, those concerned with higher studies, particularly the men of science, would need to learn another language which

can serve as an international medium of communication. This is the only way to reconcile the cultural claims of nationalism with the historical demands of international co-operation.

The endeavours of those who are engaged in research on translating machines and of those who are trying to evolve a common language of science should supplement each other, instead of running at cross purposes. From this point of view, the perspective outlined by Emil Delavenay (27) is not only unrealistic but essentially unhistorical in approach. In his opinion, "mechanical translation will also do much to preserve linguistic and cultural originality and individuality because it will encourage the use of the less widely spoken tongues in a world in which they might be endangered by the ascendancy of two or three languages of international currency". In our opinion, this is precisely what the machines should not attempt to encourage ; if this aim of raising more linguistic barriers is pursued especially in the domain of scientific communication, it will only result in considerable, misdirected energies.

6.5. The Search for a Universal Language :

Contemporary world displays two tendencies operating in opposite directions. As has already been pointed out, newer and newer nations are entering the international community of nations, each with its own culture and language, thereby further complicating the linguistic situation ; on the other hand, the number of languages carrying the world's biggest load of scientific communication is becoming smaller. To be precise, their number is now four and the percentages of scientific papers published in them are, according to a recent estimate (28), as follows :

English 44%, German 14%, French 13%, and Russian 8%. On the basis of the above figures it may be asked —why not choose English as the international language of science ? The reply is simple : the majority of the people of science are still alien to it. Moreover, such a language cannot be selected purely on rational considerations ; the language of one nation cannot be expected to become a universal language, if not for any other reason but for the fact that it will offend the national pride of other countries.

So, the international language has to be a new medium. The search for such a universal language had been going on for a long time ; its origin can be traced at least to the beginning of the last century. Since then, nearly 200 schemes have been put forward but most of them are paper projects only. Out of them, two have survived and established themselves—e.g. Esperanto and Interlingua.

6.5.1. Esperanto :

It was initiated in 1887 by Dr. L. L. Zamenhof. The grammer of Esperanto, it is claimed, can be grasped in a few hours; every rule is without exception; the spelling is phonetic and the dictionary small. Esperanto had a flourishing growth in the period between the two world wars (1919-1939). There were some 4,000 books and numerous journals appearing in Esperanto at that time. The League of Nations published a favourable memorandum on the teaching of Esperanto in schools ; in fact, many commercial schools in Britain and France adopted Esperanto for teaching. In May 1927, the Union Internationale de Radiophonie recommended broadcasting stations to use Esperanto and in December 1927, 44 stations were already giving regular Esperanto transmissions (29).

6.5.2. Interlingua :

However, the greatest advance in the recent period has perhaps been made by Interlingua. Started in 1903 by Prof. G. Peano, developed after First World War in the U.S.A. by the International Auxiliary Language Association, it has ventured into the field of scientific communication on an extensive scale, not attempted by Esperanto or any other scheme as yet. Perhaps the greatest use of Interlingua to date has been in medicine. More than twenty medical journals publish abstracts in Interlingua with all their articles. In addition, Interlingua has been used for summaries in the programme of seven international medical congresses. In May 1952, Dr. Forrest F. Cleveland of the Department of Physics of Illinois Institute of Technology started the publication of a physics periodical in Interlingua, entitled "Spectroscopia Molecular". The journal has subscribers in 28 countries and the receipts from them have been more than sufficient to cover its cost of production (30). This shows that Interlingua is not just a utopia, that it fulfils a real need of the scientists. The greatest vitality of Interlingua is due to the fact that it is not, in fact, a new language at all ; all its vocabularies are derived from such European languages as English, Spanish, Italian, French etc., the original irregularities and peculiarities of these vocabularies being removed for their use in Interlingua. The resulting language can be read at sight by anybody acquainted with one of the above mentioned languages. To facilities its complete mastery, two manuals were published in 1951, an Interlingua—English Dictionary and an Interlingua Grammer, edited by Dr. Alexander Gode (Storm Publishers, 80 East 11th. Street, New York 3, N. Y.) (31).

Interlingua's interesting experiments deserve every scientist's encouragement. One tangible way of popularizing its extensive use in science is to provide with each paper an abstract in Interlingua.

7. MECHANIZATION OF DOCUMENTATION SERVICES

The phenomenal growth of printed materials in the last few decades has made literature search a difficult task. This provided the impetus to introducing a measure of automation in this sphere.

One of the first successful attempts in this line has been in the correlation of property with chemical structure. In 1947, a team of American chemists had built up a battery of hand sorted cards on which the properties of 8,000 insecticides were recorded. Thus, by repeated sorting, for example, all the insecticides soluble in a given liquide, solid at tropical temperatures and containing a phenolic group, could be established (32). Since then there has been a spate of machines of various trade names, for mechanizing one or the other aspect of documentation work. Broadly, these machines fall into three categories :

1. Punched cards, selected either electromechanically or electronically ;
2. Systems based on photographic methods (usually microforms) with photoelectric selection by code patterns ;
3. Systems based on magnetic recording wire, drums or cores.

7.2. Limits of Mechanization :

The over-enthusiasm of the early fifties, engendered by the initial success of some of these machines, has now given way to an attitude of critical reserve towards

mechanization. The present status of the problem, indicating what the machines can and cannot do at present, has been explained with singular clarity by Vickery in the following terms (33) :

"In the first place, only a part of the whole operation we call 'searching the literature' can be handed over to a machine. To search an index, we must first of all name the subject of search in the terms used by the indexer : no existing machine retrieval system can do this for us. Then we must locate the subject name in the index– this operation can and has been mechanized. Next we must locate the documents to which the index refers us : this could be mechanized, but only the Minicard system has so far seriously attemped it. To complete our literature search, we must study and integrate the retrieved documents : this no machine can do, and it is this which takes up the greatest amount of time.

Consider next the processes involved in constructing a retrieval system. We must select documents to put into a store : no machine can yet do this. We must then construct index entries by (a) scanning each document, (b) selecting certain words, phrases or sentences as descriptive of its content, and (c) transforming these descriptions into the formal vocabulary of the index : no machine can yet do this for us, although Luhn's auto-encoding proposes a method for for selecting descriptions and some ideas about transforming them. At the present stage of technical development, we must do our own scanning : input into either a brain (by reading) or a computer (by preparing tape).

If we take all these operations into considerations, it is possible that any speed-up or lightening of labour which may result from the use of machines may turn out to be

relatively minor. Nevertheless, there are operations in information storage and retrieval which are purely clerical, and in this era of automation it is only proper that we should examine the benefits of mechanizing them."

7.3. High Cost :

Moreover, the cost of mechanical retrieval of information is as yet prohibitively high. Thus, it has been "calculated that in order to handle the daily reference load of Library of Congress, 8,333 univacs [an electronic computing machine designed by Remington-Rand Co.] would be needed at an investment of close to a billion dollars " (34).

7.4. Conditions of Success in Mechanization :

The question of economy should not, however, be over-emphasized. As a result of feverish research which is now going on in all the major countries of the world—particularly in the U.S.A. and U.S.S.R.—the cost of the machines may appreciably come down in future. Besides, to cope with the growing chaos in the documentation field, a certain degree of automation becomes inevitable. However, progress in this sphere will not come through producing still better machines. It is now well recognized that the main problem of documentation is human : a machine can think more quickly but not more wisely than human beings. Machines will become a powerful tool in our hands, only if **we** can plan intelligently the programming for the machine.

8. PHOTOGRAPHIC REPRODUCTION OF DOCUMENTS

8.1. Versatility of Photoreproduction :

Photographic reproduction of documents has already become an indispensable tool for the research workers. It is the only method left when the original stock of a paper is exhausted and inter-library loan also fails to provide a copy to the searcher. From a single extant copy of a paper, it can supply an unlimited number of copies. But it is particularly useful in cases where only a limited number of copies are needed and where printing would be definitely uneconomical. Thus, under the reprint system where mass production of periodicals will be replaced by a much more limited production of individual papers, designed for well-defined categories of readers, the demand on photoreproduction will increase enormously.

Photoreproduction is, in fact, a versatile facility. At the Royal Society Empire Scientific Conference (1946), Lucia Moholy cited about 20 different uses to which it may be put (35). Its more important uses are in (i) publishing a small number of a book or a paper which may not justify type setting e.g. dissertations, theses, private editions etc ; (ii) republishing out-of-print books for which the demand is too small to justify new printed editions ; (iii) preserving the contents of valuable manuscripts threatened with disintegration ; (vi) saving library's valuable storage space ; and (v) acquiring long runs of back volumes of periodicals with maximum economy of library funds and space.

8.2 Need of Document Reproduction Centres :

In order that a research worker may get a copy of his desired paper within a short time, there should be one or more document reproduction centres in every country. These centres should not only contain facilities for documentary reproduction but arrangement for keeping at least one copy of every research paper published in that country. In the U.S.A., there are certain depository libraries for the atomic energy reports published by the U.S. Atomic Energy Commission. This example should be emulated by other countries and the scope of the depository libraries should be enlarged to embrace the whole field of science and technology. According to our plan, as outlined in Part I, the zonal and/or national documentation centres in every country will have a wing specified for this purpose.

8.3. Obstacle to Free Use of Photoreproduction :

At present one of the factors impeding the freest use of photoreproduction facilities arises from the provisions of copyright laws existing in many countries. Many publishers forbid photoreproduction of any sort of their publications. Provided the users certify that the photoreproduction is meant for genuine research work and for their private use only (the sort of certificate which every party, placing an order with INSDOC, has to furnish), the publishers may be persuaded to relax their restrictive regulations. And this is essential for the free flow of scientific communication. Under the reprint system where all papers will be published by documentation centres, zonal or national, such obstacles would not exist.

8.4. Need of Further Research on Photoreproduction Methods

Various kinds of photoproduction methods are available at present — e.g. microfilms, microcards and paper photocopies. The paper photocopies are the easiest to handle but they are expensive, mainly due to the relatively high cost of the photograpic papers. Moreover, the photographic papers, used for this purpose, is not very easy to keep and preserve in the library, especially in tropical countries.

Microfilms are cheap but they require a reader for their use ; besides, there is considerable resistance among users to microfilms, obviously because of the inconvenience of their mode of use. It may be expected, however, that in course of time the habit of using microfilms will become more widespread. Microfilms have other disadvantages too. Owing to their inflammable nature and their unusual medium, they pose problem of storage and maintenance.

Microcards provide a compromise between paper photocopies on the one hand and microfilms on the other. But they also need expensive readers for their use.

A paper photocopy, easy to keep and preserve, and containing the microreproduction of several pages of the original, on one page, which can be readily deciphered by using a cheap magnifying glass, would indeed be a big advance on the existing form of photoreproduction. At any rate, there is an urgent need to undertake intensive research on the methods of photographic reproduction, so that the users may get photocopies of papers in a more convenient form and that too at a cheaper rate than at present.

9. LIBRARY SERVICE

9.1. Importance of the Library for Efficient Scientific Communication

Library service constitutes the last, but not the least important, link in the chain of a scientific communication system. The fare prepared by a host of other persons—the publishers, abstractors, classifiers, translators etc.—is ultimately served up by the librarian to the actual consumers—the scientists using the library. If the last link remains weak and ineffectual, the entire dish may be spoilt. That calls for careful planning of the library service ; a good part of the job consists in selecting personnel with the requisite qualifications for the library.

9.2. Mutation of Librarianship under the Reprint System

What will be the nature of a research library and what qualifications will a research librarian be required to possess in the days ahead ? Assuming that periodicals have been replaced by reprints by that time, it is evident that the book-cum-periodicals library of today will have been converted then into a predominantly documents library. Consequently, librarianship will increasingly assume the features of documentation work and the librarian those of the documentalist.

The switch over from the periodical system to the reprint system will affect all aspects of library administration in a far reaching manner, both quantitatively and qualitatively. Some of the routine administrative duties—e.g. ordering, accession, classifying, indexing, storage, circulation etc.—will become either simplified

or mechanized. For example, since all orders for desired papers will be placed with the national documentation centre of the country, ordering will become a simple affair. Accession in its traditional form will be unnecessary and at any rate impossible, since even a small research library may receive thousands of reports every year. The class index may simultaneously serve as shelf-list and accession register.

9.3. New Problems under the New Set-up

The task of classifiying, indexing and cataloguing of the reprints will be taken off the shoulders of the library staff, since these will be done, under the reprint system, by the documentation centres. The problem of storage for hundreds of thousands, if not millions, of reports instead of a limited number of books and periodicals will demand a radical alteration in shelving methods. Some of the existing reading habits of readers will also have to be changed. Libraries will then function only as places for reference reading ; the practice of borrowing materials from libraries for home reading will be discontinued ; since libraries in research institutions ought to remain open for long hours and to provide ideal reading conditions, this limitation should not inconvenience the readers much ; it will involve only a readjustment of their reading habits. Thus, the problem of circulation of innumerable reprints which would have otherwise arisen, would disappear. Information retrieval or literature search will be tackled partly by machines and partly by human skill.

9.4. Role of the Future Librarian :

A librarian working in such a library will very much resemble a worker in an automatic factory. He will be

freed from the routine administrative and repetitive technical duties. Since under the reprint system, only those papers that are needed will be acquired by the library, a more intensive utilization of individual research papers will consequently take the place of a diffuse reading of periodicals ; and to cope with this situation the librarian will be required to possess a very strong subject background ; in fact, at that time he will be recruited from among the ranks of the research workers. A sure grasp of the documentation methodology and a high degree of linguistic proficiency will be the other essential prerequisites. National or zonal documentation centres will provide this training to library personnel.

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