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ABSTRACT

In view of the vital role which scientific and technical information has come to play in the development of nations, the Director-General of the United Nations Educational, Scientific and Cultural Organization (Unesco) was authorized to undertake and to complete jointly with the International Council of Scientific Unions (ICSU) a feasibility study on the establishment of a world science information system (UNISIST). A Unesco/ICSU Central Committee was created in January 1967 to carry out the feasibility study. The conclusions of this study and a description of the proposed World Science Information System are contained in the Study Report, of which this is a synopsis. A description of UNISIST, its background, trends toward cooperations, recommendations, and implementation plans, program priorities and benefits and values are summarized. Appendices include a listing of the members and the working groups. (Author/AB)

UNISIST

Synopsis

of the feasibility study on a World Science Information System

by the United Nations Educational, Scientific and Cultural Organization, and the International Council of Scientific Unions

Unesco Paris 1971

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Preface

In view of the vital role which scientific and technical information has come to play in the development of nations, the Director-General of the United Nations Educational, Scientific and Cultural Organization (Unesco) was authorized[1] to undertake and to complete jointly with the International Council of Scientific Unions (ICSU) a feasibility study on the establishment of a world science information system (UNISIST).[2]

A Unesco/ICSU Central Committee was created in January 1967 to carry out the feasibility study. The conclusions of this study and a description of the proposed World Science Information System are contained in the Study Report, of which this is a synopsis.

The conduct of science requires countries to commit both intellectual and material resources. As governments have reviewed their national science policies, questions associated with the allocation of funds and equipment and with the development of scientific manpower have become familiar, if not resolved. The organization of the informational resources of science has been given less attention. The Unesco/ICSU joint project has as its central theme the international deployment of the informational resources of science.

Scientific information[3] embodies the heritage of man's

1. Resolutions 2.222 and 2.151 adopted by the General Conference of Unesco at its fourteenth (1966) and fifteenth (1968) sessions respectively.
2. UNISIST : an acronymic term which stands for the feasibility study and for the recommended future programme to implement its recommendations.
3. This term is to be construed broadly in the context of information for science, applied science, engineering and technology.

scientific knowledge. It constitutes an essential resource for the work of scientists. It is a cumulative resource; knowledge builds on knowledge as new findings are reported. It is an international resource, built painstakingly by scientists of all countries without regard to race, language, colour, religion, or political persuasion. As it is built internationally, so it is used internationally. Scientists who are its builders and users ask only that each other's contributions be verifiable; it is, therefore, not only a resource; it is a means through which the world's scientists maintain their discipline. It is a medium for the education of future scientists, and a principal reservoir of concepts and data to be drawn on for application to economic and technological development programmes.

The UNISIST Study is concerned with the cultivation of this resource, with increasing international co-operation to improve its accessibility and use, to the end that, as an international resource, it contribute optimally to the scientific, educational, social, cultural, and economic development of all countries.

The results of this study submitted to the Director-General of Unesco and to the President of ICSU, are directed to the several audiences which these international organizations represent:

to governments who support national programmes for generating, organizing and disseminating scientific information;

to scientific organizations which speak for the collective interests of the world's scientists;

to the technical experts, the publishers, libraries, and information scientists professionally concerned with the operation of information services for science.

Technical recommendations addressed to these three groups will be found in the body of the text.

Appropriate to this preface, however, is a declaration of certain broad principles which underlie the programme presented. UNISIST stands for:

the unimpeded exchange of published or publishable scientific information and data among scientists of all countries;

hospitality to the diversity of disciplines and fields of science and technology as well as to the diversity of languages used for the international exchange of scientific information;

promotion of the interchange of published or publishable information and data among the systems, whether manual or machine, which process and provide information for the use of scientists;

the co-operative development and maintenance of technical standards in order to facilitate the interchange of scientific information and data among systems;

promotion of compatibility between and among information processing systems developed in different countries and in different areas of the sciences;

promotion of co-operative agreements between and among systems in different countries and in different areas of the sciences for the purpose of sharing workloads and of providing needed services and products;

assistance to countries, both developing and developed, wishing access to contemporary and future information services in the sciences;

the development of human and information resources in all countries as necessary foundations for the utilization of machine systems;

the increased participation of scientists in the development and use of information systems, with particular attention to the involvement of scientists in the evaluation, compaction, and synthesis of scientific information and data;

the involvement of the coming generation of scientists in the planning of scientific information systems of the future;

the reduction of administrative and legal barriers to the flow of scientific information between and among countries.

The principles here enunciated are basic for the improvement of the international flow of scientific information.

Unesco wishes to express its gratitude to all the organizations and individuals who participated in the UNISIST Study and in particular to Professor Harrison Brown, convenor of the

Unesco/ICSU Central Committee for his invaluable contribution. As a major step towards the establishment of such a system, an intergovernmental conference is foreseen for October 1971. This conference will bring together government officials responsible for the planning and directing of science information programmes, and scientists and science information specialists so that they may define ways and means of setting up the information system outlined in the following pages.

Transmittal memorandum

Addressed to:

The Hon. RENÉ MAHEU,
Director-General,
United Nations Educational,
Scientific and Cultural
Organization.

The Hon. V. A. AMBARTSUMIAN,
President,
International Council of
Scientific Unions.

Sirs:

I have the honour to submit to you the report of the Central Committee which you jointly created to study the feasibility of a world science information system (UNISIST).[1]

I am pleased to inform you that the Committee agrees unanimously that a world science information system, considered as a flexible network evolving from an extension of voluntary co-operation of existing and future services, is feasible. Further, from the point of view of the needs of the scientific and technological communities, such a flexible network of information services is both desirable and necessary.

The UNISIST Study Report represents the fruit of our four-year-long inquiry. The members of the Central Committee are unanimous in their endorsement in principle of this Study Report, although it is recognized that some members might not be in full agreement with every detail.

The problem the Committee was called on to review is a complex one. In its popularly recognized form, it has been unfortunately termed the 'information explosion'. It is frequently

1. We have defined 'science information' as information essential to the advancement of science in its basic, applied and technological contexts.

alleged that scientific and technical articles and reports are increasing at a rate which makes it extremely difficult for scientists to keep up with the work of their colleagues. Faulty distribution practices and understocked and understaffed libraries make access to these reports difficult; once access is had, linguistic barriers interpose comprehension difficulties.

These are the more familiar characteristics of the problem. Less obvious, but more radical, are the changing needs of the world scientific community for information. The interdisciplinary approach to problems of the environment, for example, requires information drawn from a variety of sciences: chemistry, biology, sociology, to name only a few. The emerging needs of applied science, technology and engineering add further complexities. The classic information services, the scientific journals, abstracting and indexing services, libraries, have all demonstrated a cultural lag in accommodating rapidly to these new requirements. The achievement of new and flexible forms of information services, to meet these new needs is the fundamental problem; the increase in volume involved in the 'information explosion' have made it more difficult for the systems to adapt rapidly, and hence are aggravants.

Different aspects of this problem have been under study at national and international levels for many years. The UNISIST Study represents an effort to resolve these issues on a world scale.

In an effort to satisfy these new types of demands, the industrialized countries have turned to advanced communications technology. A computer system, for example, has the capability not only of handling large amounts of information at high speeds, but also that of organizing and re-organizing units of information, and hence providing the flexibility which the traditional systems have lacked.

With all the promise of mechanized systems, such solutions have created, in the minds of many observers, new problems. As electronic processing and retrieval systems are developed without provision for their compatibility, are the scientific information services constructing a Tower of Babel? Instead

of improving international communication in the sciences, will they worsen it by fragmentation into thousands and thousands of independent systems, each of which to some extent re-does the work of the others?

There is one added complexity. The problem as described above is indigenous to the highly industrialized countries. Most of the developing countries, and a sizeable number of the developed as well, lack an adequate infrastructure of libraries and information centres on which to build. How can the information resources which they need for their development first be brought to basic levels and second be reinforced by the industrialized countries?

These are not problems susceptible to facile technological solutions. Underlying them are economic, organizational, even legal problems, both within individual countries, and among the intergovernmental and non-governmental organizations through which the countries conduct their international scientific relations.

If the trends which have created this problem situation are continued without corrective action, it is the Central Committee's considered judgement that not only national science programmes but also science itself will be the losers. With the rising costs of information processing, scientific information will become a luxury which only a few wealthy countries can afford instead of the daily fare of the working scientist. Unless the channels of international communication are kept open and readied to accommodate the ever-increasing volume of traffic, scientists in different countries will work in increasing isolation, unwittingly repeating and duplicating each other's work. Without programmes to focus governmental attention on the needs of countries to develop their information resources, scientists in many countries will work under varying degrees of handicap. This will be particularly true of the developing countries, where the gulf separating their resources of knowledge and know-how from those of the developed countries will inexorably widen.

If, however, the costs of processing scientific information

can be controlled through an increased measure of international co-operation, thereby making it possible for more scientists to receive better services, a steady flow of benefits may be expected. A recent study has demonstrated that computer-based searches of the chemical literature significantly enhance the ability of research chemists to acquire the information they need for their work. Further, co-operation leading to the improvement of information services along the lines suggested in the Study Report offers to the scientist and engineer the prospect of reducing his labour through strengthening the functions of evaluation and selection of new and old information. To the developers and managers of information systems, and to the public and private agencies which support them, the increased co-operation offers the possibility of meeting new demands for information services at low costs per unit of information.

The Committee was convinced by the evidence presented to it that any trend toward the deterioration of information services is offset by a counter trend or movement toward co-operation which if acted upon augurs a more optimistic future.

The sharing of information resources through such co-operative measures as the interlibrary lending (or photocopying) of scientific publications is on the increase. The sharing of the costs of processing information, as in the indexing and abstracting of the scientific literature, the cataloguing of books for libraries, the reduction of data in evaluation centres, is an area where the Committee found new and emerging patterns of co-operation.

This is particularly so in the very large abstracting and indexing systems which have converted to mechanized operations. Volume and unit costs have risen so sharply that the job to be done appears to exceed the resources of any single country. Consequently large systems in several areas of science — chemistry, physics, biology, medicine, nuclear and space sciences — have taken steps to internationalize both their inputs and their service points.

These are not isolated examples. Taken all in all they re-

present a trend which is both world-wide and discernible in most fields of science and technology. The Committee's conclusion that a world-wide network of scientific information services working in voluntary association was feasible is based on the evidence submitted to it that an increased level of co-operation is an economic necessity.

The Committee further concluded that for ICSU and Unesco to discharge their responsibilities to the world's communities of scientists in the future, they must both play active roles to advance this new trend. There are several reasons for this. First, scientists have a responsibility for insuring that the new directions taken by information services are responsive to the changing needs of science. Some mechanism for guidance is needed. Second, in order to make progress there must be general agreement among representatives of governments, scientists, and information specialists on the goals and purposes of this co-operative trend. An international programme focus is required. Third, a way of stimulating and catalysing the voluntary agreements, bilateral and multilateral, from which the network will evolve is necessary. For that, there should be a continuing administrative function.

The Committee therefore concludes that the establishment of a programme to guide, interpret, and stimulate actions leading to increased voluntary co-operation among information services is a first essential. For the purpose of launching this action programme, an intergovernmental conference is suggested.

There are twenty-two recommendations in the UNISIST Study Report, which the Committee has endorsed. The last of these calls for the establishment of a programme, with administrative functions appropriate to the needs described above. In order to implement the recommendations in this report, the Committee calls for the establishment of an executive office, within the Science Sector of Unesco. This office would function with the guidance of a scientific advisory committee to the Director-General of Unesco to catalyse the co-operative actions comprising the UNISIST programme. At the apex

of the proposed organization for UNISIST would be a periodic intergovernmental conference functioning to establish policy, set goals, and evaluate progress toward these goals. This recommendation should receive priority attention.

An international focus and programme is only a first requirement; individual countries should in turn accept responsibility for creating national foci for developing information resources in support of their scientists and engineers. A key recommendation of the UNISIST Study calls on governments to establish such foci in the perspective of national, regional and international co-operation (Recommendation 15). The commitment of national efforts is fundamental to the higher level of international co-operation which UNISIST would attain.

The Committee would urge scientists, both in their individual capacities and through their national and international organizations, to accept their full share of responsibility for the evaluation, synthesis and compression of new scientific knowledge, and particularly the evaluation and compression of numerical data such as is performed by centres adhering to CODATA. Several of the recommendations of the UNISIST Study are directed to this purpose (Recommendations 10-13).

To facilitate the interchange of information between systems and among countries will require a concentration of efforts in the area of developing minimal standards for systems interconnectibility. The Committee calls upon all concerned, but especially the communication and information specialists, to redouble their efforts. The first six recommendations of the UNISIST Study call attention to this need.

Finally, a special charge was laid on the Committee at the outset of the study to pay attention in particular to the ways in which developing countries should share the benefits of a world network. Two recommendations in the UNISIST Study are directed especially to this question (Recommendations 20 and 21).

Mr. Jean-Claude Gardin (France) was entrusted with the task of writing the final report of the feasibility study based

on the discussions of the Central Committee and the documentation supplied by its working bodies. Mr. Scott Adams (United States) undertook the writing of a synoptic version of the Study Report.

Deep gratitude is expressed to the members of the Central Committee, the Executive Committee, the Advisory Panel, and the Working Groups who have contributed the ideas, comments, and guidelines that are reflected in the over-all fabric of the report. Our thanks are also due to the various United Nations agencies and regional, governmental and non-governmental organizations who have attended the sessions of the Central Committee where they have provided comments and information.

1 October 1970

Respectfully submitted,

HARRISON BROWN,
Convenor UNISIST Central Committee.

Contents

What is UNISIST?

In 1966, following approvals from the General Conference of the United Nations Educational, Scientific and Cultural Organization (Unesco) and the General Assembly of the International Council of Scientific Unions (ICSU), the two organizations, one intergovernmental, the other non-governmental, undertook a jointly sponsored inquiry into the feasibility of a world science information system. Guidelines for the study, which later became known as ,UNISIST' were laid down by a working party which met in Paris from 18 to 20 January 1967. The basic guideline employed consistently throughout the course of the study was that the world science information system under study must be considered as 'a flexible network based on the voluntary co-operation of existing and future information services'.

A central committee was assembled under the chairmanship of Dr. Harrison Brown, Vice-President of ICSU, and convenor of UNISIST. Working groups, each chaired by a central committee member, were established in such problem areas as internationally accepted abstracting forms and procedures; evaluation, and compaction of scientific information; research needs of a world information system; language problems inherent in the transfer of scientific information; the specific problems of developing countries, and finally, in a joint activity with the ICSU Abstracting Board (ICSU/AB) a working group on bibliographic description. In addition, the central committee appointed an advisory panel composed of representatives of large operating information systems in the sciences, to which it turned for practical advice.

The working groups produced several study reports for consideration at four meetings of the central committee,

1967-69.[1] Finally, the central committee guided the preparation of the final report of the feasibility study. This feasibility study report is published in a complete version,[2] and this present synoptic version. The results of the feasibility study show that a world scientific information system, considered as a flexible network, which would extend the voluntary co-operation of existing and future information services, is not only feasible, it is desirable and necessary if the information needs of the world scientists are to met in the future.

On the philosophic level, UNISIST is more than a feasibility study or a programme. It is a reaffirmation in terms of modern communications technology of the traditional principles maintained by scientists for the unrestricted interchange of scientific information. It is also the expression of, and a guiding force for a world-wide movement, a resultant of observable economic forces, towards increased co-operation among the information systems serving science in all countries. In terms of an action programme, UNISIST represents a potential combined effort of governments and scientists to guide the evolution of scientific information systems in a period of rapid technical development, so that they provide optimal satisfaction to the needs of scientists internationally at costs which society, through governments, is prepared to pay.

The feasibility study does not pretend to deal comprehensively with all aspects and modes of scientific communication. Oral communications, scientific meetings, audio-visual media, for example, while mentioned during the course of the study, were considered outside its purview. There was instead a concentration on the more formalized institutions of scientific communication: journals, abstracting and indexing services, scientific libraries, etc.

1. These and the principal documentation of the UNISIST study are available in the *UNISIST Proceedings* which have been deposited in microfiche form in the principal libraries of the world.
2. *Joint Unesco/ICSU Study on the Feasibility of a World Science Information System (Final Report)*, Paris, Unesco, 1970.

UNISIST is, therefore, a name which stands for a number of concepts. As a feasibility study, its life expires with the publication of the study report. As a philosophy and conceptualization, it reaffirms long-standing traditions of the sciences in a time of change; as a movement, it represents an informed and purposive response to economic forces which impel sharing of the costs of information systems, and as a programme it presents the organizational requirements necessary to stimulate positive co-operative action among the world's scientific information services.

Backgrounds of UNISIST

The UNISIST study was preceded by a series of prior co-operative efforts to investigate information needs internationally in the sciences. In 1896, the Royal Society sponsored a conference which planned the co-operative production of the *International Catalogue of Scientific Literature*, a comprehensive indexing service which lasted for twenty-five years. More recently, Unesco sponsored conferences on indexing and abstracting in the biological and medical sciences (1948), and on scientific abstracting (1949) which led to the establishment of the ICSU Abstracting Board. The Royal Society's Scientific Information Conference in 1948, and the International Conference on Scientific Information held in Washington in 1958, both represent efforts to understand and respond to the new requirements which modern science and technology have placed on the institutions which science has evolved for communications.

By 1967, when ICSU and Unesco determined to join forces in the UNISIST feasibility study, twenty years of effort had gone into studying the needs of the scientists for information, and into the development of sophisticated systems to provide for them. The so-called 'information crisis' had lost both its novelty and its power to alarm. While it may be true, as Auger has reminded us,[1] that 'The number of scientists alive today [and hence writing][2] is equal to 90 per cent of all the scientists and research workers who have existed since the beginning of history', so also it may be true that we are spending more

1. Pierre Auger, *Current Trends in Scientific Research*, p. 15, Paris, Unesco, 1962.
2. Editor's interpolation.

money, employing more people, assembling more libraries than ever before in history. Scientific journals have death as well as birth rates; scientific publications have discernible rates of obsolescence. We still have an information problem, but we have learned to live with the quantitative aspects of it.

Today, there is general recognition that the scientific information problem is not primarily one of coping with the increasing volume. While the increase in quantity of publications and data may aggravate the problem, its roots are to be found in changes in the organization of science. Science is undergoing a revolution in our time, in the course of which its goals and its institutional forms are being reshaped. The institutions of the scientific journal, of the scientific abstracting and indexing services, of science libraries and data centres are all under challenge to modify their functions and services to accommodate science in its new forms.

The scientific revolution which has stressed these institutions is in itself a highly complex phenomenon. In contrast to the compartmentalization of science in the nineteenth and early twentieth centuries into academically defined disciplines, large-scale public funding of science for social goals, energy sources, food supply, health, and national defence, has resulted in what has become known as 'mission-oriented' research. Perhaps 'problem-solving' research would be a more appropriate term, since it is the methods employed rather than the governmental sponsors of the research that have shaped the information problem.[1]

'Problem-solving' research in the sciences may draw on any discipline that can make a contribution to the solution of the research problem which has been identified as an objective in a long-range programme. It involves both basic and applied scientific research. It creates new groups, multidisciplinary in origin, which develop homogeneity in time, but which may initially be highly heterogeneous. These new groups look at the existing information services which have served the academic

1. Cf. Pierre Auger, op. cit.

purposes of science so long and so well, decide that their problem-solving biases require something different, and that they must develop their own. It may be observed that the first requirement of a new interdisciplinary group in science is usually for a retrospective bibliography recording the contributions of their several disciplines to the field as defined; the second requirement is for one or more journals to communicate findings; the third requirement is for an abstracting service to keep abreast of new developments in the new field and in related fields.

Problem-solving, interdisciplinary science has created an insatiable demand for the 'packaging' of scientific information in new forms. It has other characteristics which tend to compound the information problem. For example, its forms are less permanent; problems have a tendency to be solved, and the group redeployed. An information system cast entirely in the mould of problem-solving science may become obsolete tomorrow. Problem-solving science, being publicly funded, tends to have greater resources at its disposal for information systems and services than does academically-based disciplinary science.

By the same token, governments who provide this public funding have an increased concern for the effectiveness of the information services required by the problem-solving science which they support.

The makers of science policy are faced with choices: how much of a country's resources should go into the development of new information services to satisfy problem-solving requirements? How much should be retained to preserve the discipline-based services? Can the evolution of the latter be guided so that both types of service can be derived from a single base, thus satisfying the principles of systems economy? As we shall see later, the large, flexible computer-based systems are beginning to provide the developed countries with some answers to these questions. In the opinion of many observers, it is the criticality of the needs to construct more flexible and responsive information systems on the bases of the older conventional

systems which characterizes the science information problem for the developed countries. They have also raised a number of problems of compatibility and standardization, and the examination of these questions and recommendations for their solution form a considerable part of the UNISIST report.

However, most experienced observers would agree that computer technology cannot provide a solution for all the problems of scientific communication. The traditional institutions of scientific journals, of abstracting and indexing publications, of textbooks and libraries have strong survival values, and will not be superseded tomorrow by console displays of retrieved text, or programmed instruction. The technologically advanced countries will be operating conventional and computer-based scientific information systems in parallel for a long time to come.

The UNISIST study devoted considerable attention to the special problems of the developing countries. While consideration and recommendations relating to the special needs of developing countries for scientific and technical information will be dealt with later in this report, it is appropriate to remark here that the problems of providing access to the types of information they need cannot be solved simply by plugging into the sophisticated computer systems established by the developed countries; an adequate conventional systems base must first be built.

Information as a resource

Prior to the advent of 'Big Science', planning for scientific information services and systems rested in the hands of the scientists, librarians, and information specialists. Discussions, for example, at the Royal Society's Scientific Information Conference of 1948 were at a technical level. A phenomenon of the last twenty years has been the shift of responsibility for information systems planning from the technical to the governmental level.

Within individual developed countries, scientific information

agencies have been established in close relation to governmental offices charged with the development of national science policies. In the Soviet Union, responsibility for the co-ordination of the major scientific information services, including VINITI of the Academy of Sciences, is lodged in the State Committee of Science and Technology, Council of Ministers, U.S.S.R. In the United States of America, the White House-based science co-ordinating group, the Federal Council for Science and Technology, established a Committee on Scientific and Technical Information (COSATI) to assist it in formulating governmental science information policy. The United Kingdom's Department of Education and Science has its Office of Scientific and Technical Information (OSTI), which has similar functions.

A parallel development has occurred among the intergovernmental organizations, both regional and international. The Organisation for Economic Co-operation and Development (OECD) has an office located in its Science Directorate for the purpose of aiding member-countries to develop and to co-ordinate their national science information policies. Eight member-countries of the Council for Mutual Economic Assistance (CMEA) established an International Center for Scientific and Technical Information in Moscow in 1969 again for the purpose of co-ordinating the science information policies of member-countries.

The planning and co-ordination of scientific information systems has, in short, been subject to an escalation of attention from groups of scientists, engineers and information specialists to policy makers in governments, and in international organizations.

The reasons for this are clear. The makers of science policy in these countries have learned to consider scientific information as a national resource, to be incorporated in their formulation of national science policies in the same context as manpower and material resources. Two reasons may be suggested for this. The first is the requirement to provide adequate funds for the provision of specialized information services for the problem-solving research groups previously described; the

second is the magnitude of public investment and annual expenditures for scientific information in the developed countries.

As mentioned in the Preface, scientific information is a resource; its provision is essential for the conduct of science in every country. UNISIST would urge on those countries which have not already so provided, the establishment of an office to work in close co-operation with the agency entrusted with science development, for the purpose of planning on the development of national scientific information resources (see Recommendation 15).

We have seen how the UNISIST study—with its recommendations for an action programme—must be viewed in terms both of an adjustment to a revolution in the sciences, and of the responsibilities of governments and scientists to develop information resources as a function of their national science policies. There follows a consideration of those conditions and circumstances which lead to a reaffirmation of the thesis of the UNISIST Working Party; namely, that the world 'system' to be studied must be considered in terms of a flexible, evolving network of existing and future autonomous services, which voluntarily agree, in their own interests, to increase their co-operation.

One of the first impressions to be gained from the informational reports of scientific information programmes and activities submitted by representatives of individual countries, intergovernmental organizations, non-governmental organizations, and representatives of the international scientific unions was the extraordinary complexity of the information services and programmes in the sciences. There are the services of scientific societies established under different authorities and serving different categories of users, but meeting together under such professional organizations as the Council of Biological Editors and ICSU/AB. There are centralized programmes established by governments, there are decentralized programmes by many agencies of the same government, by universities, by private industry. The Specialized Agencies of the United Nations

conduct programmes directly, as well as through non-governmental international agencies associated with them.

This multiplicity of establishments, services and programmes represents not only the variety of laws, charters, and other legal authorities of the agencies charged with operating scientific information programmes but also the multiform population of scientists and engineers, organized in thousands of different interest groups, with an enormous variety of educational, language, and behavioural characteristics. The diversity of the systems they have established and habitually use reflects this heterogeneity.

It may be observed, nevertheless, that while the establishments, purposes, users, and governmental interests supporting information systems are highly pluralistic, the technologies common to all the systems are limited in number. Almost all countries and almost all fields of science modify only to a minor degree the fundamental institutions of scientific communications: journals, critical reviews, data compendia, libraries, etc. One result of this circumstance is that information specialists have come to talk a common technical language, regardless of the field of science they may represent. This has led, in turn, as we shall see later, to a significant increase in co-operative agreements between and among systems.

What emerges in this report, therefore, is not a 'world system' in the sense of a pre-planned, integrated organization under a single manager, but rather the flexible network of co-operating services previously mentioned. For this network to function, the participants must agree voluntarily to develop and to use common technical standards for the transfer of information from field to field, and from system to system. An analogy may be drawn to the international telecommunications network. Each country has developed and manages its own telephone system; all countries have agreed to abide voluntarily by the technical regulations developed co-operatively under the auspices of the International Telecommunication Union (ITU), itself a Specialized Agency of the United

Nations, so that the individual national telephone systems may interconnect.

Historically, progress towards international agreement on standards for purposes of scientific communications has been slow. Even such obvious needs as agreement on the form of abbreviation of journal titles, or the representation of the letters (or characters) of one language in terms of those used by another—transliteration—have taken years to resolve. While it is prudent to take a realistic view of the practical difficulties involved in standards setting, there are new circumstances today which permit of fresh attacks on traditional problems. The discipline of the computer will discourage the luxury of non-essential variation, and the economic processing of diverse large data bases will create pressure for conformity and standardization. Evidence of success in the standardizing efforts sponsored by ISO and by operating groups such as ICSU/AB is sufficient to justify optimism and to encourage renewed effort to establish standards which will enable the interconnexion of systems.

As a basis for the recommendations which follow, it may be concluded that the evolution of a voluntary association of existing systems and services (as well as those to be developed later), each preserving its own management autonomy, offers a realistic base for the development of a world scientific information network. The UNISIST 'system' is viewed in terms of an international movement towards increased voluntary co-operation among the national and the international participating services, using common rules and media, but with varying degrees and modalities of interconnexion.

The trend towards co-operation

UNISIST is a contemporary expression of a long-standing tradition of free interchange of information among the world's scientists. We have seen how this tradition resulted in the last great collaborative effort to provide a comprehensive record of the scientific publications of all countries, the *International Catalogue of Scientific Literature*. As the sciences divided their efforts by discipline or field, and have reassembled them in new interdisciplinary forms, this tradition has been maintained. Scientists exchange reprints of scientific papers with other scientists in the same sector; libraries exchange publications; abstracting services exchange abstracts. The tradition, which is as old as modern science, survived the challenge of two world wars; one has only to observe the avidity and speed with which scientists have renewed their communication channels following each such blockage to assess its strength and durability.

One of the origins of the UNISIST study was an apprehension that the unco-ordinated development of computer systems for the processing of scientific information might accomplish what two world wars had failed to do—namely, to contravene the exchange of scientific information. The (Pugwash) Conference on Science and World Affairs, meeting in Karlovy Vary, Czechoslovakia, in 1964, noted that the existing abstracting services and systems for machine coding and indexing were being developed independently so that information stored in one of them was not freely exchangeable with that stored in others. The conference recommended that 'work be initiated without delay towards developing a unified and co-ordinated system of scientific information storage and retrieval from the heterogeneous and limited beginnings that

now exist'.[1] Both ICSU and Unesco took cognizance of this Pugwash recommendation when they agreed to establish the UNISIST study.

The compatibility of machine systems for storing and retrieving scientific information constitutes a highly complex multi-faceted problem. Any two systems demonstrate a spectrum of interfaces, ranging from the capacities and capabilities of equipments of different manufacture, through programming languages utilized, to the selection and the ordering of elements included in the bibliographical records, and to the variety of approaches taken for the intellectual organization of scientific concepts, the thesauri, or controlled scientific vocabularies, and classification systems.

Formidable as these questions may appear, they are not insurmountable; considerable work had already been done on them, and there are strong incentives, economic in nature, which will accelerate the efforts to solve them. Indeed, it is anticipated that the UNISIST programme recommended in this report will focus the world's attention on those aspects of the problem which remain unresolved.

Earlier in this report, the UNISIST programme was defined, *inter alia*, as a movement which represents an informed and purposive response to the economic forces requiring the sharing of the costs of information systems. This theme, which is central to the UNISIST programme, requires some further discussion.

The trend or movement towards increased measures of co-operation rests upon economic forces, and appears to be universal. Basically, the increases in volume of the information units to be processed, coupled with the increase in manpower costs of processing them, is driving the sponsors and managers of information systems at all levels to examine the re-allocation of fields and resources as a condition of successful adaptation to their growing responsibilities. In some cases, solutions have been found in the reconcentration of processing functions;

1. *Scientific Research*, Vol. 7, 5 February 1968.

examples may be found in regional or national programmes for sharing the labour of cataloguing books in libraries. In others, the scientific information systems are increasingly concerned with the exchange of products of their systems, intermediate or final, to each other's economic advantage, and to the over-all economic advantage of the countries and scientific unions which sponsor them.

Let us examine some instances of the way in which this trend is manifest in various countries, and at various levels of scientific information systems. Possibly because they are one of the oldest of the communication institutions for science, or possibly because they have been chronically underfunded, research libraries were among the first to demonstrate 'information sharing'. They have shared the costs of acquisition of publications through the acceptance of specialization. The Federal Republic of Germany has a plan for sharing responsibilities among the libraries servicing scientific research; the national libraries of Denmark, Norway, Sweden and Finland have agreed on a comparable plan for the sharing of responsibilities for collecting the literature of scientific fields. They have developed regional and national networks, linked by telecommunications systems to share each other's resources through interlibrary loans and photocopies. And they are now in the process of computerizing regional and national union lists which they rely on to locate sources from which to borrow the needed scientific literature. The library community realized, a long time ago, that it was economically impossible for one library to have every scientific publication, and the realization has driven them increasingly to seek out co-operative means of sharing both resources and workloads.

Another important development in the library community has been the effort by the United States Library of Congress to produce a standardized machine-readable catalogue record which could be manipulated and reformated by other libraries to meet their particular needs. Known as MARC (Machine Readable Cataloging), this programme has become international through co-ordinated programmes in the United

Kingdom (the British National Bibliography) and Canada. Variations of the MARC format have been devised for specialized purposes (e.g. serials and maps), including an all-purpose communications format, facilitating system-to-system transfer of information. This communications format is currently under consideration as an international standard. These library developments not only strengthen the technologies which UNISIST can employ, but also provide evidence of the trend towards interdependence and co-operation.

Increased co-operation may also be observed among the other communications institutions of science. For example, the abstracting services participating in the ICSU Abstracting Board are currently sponsoring a number of co-operative projects designed to increase potentials for co-operation: common classifications of science for services in the same sector; a multilingual thesaurus for services of different language bases operating in the same sector; sharing of responsibility for abstract preparation between services. In the field of scientific translations, the co-operative development of deposits or pools of translations in France, the United Kingdom, and the United States, and the establishment of the European Translation Centre in Delft may be cited as examples of co-operative efforts to share the costs and benefits of a specialized resource of scientific information.

The influence of national governments in encouraging the pooling of information resources and the co-ordination of services in any one country should not be discounted. The translation centres just cited were each advanced by the respective governments as measures of achieving improved services and greater economies through centralization.

It is in the area of the computer-based system—about which the Pugwash Conference expressed its concern—that the economic forces leading to increased measures of co-operation can be most clearly observed. Admittedly, these systems are new, and we have just begun to study the costing and the economics of services derived from them at national levels, and internationally through organizations such as

OECD. Nonetheless, on the basis of empirical evidence, these factors appear to operate.

In systems terms, cost-sharing in a computer-based system for the processing of scientific information is possible at each of the three main systems divisions: input, processing and output.

The unit costs of *input*, that is of preparing the individual bibliographic records in terms both of the descriptive elements and of the intellectual analysis of their subject content are high. Indeed, the high costs of maintaining input for an ever-increasing volume of scientific publications tends to limit the world's population of potentially competitive systems. Further, it has already become evident that no one country, even among those presumed to have superior resources, can afford to maintain the input levels independently.

This has been one of the forces underlying the internationalization of large information retrieval systems in the sciences. This internationalization may take two forms: first, the planning and development of a system *ab origine* where the costs of input are divided (as in the case of the International Nuclear Information System—INIS—of the International Atomic Energy Agency); and second, the utilization by multiple countries of the cost-sharing basis of a system already designed and built by one country (as in the case of MEDLARS and the systems developed by Chemical Abstracts Service).

The internationalization of a nationally initiated system usually takes the form of dividing responsibilities for abstracting or indexing the national literatures in accordance with the standards of the given system, and thus provides political and technical as well as economic benefits.

Economic savings through sharing the costs of *processing* are just beginning to be explored. Instances may be cited of the co-operative use of photo-composition devices by two agencies, and of countries wherein the processing of tapes received from different systems has been centralized. Although these national centres in many instances make the products of their processing available internationally, we have yet to gain

experience of the operation and maintenance of a co-operatively established and funded international processing centre for scientific information.[1] However, from the point of view of systems economics, where the workload requirements do not approach the system's capabilities, it is considered more desirable to have shared-time arrangements on a central computer than to decentralize the processing.

It is at the *output* level where these large systems demonstrate economic incentives for increased co-operation. These systems, whatever the field of science, have a common characteristic. Once the capital costs of developing the system, and of building and maintaining its data base, have been met, the incremental costs of providing additional services over the basic one for which the system was intended are relatively modest. The systems have an incentive, therefore, to exploit their data bases in order to provide additional services and products, thereby reducing their unit costs of processing.

This lends to co-operative agreements of two types. Those systems which maintain controls over the types of uses made of their tape products (as in the case of MEDLARS) may enter into co-operative agreements with segments of the scientific community for the production of more specialized services. Those systems which make their tape products more readily available, as in the case of Chemical Abstracts Service, the Science Citation Index of the Institute for Scientific Information, of *Excerpta Medica*, make it possible for national processing centres to acquire very large data bases on favourable terms compared to the costs of creating the file independently. This has made it possible for service centres in different countries to provide 'selective dissemination of information' services to the scientists of the country by merging the output products of disparate systems in different sectors of science. An interesting development has been the establishment of an international organization of these service centres with common processing

1. See, however : N.E.C. Isotta, 'Europe's First Informations Retrieval Network', *ESRO/ELDO Bulletin*, No. 9, April 1970, p. 9-17.

objectures and problems: the Association of Scientific Information Dissemination Centers (ASIDIC).

There are a number of technical advances which must be made to increase the reliability and efficiency of such services, and indeed the later recommendations of this report are directed in part towards this end. The type of SDI services now provided by the Kunglike Tekniska Hogskolans Bibliotek and the Karolinska Institutet in Sweden; by the University of Georgia and the Illinois Technical Research Institute in the United States, by the National Science Library of Canada, and by a growing number of other centres may well augur the shape of things to come. The economic auspices are favourable for 'third party' reprocessing of tapes generated by the large abstracting and indexing services. Apart from the innumerable opportunities for the co-operative exploitation of machine readable data bases providing access to the world's scientific literature, it may well be that within this development we have an economic model for a global scientific information system which will answer at the same time to the information requirements of discipline-based and of mission-oriented, or problem-solving, science.

In summary, the high costs of acquiring and of processing resources of scientific information have resulted in an observable trend towards co-operation among the institutions and systems serving scientists. The trend is not universal, but it has been abetted by governments in the developed countries. Despite the earlier concerns of scientists, the trend towards co-operation among the developing machine systems is well established in relation to the sharing of the costs of inputting information and to the utilization of the products of the systems. This trend rests on economic realities, and information sharing in the sciences, once a high principle, has now acquired an economic motivation.

Introducing the UNISIST programme

The balance of this report is devoted to a description of the programme proposed for encouraging and catalyzing the voluntary co-operation on which UNISIST rests, to the specific recommendations, and to a consideration of the benefits which make UNISIST both desirable and necessary.

This report proposes, therefore, the establishment of an international programme to be known as UNISIST as a focal point for co-operative efforts to enhance the international transfer of scientific information. The scientific information services and their sponsors in all countries should be invited to participate in assisting this programme to achieve its objectives.

A major function of this UNISIST programme is to advance the trend towards information sharing by creating opportunities for further co-operative agreements among governments, international organizations and operating services. A second major function is to provide guidance to this movement in the interests of the world's community of scientists so as to ensure responsiveness to the informational needs of science.

In the implementation of this programme the strategy should be one of successive approximation, that is, of innovation, followed by periodic evaluation of progress, re-definition of goals, and further innovation.

While the long-range goal of the UNISIST programme is to develop international networks of information services in the various sectors of science, the UNISIST programme should have intermediate objectives. Listed below are five broad objectives towards which specific programmes, projects and activities can be oriented. Together, they constitute the

direction the UNISIST programme should take in its initial period. Individualiy, they serve as bases for the twenty-one programme recommendations and one organizational recommendation contained in this report. Their categorization broadly reflects in general the groups (national governments, scientists, information specialists) to whom the recommendations are directed.

Programme objective I

UNISIST should work towards the improvement of the tools of systems interconnexion.

In terms of the economics of contemporary systems design, output from one system must be considered as potential input to another. As a generalized principle of systems economy, this should guide the development of scientific information systems, whether conventional or computer-based and whether they are established internationally in a single sector of science, or nationally in multiple sectors of the sciences. In order to make the products of information systems exchangeable from one system to another, so as to facilitate a sharing of workloads, common standards, rules and procedures must first be co-operatively developed and maintained. Such matters as variant practices of citing journal references, abbreviating journal titles, the spelling of authors' names have impeded co-operation among the conventional abstracting and indexing systems in the past. These systems are now being mechanized, and there is an urgent need to resolve not only these traditional questions, but also the new problems associated with the standardized representation of these elements in machine-readable form. The first six recommendations of this report are directed to the prior need to improve the tools through which systems can achieve interconnectibility.

Programme objective II

UNISIST should work to strengthen the functions and improve the performance of the institutional components of the information transfer chain, viz., the libraries and repositories, the abstracting,

indexing and translating services, and the information analysis centres.

The formal structure which has been evolved for the acquisition, organization, dissemination, and more recently the evaluation of scientific information represents a concentration of resources, material and human, indispensable to any future network of information services. The further evolution of these institutions should be assisted and guided by the UNISIST programme. Recommendations 7 to 10 are directed towards the achievement of this objective.

Programme objective III

UNISIST should work to develop the human resources essential to the planning and operation of future information networks.

Recommendations 11 to 14 are directed towards the strengthening of the capabilities of scientists, editors, and documentalists, as essential agents in the information transfer process. A large-scale effort should be made to cultivate the manpower resources necessary to UNISIST, to involve such groups as scientific editors, scientific societies, information scientists and librarians, to develop their skills through educational programmes, and to provide a stimulus through the provision of opportunity for research. A particular appeal should be made to young scientists to involve them early in the planning and development of information systems which future generations of scientists will use.

Programme objective IV

UNISIST should work with governments to provide optimal economic and political environments for the development of systems interconnectibility and co-operation.

Realization by governments that scientific information is a national resource to be considered in the formulation of national science policies, and their sympathetic involvement in co-operative programmes to enhance this resource and to remove impediments to the transfer of information is essential to the construction of future networks. Recommendations 15 to 19 are directed to this end.

Programme objective V

UNISIST should provide assistance to developing countries by helping them to develop minimum bases of scientific information, and by developing pilot projects in co-operation with other United Nations agencies.

A special requirement laid on the UNISIST study by both Unesco and ICSU was that special attention be given to the needs of the developing countries. These needs are heterogeneous; the only universal is a need to develop scientific information infrastructures. Recommendations 20 and 21 are directed towards the solution of the special problems of developing countries.

Following are the specific recommendations, twenty-two in number, presented with brief commentaries.

Recommendations

Group I: Tools of systems intercommunication

The first set of six recommendations relate to the development of tools for the interconnexion of existing and future systems. Their order is not necessarily an indicator of their priority; a discussion of priorities will follow the presentation of the twenty-two recommendations.

Recommendation 1. Surveys of resources

The basic philosophy of UNISIST makes it mandatory to develop international programmes for sharing the work and the products of information transfer at each stage of the process through the voluntary co-operation of all parties concerned. As a step in this direction, UNISIST adherents should be called upon to extend their efforts to survey information services of national, regional, or international scope; and to provide for their stepwise integration into a world referral network. Pilot studies should be conducted to establish the systems design requirements of the network.

UNISIST's goal is to improve the effectiveness and decrease the costs of providing science with its needed information services through programmes which encourage the sharing of functional responsibilities and products. All will agree that the repetitive reprocessing of a unit of scientific information has elements of waste, yet the fundamental information which would help to plan a more economic pattern is lacking. Despite nationally based inquiries in a number of countries into the details of their scientific information resources and services, and despite surveys conducted by various international

organizations, including Unesco itself, the information we have on which to plan is partial and inadequate. A first requirement is a programme to collect comprehensive information from all countries, in all fields of science, relating to all functions involved in information transfer. This requires surveys of the existing scientific information services to provide a continuing mechanized record of their performance, with programmes to detect gaps and overlaps formally defined, and a mechanism for proposing and for responding to corrective action.

A fundamental purpose of this recommendation is to provide the comprehensive information on which more formal systems analysis can be conducted at a later date. Another purpose is to provide a baseline against which progress can be measured as the UNISIST programme matures.

The following specific benefits can be expected from the adoption of this recommendation:

1. Once overlaps have been clearly identified, the information systems can move to eliminate proved redundancies. As a complement, necessary duplication can more readily be justified.
2. Governments and other agencies can assess the needs for additional services where there are lacunae.
3. Meaningful systems analysis can be accomplished on the basis of adequate information.
4. With more complete information it would become easier to conceptualize a world network of scientific information systems, and to provide UNISIST with more finite parameters.

Recommendation 2. Standardization: bibliography

Current expert consultations should be continued within the framework of UNISIST to accelerate international efforts through the International Organization for Standardization (ISO) towards the achievement of standard codes and formats for the representation of bibliographic elements in machine systems, and of unified transliteration rules, character sets, and other related matters.

The problem of the compatibility of computer-based information processing systems is a complex one. Generally speaking, it has three principal aspects: the characteristics and components of the unit records processed by the system; subject specification in the systems; and the hardware, software, and systems design characteristics and capabilities. It is to the first aspect of the compatibility problem that this recommendation is addressed.

Both UNISIST and the OECD Science Information Policy Group have recognized the need to standardize a number of systems components as prerequisites to the interconnexion of machine systems. Some of these represent long-standing standardization problems, for example agreement on transliteration, or the representation in one alphabetic or non-alphabetic language of the alphabet or symbols used by another.

Others have been more recently highlighted through the requirements of computer systems. It is highly desirable that computer-based systems agree, for example, on the elements of a bibliographic citation which are essential to a universally understandable representation of a published scientific work. Similarly, it is important for them to agree on formats or layouts of coded information which represent these bibliographic elements on the magnetic tapes which the systems will interchange. These are but a few of the standardization requirements, all of which are concerned with the descriptive or explicit characteristics of the units of information potentially to be exchanged among systems.

Standards should be elaborated by those who benefit from them and have economic stakes in their applications. Once they have been agreed upon by the participants with the assistance of the International Organization for Standardization (ISO), their maintenance depends on the voluntary co-operation of participants. It is not the function of UNISIST to set standards, but rather to accelerate on-going efforts now being conducted through ISO, and to bring about that co-operation which will make the standards viable.

Recommendation 3. World register of scientific periodicals

An international registry of scientific periodicals should be established as a basis of a system for the normalization of the citations of the journal literature of science and technology; the scope, functions and organization of the system should be in general agreement with the recommendations of the UNISIST/ICSU-AB Working Group on Bibliographic Descriptions, after endorsement by UNISIST adherents.

One of the desiderata for the inter-systems transfer of units of scientific information is that of supplying a unique coded designator for each unit of information which one system might wish from another. As a first step towards providing such designators for individual bibliographic units (papers in journals, monographs, technical reports, etc.), a system which would provide universally acceptable codes for the titles of scientific journals is needed. The Central Committee commends the efforts which have been pursued by the International Organization for Standardization (ISO) and others to standardize internationally the abbreviations for scientific journals. It also commends the efforts different countries have undertaken in establishing machine-readable files of information relating to scientific serials. To advance this objective, ICSU contracted with the Institution of Electrical Engineers, United Kingdom, for a feasibility study of a World Register of Scientific Periodicals, to be maintained in machine-readable form by international co-operation.

This World Register[1] constitutes a first concrete step towards potential world-wide registry system which would assign unique coded designators to each discrete item of the world's output of scientific information. The designators would be based on descriptive rather than on subject parameters, and hence would be of an objective character.

The specific benefits foreseen by the Central Committee in making this recommendation are:

1. A copy of the contractor's report describing the World Register is available on microfiche in the *UNISIST Proceedings*.

1. A centralized system for the maintenance of standardized information on the titles, abbreviated titles, and codes for scientific journals will standardize world-wide practice in journal citation.
2. A centralized system will help to ensure conformity of journal citation between and among mechanized systems.
3. A centralized system for title information will provide the basis on which future systems for the unique identification of individual bibliographic units can be built.

Recommendation 4. Subject specification

The attention of scientists, learned societies, and information science associations should be drawn to the need for joint efforts in developing better tools for the control and conversion of natural and indexing languages in science and technology. UNISIST adherents should be invited in particular to consider the initiation of a few pilot projects, under the sponsorship of scientific organizations, aimed at testing new methodological and organizational devices in this respect, with a special emphasis on international and interdisciplinary requirements.

The previous recommendation was directed towards the standardization of conventions relating to the descriptive or the extrinsic characteristics of documents; Recommendation 4 is directed to an even more problematic area: subject specification in scientific information systems. Involved here are not only epistemological and practical problems relating to the classification of science during a period of vigorous growth and dramatic change, but also problems relating to the standardization of scientific terminology as among countries and as among the multiple fields of science for the applied purpose of developing controlled vocabularies or thesauri for the information systems, and of progressing towards the automatic indexing of documents.

The above recommendation relating to subject specification is a realistic recognition that much work needs to be done before these questions can be solved. Agreement among the information systems on definitions for the broad categories

of science (i.e. the classic disciplines and the new interdisciplinary fields) would have practical benefits for the inventorying of resources as well as for referral functions, and would appear to be attainable. The use of the Universal Decimal Classification in particular, for this purpose, has been advocated. Its further potential has yet to be realized, and both a continuing programme to strengthen UDC and further studies and experiments to test its applicability to retrieval systems are desirable. Unesco should continue to support clearinghouses for classification and subject-descriptor systems; beyond this, the importance of achieving international agreements on verbal structures or thesauri for information processing is such that a concentrated effort, starting with pilot studies, should be made to explore the feasibility of integrating thesauri in the various fields of science. National and international scientific organizations including the International Unions affiliated with ICSU should examine the relation of the ongoing work of standardizing scientific nomenclatures internationally to the parallel activity of developing controlled vocabularies or thesauri in the same areas of science. Finally, renewed effort should be given to lexicography in the sciences. Not only are conventional uni- and multilingual dictionaries in the sciences needed, but, as a research objective, a deeper understanding of the function of language analysis in scientific information is needed to provide research on automatic indexing with relevant terms of reference.

Recommendation 5. Standardization: systems aspects
Provision should be made within UNISIST for active consultations with computer and information systems experts in order to speed up the resolution of pending issues in matters of machine standards for systems interconnection in agreement with ISO. The practicability of conversion programmes should be further investigated as a temporary alternative to fully compatible codes and formats.
This is the third aspect of systems compatibility—the descriptive, or extrinsic characteristics of the unit bibliographic

records being the first, and the intrinsic subject characteristics of the records being the second. Problems here are associated with the variety and types of computer hardware capabilities, of systems requirements on the hardware, of systems designs, etc. Generally speaking, problems of this character are common to other types of computer application, and hence have been worked on by computer experts and systems analysts in continuing efforts to achieve international standardization.

There are some aspects of the systems-interface problem which are of particular concern for the processing of scientific information. Character set requirements, and the coding for character sets, as well as codes for languages and countries are at issue.

While there may be wide variations among the character sets required by different fields of science, for example, mathematics and chemistry, there appears to be no reason why agreement cannot be achieved on common codes for other elements.

Special mention should be made of the need to secure prompt acceptance of a 'communications format' for bibliographic information on magnetic tape. Whatever variant formats individual systems may develop, each should develop the capability of converting into and converting from a generalized intermediate or 'carrier' format which would be hospitable to all forseeable requirements. Agreement on such a 'common carrier' format among the systems in all fields of science and in all countries should be expedited as a basic requirement for intercommunication among systems.

Recommendation 6. Telecommunications

A working group or a conference should be envisaged to review, in the perspective of UNISIST, the present trends and future potential of telecommunication and teleprocessing networks for the transfer of scientific information. The participation of international organizations such as the International Telecommunication Union (ITU), the International Federation for Information Processing (IFIP), and the International Federation for Documentation (FID) should be sought; the agenda should include

not only the more immediate technical components, but also the organizational, political and economic aspects of the subject.

The onrush of telecommunications technology has created a potential for interlinking scientific information systems in a variety of ways. Centralized processing on a shared-time basis with remote display of information is technically possible today; automatic switching from one file of data to another may well be so in the near future. Any UNISIST programme would serve only to preserve the *status quo* were it not to provide an opportunity for a realistic review of the opportunities which telecommunications networks will offer in the future.

One modest beginning in the field of space sciences has already been made: information from NASA's RECON system is stored at the European Space Operation Centre (ESOC) in Darmstadt where it is available for search in an on-line mode by the European Space Research Organization (ESRO) headquarters staff in Paris and by the European Space Technology Centre (ESTEC) in the Netherlands.[1] The extension of this trans-national capability to other areas of science, now that the technical feasibility is evident, is a function of the economic and political feasibility of this type of network. It appears highly desirable that UNISIST sponsor an inquiry, to involve representatives of governments as well as technical experts, into the economic and political feasibility of establishing telecommunications or teleprocessing links between and among scientific information processing and service centres.

1. N.E.L. Isotta, op. cit.

Group II: Effectiveness of information services

The six preceding recommendations have been directed towards improving the *tools* of information transfer, and have been of a technical character. Recommendations 7 to 10 which follow are directed towards the strengthening of the different document institutions which use the tools: libraries, abstracting and indexing services, translation centres, information analysis centres, evaluated data centres.

Recommendation 7. Library infrastructure

A strong scientific library system should be recognized as an essential component of scientific information transfer in modern times. In collaboration with the international and national organizations concerned (IFLA, IATUL, etc.), UNISIST should direct its efforts to a statement of the minimum set of functions and levels of performance that scientific libraries—and eventually special depositories—ought to maintain for their optimum performance.

As the English scientist Ziman has written: 'A scientific laboratory without a library is like a decorticated cat: the motor activities continue to function, but lack co-ordination of memory and purpose.'[1] The fundamental role of the library in the transfer of scientific information was confirmed during the course of the study. The scientific library traditionally acts as the focus for the acquisition, organization, storage, and dissemination of the published (and frequently the unpublished as well) literature of the sciences. It was noted that libraries

1. John M. Ziman, *Public Knowledge: An Essay Concerning the Social Dimension of Science*, p. 102, Cambridge, Cambridge University Press, 1968.

had been slow to respond to the challenges before them, but that promising developments were now taking place in a number of countries. It was further noted that librarians as a profession were highly co-operative, and had an advanced degree of experience in the development of co-operative processing and service networks.

Recommendation 8. Strengthening of basic access services
On-going experiments and programmes aimed at increasing the effectiveness of abstracting, indexing and translation services —geolinguistically, disciplinary, or mission-oriented—should be publicized and encouraged. Particular support should be given to co-operative schemes resulting in an international sharing of the work and products of such services, as essential building blocks of the world-wide information network to which UNISIST is dedicated.

Abstracting, indexing, and translation of scientific information, the services which provide access to the literature, are here considered. Both Unesco and ICSU have long had an interest in the improvement of scientific abstracting and indexing. In the ICSU Abstracting Board (ICSU/AB) the latter organization has not only an effective forum where the world's disciplinary-based abstracting services can exchange ideas and develop co-operative programmes; it has also the nucleus of an action group dedicated to the UNISIST principles. The work of improving the effectiveness of abstracting and indexing services is obviously not limited to this group. Organizations representative of problem-solving science and governmental agencies are also concerned.

It is among the members of abstracting, indexing and translating services, whatever their orientation, that the 'information sharing' agreements will first develop; the functions they perform are not inexpensive, and the volumes of information they must deal with significant.

The precise responsibility of governments for ensuring the coverage of the publications of scientists by abstracting and indexing services raises a long-standing issue. While not pre-

suming to contravene the interests of governments in supporting abstracting services limited to the scientific productivity of a single country, most scientists believe their contributions will become known more quickly and will become more generally available if efforts are made to ensure its coverage by the international scientific abstracting and indexing services.

Recommendation 9. Information analysis centres

The development of specialized information centres serving the needs of specific user groups should be recognized as a necessary complement of a world network of basic access services as envisioned in Recommendation 8. Among the functions of such centres, the evaluation and synthesis of current papers into dependable, coherent systems of knowledge should be given special attention; pilot studies would be useful, under international sponsorship, to assess the institutional and other means that may be required to implement the related concept of 'information analysis' as an integral function of science information.

A recurring theme in the discussions of the Central Committee was that of the need of the sciences to provide for the evaluation and the compression of scientific information. Indeed, this need received even greater attention than did the question of accessibility. Information analysis centres, staffed with an appropriate quotient of scientists, were considered the instrument of choice for the assemblage, evaluation and compaction of new information in the mission-oriented and other interdisciplinary fields of science. These functions are necessary to introduce measures which would operate to reduce the amount of publications to be scanned by individual scientists, and to produce critical reviews or 'state-of-the-art' papers to help the scientist keep up with development in his own and in related fields.

While the central scientific research institutes in the U.S.S.R. have been providing analogous functions for a number of years, in other countries information analysis centres constitute a new and experimental form of information service in response

to the needs of mission-oriented science and other interdisciplinary fields of science. There is a need to conduct pilot studies of the functions and activities of information analysis centres under international sponsorship. Agencies sponsoring information analysis centres should cultivate the evaluation and synthesis functions of centres they support, and plan so that their functions may be complements of, and not substitutes for, the library systems with which they should be associated.

Recommendation 10. Numerical data centres

The collection, critical evaluation, organization, and dissemination of numerical data, a field in which CODATA represents the interests of the international scientific unions is functionally closely related to the processing of published literature, and must be provided for in any future network of information services in accordance with UNISIST principles. Special attention should be paid to the development of networking capability among numerical data centres, and to the functional interrelationship of such centres with the bibliographically oriented network.

The compilation of evaluated numerical data in the sciences and the publication of data *compendia* have their roots in history. As both the demand for and the supply of reliable data have assumed increasingly greater importance to the natural sciences, ICSU moved to establish a Committee on Data (CODATA) for the purpose of surveying the world's resources of evaluated scientific data, and the services through which they are made available.[1] These services are becoming concerned with questions of their interconnectibility, as are the literature-based services. Furthermore, the data and the literature services are functionally interrelated. As judgements are made on the 'best' value for this or that measurement from among a range, surveys of the published literature are necessary. The depth indexing of data reported in scientific papers would assist data centres materially.

1. CODATA, *International Compendium of Numerical Data Projects.* Berlin, Heidelberg and New York, Springer Verlag, 1969.

Recommendations

As science is organized for large interdisciplinary and international goals, such as in the recent past the International Geophysical Year (1 July 1957 to 31 December 1958), or the Year of the Quiet Sun, enormous quantities of raw numerical data are collected for later evaluation and use. It is important that the investment made by the society in this information resource be protected. Adequate attention should be devoted to the creation of service centres to facilitate access by scientists to resources of evaluated data.

Group III:
Responsibilities of professional groups

The next group of recommendations is directed towards the strengthening of the professional groups which constitute the manpower resource for the UNISIST programme. Recommendations 11 to 14 are concerned with the responsibilities these groups have for the implementation of UNISIST, and UNISIST's responsibilities for their professional growth and development.

Recommendation 11. Responsibilities of scientific editors
The authors of articles and editors of scientific journals should exercise a special responsibility for the maintenance of quality controls inherent in the disciplines of science. Their efforts to maintain referee systems should be encouraged. At the same time, editors should realize that the primary publications for which they are responsible are part of an information processing continuum, and that their co-operation with other groups (e.g. abstracting and indexing services) is essential.

The UNISIST study reaffirms the conclusion that the primary scientific journal, which has traditionally played such an important role in the communication of scientific information, will not be displaced in the immediate future. The fact that the journal serves other purposes than that of disseminating information, particularly that of maintaining the discipline of a field through peer group judgements, provides it with survival value.[1] That there are imperfections in this system, many of them detrimental to the orderly growth of science, few will deny. Authors abuse privilege of authorship; referees

1. See J.M. Ziman, op. cit., p. 39.

may indulge duplication and error. The time is overdue for a tightened discipline.

The scientist-editors who provide the editorial and referee systems of scientific journals should be commended and encouraged. Noting that the editorial responsibility frequently extends to the planning of review article coverage of fields of science, the Committee also commends this contribution to the compaction of scientific information.

It has often been the practice in the past for editors to work in isolation, responsible only to the scientific society or institution which employs them. The formation of editors into regional or sectoral professional groups, such as the European Association of Editors of Biological Journals, and Editerra (an association of editors of earth science journals formed under the auspices of Unesco), would provide useful mechanisms for the discussion of common technical and economic problems. Such organizations should prove useful for qualitative improvement of primary publications. Furthermore, a closer liaison between scientific editors, who originate the published materials and the abstracting and indexing services, the information analysis centres and the libraries is desirable in order to improve the over-all effectiveness of the information transfer chain.

Recommendation 12. Participation of scientists

International federations of scientific societies should exert continuing influence on national members to enlist their participation in programmes aimed at the improvement of world-wide information transfer, such as critical surveys of information resources in given provinces of science and technology, planning and development of existing and new services, advances in language control, training of scientists in information processes, and particularly evaluation and consolidation activities.

Most of the national member societies of international scientific unions and of federations of societies of librarians and information scientists have formulated programmes for international co-operation. The implementation of the UNISIST

programme can be greatly enhanced through the orientation of these international interests and programmes towards the UNISIST objectives described in this report. Since communications will play a major role in the enlistment of local and national support for UNISIST, the international scientific unions, and the international organizations of librarians, documentalists, and information processing societies should encourage their national constituents to shape their international programmes in conformity with UNISIST objectives and the recommendations of this report.

Furthermore, scientific organizations should pay particular attention to the increasing need for the participation of scientists in the evaluation and consolidation of scientific information, specifically in the critical evaluation of data and the production of high-quality critical reviews of current developments.

Specific areas of national activities, to be undertaken in co-operation with national governments, are suggested as follows: critical surveys of national information resources; short- and long-term policies for the development of information resources; development of lexicographic tools of information transfer; the promotion of programmes for the training of scientists in the newer technologies of information transfer; the planning of systematic coverage of fields of science by critical review summaries.

Recommendation 13. Manpower development

For all nations to take an active share in the operation of international information systems, a concerted effort is needed to provide information specialists, librarians and documentalists, with improved educational facilities. UNISIST should encourage competent professional organizations, such as IFLA, FID, IFIP and others, to organize this effort with the co-operation of the scientific unions—as representative of producers and users of information—as well as governmental bodies. Attention should be given to the desirability and feasibility of internationally oriented training and educational assistance programmes, which

might include proposals for pooling resources, where needed, in a number of regional education centres.

There are two aspects of the educational requirements of UNISIST. The first, namely the training of the scientist-user in the new modalities of information transfer, has already been commented upon. It may be anticipated that the junior rather than the senior scientist will be more amenable to training in the use of modern information systems technology. The second aspect of training relates to the need to develop adequate manpower resources of information specialists, responsible for the operation of the systems to be involved in UNISIST.

While there are a number of national programmes for the training of librarians and other information specialists, these are at diverse levels of sophistication. Active participation in the type of information services to be involved in UNISIST will require the provision of advanced training opportunities for personnel in both the developed and the developing countries, with special attention paid to the needs of the latter.

Disparities also exist in the status and the salaries of information specialists and librarians from country to country. Such groups are indispensable for the operation of local components of the UNISIST scientific information network proposed in this report. Governments and other concerned agencies should reassess the role of librarians and information specialists in their national economies.

Recommendation 14. Research in information science

The present efforts of national and international organizations to conduct or to support research on many aspects of information science—linguistic, cybernetic, etc.—should be acknowledged and encouraged by UNISIST adherents as contributions of vital import to the evolution of a world-wide information system. A group on the evaluation of research on information science should be established within the framework of UNISIST to collect and evaluate information on research in progress in this field, to advise UNISIST adherents on systems planning

matters and to promote international co-operative programmes in information science analysis and research activities.

A sophisticated developmental effort such as UNISIST cannot be undertaken without an awareness of and a responsiveness to the studies and experiments being conducted at universities on the research and development frontiers internationally. The developed countries are the principal sponsors of this research and development at the more theoretical levels, as in the United States, the U.S.S.R. and the United Kingdom. During the first phase, it is not advisable that UNISIST initiate new research projects of a basic character, but rather that it limits its activities to the monitoring of research and development in information science conducted by others.

The fields of research of interest to the UNISIST programme are various, and range from computational linguistics, through networking, computer-aided instruction, and artificial intelligence to systems analysis. Results obtained in these and in other fields should not only be collected and reported to the UNISIST adherents, both national and internatio' but should also be evaluated for their potential applica in the evolving UNISIST service network.

The monitoring of these research developments, and their evaluation and reporting, warrants the establishment of a modest staff of information experts associated with the UNISIST programme. This group would also function to analyse and publicize research needs. Rotation of a part of its membership on a periodic basis would provide a continuing source of new talent for UNISIST, and, at the same time, permit of opportunities for advanced study.

At the present time, it is not recommended that systems analysis be employed to design a world network of scientific information services as a preliminary to the initiation of the UNISIST programme. This powerful new technology should be employed at the appropriate time. In addition, immediate applications of systems analysis technology to well-defined subsets, nationally or internationally segmented, of information systems, can and should be undertaken; more knowledge.

more planning, more effective design is needed in these subsets before the parameters of an international or global network can be realistically defined.

The UNISIST strategy of evolution and of successive approximation requires that, from the very beginning, UNISIST should have an inbuilt programme for programme monitoring and evaluation. When adequate data and information has been acquired from the analysis of subsets of the network and from the ongoing programme evaluation to warrant a formal programme or programmes to accomplish the extended systems analysis fundamental to network design, such work should be undertaken without hesitation.

Group IV: Institutional environment

As the formulators and agents of public policy, governments have an interest in each of the three previous groups of recommendations since, to one degree or another, they involve the commitment of public resources; however, the following recommendations, numbers 15 to 19, are addressed *exclusively* to governments, since they and they only are capable of undertaking the recommended actions in the public interest.

Recommendation 15. National scientific information agencies
A governmental or government-chartered agency should exist at the national level to guide, stimulate, and conduct the development of information resources and services in the perspective of national, regional, and international co-operation. These agencies should, in particular, give their support, or themselves adhere to, co-operative programmes of international scope in consonance with the principles and goals of UNISIST.

As suggested earlier, scientific information constitutes a national resource to be considered in the formulation of national science policies in the same sense as scientific manpower and material resources. It follows that each country should have a focal point, preferably in association with its principal science development agency, for the assessment, cultivation and utilization of this resource. We have seen how the magnitude of public investments in scientific information systems has brought this about in the developed countries. It is important that such a governmental focus be established in all countries wishing to participate in the UNISIST programme. Unless public policy in each country endorses the principles of international co-operation and the allocation of resources to the

strengthening of its domestic services, the scientists of that country cannot benefit from the UNISIST programme.

It is noteworthy that a number of countries have already established such foci, and that regional intergovernmental organizations with responsibilities for information resources and services have been concerned with the furtherance of this trend, and with the co-ordination of the emerging national scientific information policies. Thus, the Organisation for Economic Co-operation and Development (OECD) through its Science Information Policy Group has had an active and effective role in this matter; similarly the newly established International Centre for Scientific and Technical Information in Moscow may be expected to play an important role in the co-ordination of the national information policies of its member countries.

The establishment of a national focus does not carry with it the obligation to establish new national services to advance the UNISIST programme. Such decisions can only be made on the basis of local needs and advice. It does carry with it an obligation to foster the development of national resources and services of benefit to the scientists and engineers of the country, and the obligation to create a favourable environment, through the removal of economic or legal barriers, for the development of international information-sharing agreements of benefit to scientists of all countries.

Recommendation 16. Service networking

The world-wide availability of scientific documents and data should be acknowledged as one of the ultimate goals of UNISIST, involving a network and co-operative operation of scientific and technical libraries, information analysis centres, and data centres across national frontiers. The governmental planning agencies mentioned in Recommendation 15 should therefore encourage or initiate programmes aimed at integrating any number of document, information or data sources into comprehensive systems (local, national, regional, or international) in which every scientific library or centre may ultimately be used as an access point, or node in a switching network.

Recommendations

No scientist can be guaranteed an automatic flow of all the information he requires; he must in the future, as now, invest time and energy to acquire what he needs. This does not, however, diminish the responsibilities of governments to remove or reduce the barriers, many of them artificial, which stand between the scientist and the information he needs, or their responsibility for improving the availability of such information.

For many years it has been accepted that no one library can possibly acquire all the publications needed by its patrons, and that it must enter into co-operative agreements with other institutions for the sharing of resources. The development of interlibrary lending among scientific libraries has grown enormously in individual countries over the past few years. The traffic has been accelerated by technical developments in reprography (microfiche, xerography, etc.) and as telefacsimile becomes economically feasible, may grow even faster.

The agreements established by scientific libraries establish *de facto* service networks, and constitute the principal means through which needs are met with limited resources. With few exceptions, however, national policy (and economic considerations) confine these network operations to the boundaries of individual countries. There are provisions and channels for international interlibrary lending of scientific information materials. The professional groups most closely concerned: the International Federation of Library Associations (IFLA) and the International Association of Technical and University Libraries (IATUL) are dedicated to programmes of co-operation. What is lacking is endorsement on the part of governments of the principles of international sharing of document and data resources, and programmes to build service networks which transcend national frontiers. The economic advantages of sharing costly resources are obvious; the new developments in reprography and telecommunications make such networking even more attractive.

Recommendation 17. Information transfer networks

The national or regional information agencies described in Recommendation 15 should give increased attention to the requirements of modern information transfer networks, using advanced processing and communication facilities. Early efforts should be made to develop concerted policies in this area, involving bilateral or multilateral co-operation among UNISIST adherents.

As the transition is made in the developed countries from the type of document and data service networks described in Recommendation 16 to the more sophisticated services involved in the interlinkage of computer systems for automatic switching and referral, new types of requirements will be imposed on the government information agencies. Countries will need to make concentrated efforts to create pools of qualified manpower, especially trained in the information, communication, and computer sciences. Furthermore, the conversion to computer-dependent networks will involve both governmental and intergovernmental decisions and actions at each step of the way. There are not only economic questions relating to investments in instrumentation; there are legal and organizational questions as well.

It is not too early to plan for the long-range developments of communication networks linking computer to computer, and information service centre to service centre. Such networks are today in process of development in the more highly industrialized countries. Their extension across national frontiers is inevitable. At the heart of global forecasting today is the World Weather Watch, which employs satellite communication for the daily transmission of meteorological data. The UNISIST Central Committee would urge, therefore, that governments, working alone or in concert, undertake preparatory studies of the interlinkage requirements of computer-based scientific information and data systems, and of the structure, characteristics and functions of automated scientific information service networks.

Recommendation 18. Pricing policies

The pricing policies of scientific information services should be subjected to continuing studies for the purpose of observing their effects on user access to information and of analysing the effect of user charges on equality of access in different fields and in different countries.

Nowhere is the pluralistic character of the world of information services out of which UNISIST must grow so fully demonstrated as in the matter of pricing policies or 'user charges'. The reason is not hard to find. The highly diversified conditions under which services are provided and prices (if any) for them are determined reflect a great variety of economic ideologies and policies. Differing degrees of governmental and non-governmental subsidy and the co-existence of non-profit and of profit-making scientific information services contribute to this diversity.

These circumstances enforce the conclusion that common pricing policies for information services today are unrealistic. Individual governments and intergovemmental agencies are conducting studies of the economics of information transfer, and we may expect more and better information on this subject in the future. To this information should be added that which can be developed by studies of the effects of disparate pricing policies on the utilization of information by scientists.

Recommendation 19. Administrative barriers

The national scientific information agencies mentioned in Recommendation 15 should regard it as part of their responsibilities towards the world scientific community to reduce unnecessary restrictions on the circulation of information. In particular, they should stimulate revisions of national copyright laws in order to better conciliate public interests in document availability with individual motivations for legal protection, and ultimately evolve an international 'doctrine of fair use' in this area.

The needs of their scientists for current information should influence governments to re-examine policies and practices which tend to hinder the free flow of information. Out-dated

customs practices making the import of scientific information cumbersome; low priorities for foreign exchange allocation —these and other restrictions are deleterious to the growth of scientific information resources, and wherever possible should be removed.

It is in the area of copyright where the government agencies responsible for the national scientific information programmes should take on a new responsibility. The rapidity with which the new information technology has developed has raised problems which could not have been foreseen when individual countries adopted their laws of copyright, when the Berne Copyright Convention was signed, or even when the Geneva Universal Copyright Convention, 1952, was agreed to by many countries. Photocopy, computer programmes, machine-readable data bases: these technological developments of use for scientific information transfer are quite unprovided for in copyright legislation, which is generally protective of the rights of creative literary authors and commercial publishing firms.

In this context, the Central Committee calls attention to the unique function of the published open record in the sciences, previously referred to. Individual scientists consider scientific journals a *public* record to which they *contribute*; they do not regard them as sources of *private* income. It follows that the more public this record can be, the better it serves science.

The establishment in each country of a special task force or group to investigate the effects on national copyright legislation of the new communications technology would be desirable. The UNISIST programme should attempt to integrate the recommendations made by these national groups into an international 'doctrine of fair use' acceptable to all participating systems and countries.

Group V:
International assistance to developing countries

Earlier mention has been made of the special concern of both Unesco and ICSU that the UNISIST programme make provision for redressing the imbalance between the provision of information services in the developing and the developed countries. In response, the UNISIST Central Committee appointed a Working Group on Scientific Information Needs in Developing Countries. The reports of this working group are included in the *UNISIST Proceedings*,[1] and its conclusions have been influential in the two recommendations, 20 and 21, which follow.

Recommendation 20. Developing countries: information infrastructure

The existence of a qualified and adequately funded national structure for scientific research and development should be acknowledged as a prerequisite for the evolution of an effective scientific library and documentation network in any country. Subject to this condition, developing countries should consider the following actions as instrumental to the purposes of UNISIST: (i) the establishment of a central scientific and technical information agency, responsible for planning and co-ordinating the development of information resources; (ii) the establishment of co-operative agreements with other countries; (iii) promotion of the adoption of standards, methods and procedures that might facilitate the integration of information services into a world-wide network.

There cannot be a double standard for scientific research, one for science conducted in the developed, another for science

1. See footnote 1, page 20.

conducted in the developing countries. Quantitative measures of scientific productivity between the two may differ, but qualitative may not.

This principle underlies the UNISIST response to the requirement which both ICSU and Unesco imposed on the study to pay particular attention to the scientific information needs of the developing countries. If scientific information is to be regarded as a resource essential for the maintenance of high-quality research in the sciences, how then can the developing countries, both in terms of the newly emerging nations and in terms of those with longer traditions, acquire this resource, or gain access to it?

The UNISIST study is not the first to attempt answers to this question. In 1964 and 1965 the Advisory Committee on the Application of Science and Technology to Development, of the United Nations Economic and Social Council, reviewed the functions of scientific and technical information in development; in 1969 the United Nations Industrial Development Organization made a comparable study. These efforts were more concerned with the transfer of technological knowledge for relatively short-term and concrete uses than with resources of basic scientific information for the support of research.

This is entirely understandable. A plateau of economic development achieved through technology is prerequisite to a nationally sponsored science development programme. And this technology, predominantly from information sources external to the country, is largely achieved on a person-to-person basis, through training and travel opportunities, and through international corporate structures in industry.

This priority in time to technological information, transmitted through less formal channels, is not incompatible with the UNISIST objectives. Technology and science are interdependent. Science is dependent on engineering for instrumentation on the one hand; on the other, an adequate scientific base assists a country to develop its own technology.

Technology, and the technical, industrial and economic information involved in its transfer, is, in short, essential to the

development of a national infrastructure without which a national scientific development programme is impossible. This is true of developing as well as of developed countries.

The UNISIST Working Group on Developing Countries attempted to define threshold criteria to be attained by a developing country before it could reasonably expect to derive benefits from UNISIST: namely, the existence of a nationally funded R. and D. programme, of higher education institutions in science and technology, of a pool of scientific manpower, etc.

In addition to these threshold criteria, meaningful participation in UNISIST would require the development of programmes or resources similar to those already recommended in this report. Specifically:

1. A national (or regional) agency should be established, with governmental (or intergovernmental) support, for the purpose of planning for improvements in scientific information services, of promoting the growth of scientific library resources, and of developing a pool of qualified manpower. This would, in short, be a development agency, charged with the dual responsibility of increasing domestic resources, and of liaison, under the UNISIST programme, with foreign services. Where the geopolitical circumstances permit, this agency might well be regional, rather than national in character, and be based on the voluntary co-operation of the independent governments in that area.
2. A strong, well-equipped library and documentation structure should be developed to provide necessary support for effective participation of the developing country in UNISIST. Existing computer-based retrieval systems produce citations and abstracts which increase the requirements for the published literature; they do not yet substitute for the scientific journals and books themselves. While any developing country will of necessity turn to library resources external to the country for support, it is desirable to build and to organize reserves of heavily used books and journals, to inventory national holdings, to develop interlibrary lending, and otherwise to strengthen the library functions.

3. In preparation for adaptation to computer retrieval systems of the future, the developing countries should see, through these national or regional agencies, that their information activities and procedures accord with international standards.

Recommendation 21. Developing countries: linking to UNISIST
The action of UNISIST with regard to the scientific and technical information needs of the developing countries should be: (i) to provide a forum where on-going programmes of assistance to library and information services in developing areas may be discussed irrespective of their organizational support; (ii) to propose guidelines for the establishment and management of effective information networks in developing countries; (iii) to take part in the design of a few pilot projects, together with other competent international organizations, aimed at assessing effective approaches for linking developing countries with UNISIST.
The previous resolution was directed towards the achievement of those threshold criteria which a developing country, working alone or with technical assistance, should meet in order to be meaningfully involved in a world scientific information network.

A UNISIST programme can and very properly should make special provisions for assisting the developing countries. Three suggestions for functions which a UNISIST Executive Office could undertake follow.

1. Co-ordination. The interests of Ecosoc and of UNIDO in technology transfer and industrial know-how have already been referred to. Unesco, as the United Nations agency primarily responsible for scientific information, has long operated programmes in this area. The centres for scientific documentation developed by Unesco remain as models for future efforts. In addition, other Specialized Agencies of the United Nations, non-governmental international organizations, such as the World Federation of Engineering Organizations, individual national governments and philanthropic organizations have assistance programmes in the scientific information field. The dual character of

UNISIST's sponsors—Unesco, an intergovernmental organization, and ICSU, a non-governmental agency in the sciences—and the special competence they can assemble in the international exchange of information suggest that UNISIST could usefully serve as a forum or clearing-house for the discussion of technical assistance programmes sponsored by other governmental and non-governmental agencies.

2. Provision of guidelines and criteria. UNISIST should make provision for technical assistance, through expert consultants, selected from among its participants, to help the developing countries plan for the provision of scientific information services.
3. Pilot projects. It is desirable for several reasons that planned experimental efforts, demonstrations, and pilot projects be initiated to gain experience in linking the developing countries to the computer-based information networks. These projects might well be co-operative among several countries of a region, and should involve two-way participation in the UNISIST network.

Group VI: Organization of UNISIST

Recommendation 22. UNISIST management

To implement the various recommendations contained in this report, UNISIST should be provided with three interrelated managerial bodies: (a) an intergovernmental conference responsible for approving UNISIST's programmes and reporting on their progress; (b) an international scientific advisory committee, with a strong representation of ICSU and member unions, as well as information experts and services, charged with the responsibility of assessing progress in communication practices and changes in user requirements, as a basis for, and as a result of UNISIST programmes; (c) an executive office, serving as the permanent secretariat of UNISIST, responsible for preparing and administering programmes and budgets. This last body should be placed in the administrative set-up of Unesco within the Science Sector.

Implementation of UNISIST

The twenty-one programme recommendations reflect the two broad functions to be accommodated in plans to implement UNISIST. These are first, the catalytic function in which the role of UNISIST is to stimulate higher levels of co-operation among the autonomous services, and second, direct programme actions to initiate projects designed to develop new tools, pilot experiments, and systems design studies to modify the environment in which the co-operative agreements will take place.

The following table displays the categories of programme recommendations as they relate to the catalytic and to the operational aspects of the proposed UNISIST programme.

Group	*Recommendations relating to the catalytic components*	*Recommendations relating to the programme-oriented components*
I. Tools of systems interconnexion		1-5
II. Effectiveness of information services	7-8	9-10
III. Responsibilities of professional groups	11-12	13-14
IV. Institutional environment	15-19	
V. International assistance to developing countries	20	21

The catalytic functions involve interaction with a variety of groups: representatives of the scientific and the information science communities on the one hand, and representatives of

governments on the other. These are the groups with responsibilities for implementing the recommendations through action programmes. They are also the groups which share, in their respective contexts, responsibility for guiding the future development of UNISIST: the scientific community from the point of view of its answering the requirements of science, the information science community from the technical point of view, and the governments from the point of view of science policy, national and international.

These considerations underlie the following organization proposed for implementing the UNISIST programme.

Organizational location

It is proposed initially to locate the policy and management functions of UNISIST within the framework of Unesco. Several possibilities were examined during the course of the study: the placement of UNISIST within an existing non-governmental scientific organization; its establishment as an independent non-governmental technical agency with governmental representation, on the model of the European Molecular Biology Organization (EMBO); its establishment as a new United Nations Specialized Agency; its placement within Unesco. The recommendation that UNISIST be placed initially within the structure of Unesco is pragmatic; this would enable its more rapid realization.

This location may properly be determined as UNISIST grows and as its character changes. One possible variation, which might be considered in course of time, is the model of the Intergovernmental Oceanographic Commission, created in 1960 within the Unesco structure, but with its resources derived from contributions by national members, rather than through Unesco's own budget.

UNISIST intergovernmental conference

At the apex of the proposed organization for UNISIST would be an intergovernmental conference, convened at the invitation of the Director-General of Unesco, on a periodic

basis. The conference would be composed of representatives of the governments and of regional governmental organizations participating in UNISIST. The conference would function as the top policy-making body for UNISIST; it would meet to assess programme accomplishments, to evaluate and to revise the UNISIST objectives as needed, and to interact with the international scientific advisory committee in evolving specific programmes. The representatives of governments to the conference would have a continuing responsibility for liaison with the ministers of science and of education in their respective countries.

UNISIST scientific advisory committee

This committee would function, under the broad policy guidelines established by the intergovernmental conference, to strengthen the responsiveness of the UNISIST programme to the needs of the international scientific communities. It would be composed of representatives of the international scientific unions, of the scientific information services, and of other groups, such as the World Federation of Engineering Organizations, with an interest in scientific and technical information.

The scientific advisory committee would convene regularly to assess and evaluate the development of the UNISIST programme, to advise the Director-General of Unesco, and through him the UNISIST executive office, on the changing character of the information needs of the scientific community, and to propose specific programmes to accommodate such changes.

UNISIST executive office

The office responsible for the management of the UNISIST central functions should be located within the framework of the Science Sector of Unesco. Its staff should consist of qualified scientists and scientific information experts with administrative experience. The functions of the executive office would be to develop and administer UNISIST programmes in accordance

with the general guidelines to be laid down by the intergovernmental conference. The executive office would have responsibility for budget formulation and administration within the Unesco framework.

The executive office would be modest in size; an initial contingent of twelve positions and a budget of between three-quarters of a million and a million dollars per year is proposed for the first two years of operation.

Programme priorities

Several considerations enter into the determination of a programme implementation strategy. To begin with, practical considerations dictate that programme priorities be carefully selected on the basis of practicability, temporal status in an evolutionary scheme, and demonstration of social gain. To put it another way: first things must come first, be successful, and be important. On the other hand, although the contributions of the programmes recommended to UNISIST may be interrelated, the programmes themselves lack comparable elements. One consideration seemed particularly prudent to the committee, that of assigning a priority to 'tool building'. The conduct of a relatively short-range project whose accomplishment is a necessary first step to a later objective is a desirable principle. Work on the development of technical standards for the interchange of machine-readable information must obviously precede widespread interchange.

In efforts to catalyse co-operative agreements between and among information systems, it would appear prudent, following this same principle of evolutionary development, to assign priority to those systems in the established scientific disciplines who have already, through the intermediacy of ICSU/AB or other agency, considerable experience in co-operative activities. Furthermore, it may be noted that these systems provide the large data banks from which others may draw for national or specialized scientific interests.

Practicability is, of course, a matter of judgement. In the assignment of programme priorities, one must protest against conservatism on the one hand and the uses of unrealistic overextension on the other. Since the limits of machine systems are unexplored, it appears desirable to err on the side of innovation.

A further consideration in the establishment of programme priorities is that UNISIST, in order to grow, must be able to demonstrate some practical successes in areas of public concern. For example, it is desirable that one or more successful programmes designed to involve a developing country in UNISIST be accomplished, or that an information analysis centre in an area of significance be made operable. Similarly, since UNISIST provides a unique opportunity for the information system being developed in the CMEA countries to be made connectible with those being developed in western countries, an early success in achieving common standards for inter-communication would constitute a programme priority. Rather than attempt to rank order non-comparable programme recommendations, this report arbitrarily groups selected recommendations which were clearly related, on the one hand, and on the other identified single actions. The recommendations are further divided into two categories: the first representing programmes which should be initiated immediately, and the second programmes which might be deferred until a second echelon. These categories are as follows.

Priority 1

A. Tools of systems intercommunication

The recommendations included in this group are those relating to standardizing the elements of bibliographic description (Recommendations 2 and 5) to the development of indexing tools and language controls (Recommendation 4), and to the World Register of Scientific Periodicals (Recommendation 3).

Recognizing that some of the proposed objectives will take longer than others to accomplish, the committee nonetheless would encourage the immediate initiation of programmes which concentrate on the technical aspects of inter-systems communication. Accomplishments in this programme area would materially improve the capability of the systems to undertake co-operative work and product-sharing agreements. Progress can also be made in this area on a step-by-step basis,

with individual accomplishments building up a record of operational success.

B. Assistance to developing countries
This will be a programme of long duration. The disparate rates of scientific and technological progress between the developed and the developing countries should be offset, no matter how modestly in the beginning, by UNISIST efforts to improve access to scientific and technical information. A limited number of carefully planned pilot projects, experimentally controlled so that their results can be evaluated, should be initiated without delay. Training efforts benefiting technical personnel in developing countries should be accelerated.

C. World survey of information services
Recommendation 1 proposes the establishment of a permanent inventory of scientific information resources and services in individual countries, and in the fields of the sciences. A number of fractional surveys, non-standard and hence not comparable, have been accomplished in the past. As a necessary precondition to an increase in the level of co-operative activities for the planning of a world referral network, it is essential that information of a standard nature, continuously updated, be collected and made available. It is obvious to the central committee that the collection of such information must precede any meaningful systems analysis.

Priority 2
While the following programmes are in a priority category, their initiation can be deferred until after a start has been made on the Priority 1 programmes listed above.

A. Group on the evaluation of research in information science
This group, proposed in Recommendation 14, might well be created in the second or third year of operation of the UNISIST programme.

B. Information analysis centres

Recommendation 9 called for the establishment of a small number of information analysis centres as pilot projects, with a view to acquiring information relating to their costs and benefits to the scientific community. Time will be needed to develop and validate preliminary plans for such pilot projects.

Intergovernmental conference

As the first step towards the implementation of UNISIST, it is desirable to bring these recommendations to the attention of the three audiences to whom they are directed: the representatives of governments, of the world's scientific communities, and of information specialists. Every effort should be made to inform them and to encourage discussion of the findings and recommendations of the UNISIST study.

To provide for this opportunity, it is proposed to hold an intergovernmental conference in October of 1971.

Benefits and values from UNISIST

Who stands to benefit from UNISIST, and in what ways? What are the values to be found in achieving higher levels of co-operation and interconnectibility of scientific information systems? Can financial savings be anticipated? These questions must be answered to the satisfaction of UNISIST's potential participants, governmental and scientific, before they can be expected to consider committing the resources needed to implement the recommendations in this report.

It should be clearly understood that UNISIST does not guarantee that the costs of processing scientific and technical information will be reduced below present levels. UNISIST participants will undoubtedly have to incur additional expenses over those they now meet.

On the other hand, the costs to governments of supplying scientists with information will continue to escalate even though nothing is done; UNISIST offers opportunities to control these rising costs through pre-planned co-operative agreements. Furthermore, UNISIST will make possible new products and services at costs which are considerably less than proportional to the benefits. The alternative lies between the investment of more money in independent outmoded systems, and investing more money in interdependent modern ones.

There are several groups of beneficiaries from UNISIST, and they benefit in different ways. In addition, the groups are interactive, so that benefits of primary significance to one group have secondary significance for another. The following are directly affected by the successful implementation of UNISIST: individual scientists; sponsors of scientific research; sponsors and managers of information systems; science educators; and developing countries.

Benefits to individual scientists

Better information means better science. This is not the same as more information, it should be noted, but more highly selective, validated information produced at the time it is needed, and for the specific purpose in hand.

The individual scientist produces information in order to live, and consumes information in order to produce. He needs information for many other purposes: to review what has been accomplished in his own or related fields bearing on the topic of his investigation, to review the strengths and weaknesses of alternative methodologies, to verify the standard data which he must use, to compare his experimental results with those produced by other investigators. In short, he interacts with information from hour to hour. Deny him access, and he is handicapped; improve his ability to interact, and his personal performance is enhanced.

The primary beneficiary of a UNISIST network is, therefore, the individual scientist whose productivity and intellectual satisfaction are directly affected by the amount, pertinance and quality of the information made available to him.

Benefits for the sponsors of scientific research

It is in the conduct of scientific research and development programmes, whether they be supported by governments, by not-for-profit agencies, or by private industry, that the economic benefits of information first become apparent. While comprehensive data exist or are being collected systematically to demonstrate the increase in the productivity of scientists, or the number of scientist man-hours which have been 'saved' through having information available, or the number of man-hours 'lost' through its non-availability, there are thousands of anecdotal reports, sufficient in volume to convince the most sceptical.

Benefits from UNISIST should, therefore, be reflected in increased productivity of national and international research

and development efforts. In supporting the improvement of access to information resources, as the developed countries have been doing, they are clearly motivated by a desire to reduce the amount of unintended duplication in research efforts. Better information means better management by research administrators, and better utilization of the intellectual resources of science. It also means financial savings of consequence.

Benefits to the sponsors and managers of information systems

Earlier in this report, the potential for economic improvement in the design and management of large information services has been described. There are savings to be found through sharing the costs of input, a circumstance favourable to the internationalization of systems. Similarly, there are savings to be found through centralization of processing. Finally, there are major savings to be had in utilizing the outputs of the large systems to produce new services and products at incremental costs, as compared to developing independent systems.

Where national governments are supporting the independent building of information files and data banks, and where these are duplicative of files being established by the large international systems in the sciences, a reassessment might be made to see whether potential savings can be realized. Similarly, those agencies planning selective dissemination of information programmes should investigate the experience of the newly formed international Association of Scientific Information Dissemination Centers (ASIDIC), whose members reprocess tapes procured from the large systems.

Benefits to science educators

While the major attention in this report has been devoted to scientific information in support of research or of development,

it is obvious that information transfer is at the heart of the educational process, and that adequate provision of scientific information has both a quantitative and a qualitative effect on the education of scientific manpower. In many, if not in most, of the fields of science, education and research are inseparable at the graduate level. Accessibility to improved information resources under the UNISIST programme would materially strengthen national educational programmes in the sciences.

Benefits to developing countries

The realization of the potential benefits of UNISIST depends in the long run on the initiatives of the individual developing countries. Where dedication to a development programme and a willingness to commit resources exist, the UNISIST programme can provide a variety of benefits. Technical assistance will be available for establishing a national (or regional) development programme for scientific and technical information. Through co-ordinating the informational aspects of development programmes of intergovernmental and national agencies, UNISIST can assist in the building of information resources. Most importantly, the training programmes which UNISIST proposes to foster are directed to the development of skilled manpower essential to the provision of information services in the developing countries. UNISIST will act to reduce those administrative barriers which today make it difficult for developing countries to acquire the scientific publications and materials they need. Through the use of contemporary communications technology, such as the use of satellites to transmit Telex messages, UNISIST will act to speed the process through which scientific publications not available in a developing country can be made available by the industrialized countries through interlibrary loan or photocopy.

The foregoing benefits have to do with the development of infrastructures which act to support the functions of the

sophisticated electronic retrieval systems in the various fields of science. As mentioned earlier, these systems increase the demands for full texts of scientific papers, and do not offer a substitute for them. At the earliest possible moment, it is intended to initiate pilot projects whereby groups of developing countries may establish service centres linked to the large electronic information retrieval systems. In this way, scientists working in developing countries may receive the same benefits from mechanized literature search services and selective dissemination of information programmes as their colleagues in the industrialized countries.

It should be noted that the accomplishment of an information infrastructure will reinforce other types of technical assistance programmes and increase their chances of success. It is also true, as noted above, that this infrastructure is essential to the development of indigenous educational programmes.

Where the potential for utilizing more sophisticated systems has resulted in the establishment of a pilot project, the project should be so planned as to maximize the number of user groups and purposes affected. The project, for example, should bear a relationship to research in the country, to economic growth and development, and to the education of scientific manpower. In this way, a larger return can be expected for the investment.

Finally, there are the less tangible, but no less real and no less practical benefits to international understanding and co-operation in the sciences which UNISIST will both engender and provide. Both Unesco and ICSU are dedicated to the advancement of science internationally, without regard to political boundaries, the end goal being the over-all benefit of mankind. Unesco, among all the members of the United Nations family of international organizations, is the one agency with a mandate to 'maintain and diffuse knowledge ... by initiating methods of international co-operation calculated to give the peoples of all countries access to the printed and published materials produced by any one of them'. Information is the life-blood of science, and UNISIST, as a programme to enhance the sharing of information among the world's

scientists, becomes another means through which these two international agencies, and others associated with them in the same cause, can work towards their common goal.

Appendix A

Members of the Unesco/ICSU Central Committee on the Feasibility of a World Science Information System

Dr. B. W. ADKINSON,
Office of Science Information Service,
National Science Foundation,
Washington (United States).

Eng. N. B. ARUTIUNOV,
Directorate for Scientific and Technical Information,
State Committee for Science and Technology of the U.S.S.R.,
Council of Ministers,
Moscow (U.S.S.R.).

Professor A. AVRAMESCU,[1]
Scientific Documentation Centre,
Academy of the Socialist Republic of Romania,
Bucarest (Romania).

Professor G. A. BOUTRY,
Conservatoire National des Arts et Métiers,
Paris (France).

Dr. H. COBLANS,
Publications Department, ASLIB,
London (United Kingdom).

Dr. Milton HARRIS,[1]
Board of Directors,
American Chemical Society,
(United States).

1. Dr. Lazar and Dr. Sherwin had to forgo their participation in the work of the Committee; they have been replaced by Professor A. Avramescu (Romania) and Dr. Milton Harris (United States).

Appendix A

Dr. H. T. HOOKWAY,
Office of Scientific and Technical Information,
Department of Education and Science,
London (United Kingdom).

Professor Dr. H. KAISER,
Institut für Spektrochemie und Angewandte Spektroskopie,
Dortmund (Federal Republic of Germany).

Professor M. KOTANI,
Science Council of Japan,
Tokyo (Japan).

Dr. P. LAZAR,[1]
Hungarian Central Technical Library and
Documentation Center,
Budapest (Hungary).

Professor A. I. MIKHAILOV,
VINITI,
Moscow (U.S.S.R.).

M. P. PIGANIOL,
Compagnie de Saint Gobain,
Neuilly-sur-Seine (France).

Dr. C. SHERWIN,[1]
Gulf General Atomic Inc.,
San Diego, California (United States).

Dr. F. A. STAFLEU,
Botanical Museum,
Utrecht (Netherlands).

ICSU Representative: Professor H. BROWN,
National Academy of Sciences,
National Research Council,
Washington (United States).

Unesco Representative: Dr. A. WYSOCKI,[2]
Department of Science Policy and Promotion of Basic Sciences, Unesco,
Paris (France).

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1. Dr. Lazar and Dr. Sherwin had to forgo their participation in the work of the Committee; they have been replaced by Professor A. Avramescu (Romania) and Dr. Milton Harris (United States).
2. In 1968 succeeded Dr. A. Perez-Vitoria.

Appendix A

Advisory panel

Mr. S. ADAMS,
National Library of Medicine,
Department of Health, Education and Welfare,
Public Health Service,
Bethesda, Md. (United States).

Mr. R. BREE,
CID, Commission des Communautés Européennes,
Luxembourg.

Dr. R. L. KENYON,
American Chemical Society,
Washington (United States).

Mr. J. PAGE,
European Space Research Organization,
Neuilly-sur-Seine (France).

Dr. P. V. PARKINS,
Biological Abstracts,
Philadelphia, Pa. (United States).

Mrs. J. POYEN,
ICSU/AB,
Paris (France).

Dr. J. R. SMITH,
INSPEC,
The Institution of Electrical Engineers,
Stevenage, Herts. (United Kingdom).

Dr. F. A. SVIRIDOV,
FID,
The Hague (Netherlands).

Dr. J. E. WOOLSTON,
Division of Scientific and Technical Information,
International Atomic Energy Agency,
Vienna (Austria).

Appendix B

1. *Working group on the evaluation, compression and organization of scientific information (1968)*

Chairman: Professor Dr. H. KAISER (see Appendix A).
Members: Dr. F. L. BRADY, Washington (United States).
Professor J. ENGELFRIET, The Hague (Netherlands).
Dr. A. C. MENZIES, Harrow-on-the-Hill (United Kingdom).
M. P. PIGANIOL (see Appendix A).

2. *Working group on indexing and classification (1968)*

Chairman: Mr. D. J. FOSKETT (United Kingdom).
Mr. A. VAN DER LAAN, The Hague (Netherlands) (FID).
Members: Mrs. I. DAHLBERG (Federal Republic of Germany).
Dr. P. LAZAR (see Appendix A).
Dr. F. A. SVIRIDOV, The Hague (Netherlands) (FID).

3. *UNISIST/ICSU A.B. working group on bibliographic description (1968 onwards)*

This group merged in 1968 with the *ICSU A.B. Working Group on Abstracts Standardization* (Chairman: Professor G. A. Boutry, see Appendix A), and united with the *UNISIST Working Group on International Standards for the Transfer of Basic Bibliographical Data* (Chairman: Dr. C. W. Sherwin, see Appendix A).

Chairman: Dr. H. T. HOOKWAY (see Appendix A).
Members: Dr. Nathalie DUSOULIER, CNRS, Paris (France).
Dr. S. HAMADA, JICST, Tokyo (Japan).
Dr. Dieter HOENE, Chemisches Zentralblatt, Berlin.
Mr. M. D. MARTIN, Information Systems, IEE, London (United Kingdom).
Mrs. J. POYEN, ICSU A.B., Paris (France).
Dr. V. P. ROMANOV, VINITI, Moscow (U.S.S.R.).

Mr. K. SCHNEIDER, Zentralstelle für Maschinelle Dokumentation, Frankfurt/Main (Federal Republic of Germany).
Dr. B. V. TELL, Royal Institute of Technology, Stockholm (Sweden).
Mr. J. L. WOOD, Chemical Abstracts Service, Columbus, Ohio (United States).

4. *Working group on language problems*

Chairman: M. P. PIGANIOL (see Appendix A).
Members: Professor Dr. Helmut ARNTZ, Burg Arntz (Federal Republic of Germany).
Dr. A. I. CHERNYI, VINITI, Moscow (U.S.S.R.).
M. J. H. D'OLIER, Centre de Documentation du NRS, Paris (France).
Mr. D. J. FOSKETT, Institute of Education, London (United Kingdom).
Dr. David G. HAYS, Faculty of Social Sciences and Administration, Buffalo, N.Y. (United States).

5. *Working group on research needs in documentation (1968-69)*

Chairman: Eng. N. B. ARUTIUNOV (see Appendix A).
Members: Professor A. MIKHAILOV, VINITI, Moscow (U.S.S.R.).
Professor J.-C. GARDIN, CNRS, Marseille (France).
Dr. A. MERTA, Central Department for Scientific, Technical and Economic Information, Prague (Czechoslovakia).
Dr. Don. R. SWANSON, Graduate Library School, University of Chicago, Chicago, Ill. (United States).
Dr. B. V. TELL (see 3 above).

6. *Working group on scientific information in developing countries (1969)*

Chairman: Dr. H. COBLANS (see Appendix A).
Members: Mr. John GREEN, Government Relations, Washington (United States).
Mr. C. KEREN, Center of Scientific and Technical Information, Tel Aviv (Israel).
Professor I. MALECKI, Academy of Sciences, Warsaw (Poland).

Appendix B

Dr. Armado M. SANDOVAL, Centro de Informacion, Syntex International, ATSA, Mexico (Mexico).
Professor C. I. O. OLANIYAN, School of Biological Sciences, University of Lagos, Yaba, Lagos (Nigeria).
Dr. I. N. SOROKIN, VINITI, Moscow (U.S.S.R.).

7. *Working group on communications format (1970)*

Chairman: Dr. B. V. TELL (see 3 above).
Members: Mrs. H. AVRAM, Library of Congress (United States).
Mrs. A. BERTHELOT, CNRS (France).
Ing. K. HAVLICEK, Centre for Scientific, Technical and Economic Information (Czechoslovakia).
Dr. L. N. SUMARAKOV, State Committee for Science and Technology (U.S.S.R.).
Mrs. VICHNIAKOFF, CNRS (France).
Mr. S. T. WATERS, MEDLARS (United States).
Ing. R. ZAJAC, Committee for Science and Technology (Poland).

8. *Working group on the international serials data system (1970)*

Chairman: Mr. M. P. PIGANIOL (see Appendix A).
Members: Dr. B. ADKINSON (see Appendix A).
Dr. H. COBLANS (see Appendix A).
Dr. L. N. SUMARAKOV (see 7 above).