

The Furture Role of Electronic Publishing in Primary Scientific Communication

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THE FUTURE ROLE OF ELECTRONIC PUBLISHING IN PRIMARY SCIENTIFIC COMMUNICATION

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1. Introduction

Scientists rely on accurate, rapid and widely disseminated publication for the communication of the results of scientific investigation. ICSU Press was established to ensure that these needs were satisfied for all scientists regardless of discipline or geographical or political factors. With the development of the Internet, transmission of digitally stored texts and graphics added a new dimension to the process of primary scientific communication. This process is the subject of this paper on electronic publishing. In 1993 the author proposed that a major study of electronic publishing should be carried out to identify issues of concern and to advise on future action for the benefit of science. Authors and publishers recognised that electronic publishing would materially affect the important role of editors in managing the publication process; and many of them thought there was a serious threat of a breakdown in the long established system of publication through scientific journals due to loss of revenue required to support the system.

It was agreed that ICSU Press should conduct this study and a preliminary consultation identified two issues requiring special attention before the intellectual property rights in the digitally stored texts of research results could be fully exploited. These were: (1) that there was a need for an internationally recognised system for the bibliographical control of digitally stored texts; which was a matter of concern to publishers as well as authors; and (2) that a reliable and economical method was required for the protection of digitally stored texts against non-permitted copying.

2. A Meeting of Experts

To explore these and related matters, representatives of international organisations, who were interested in bibliographic control and protection of intellectual property rights in digitally stored texts, were invited to a small gathering of experts held in collaboration with UNESCO in Paris in June 1993. The meeting was invited to consider what initiatives should be undertaken by ICSU in seeking to satisfy these

needs.

A report of this meeting ([ref.1](#)) was presented to the 24th General Assembly of ICSU held in Santiago (Chile) during October 1993. The report was received with enthusiasm and the Assembly resolved that ICSU Press, in close collaboration with the Scientific Unions should maintain a watching brief on the rapid expansion of electronic publishing which was expected to occur during the next few years and which might (1) seriously affect the economic viability of journals publishing, (2) engender a reduction in the use of the peer review system and (3) result in an increase in the problems concerning intellectual property rights. Recognising the maintenance of the necessary infrastructure to be of the utmost importance to authors, publishers and readers as these developments took place, ICSU Press was requested to report periodically to the ICSU Executive Board to ensure that the best interests of the international scientific community were taken into consideration.

3. An International Conference of Experts

In order to respond to this invitation it was clearly important to ensure that progress was carefully monitored and also that we were fully informed on the latest issues. It was decided to convene a second larger conference of experts to be planned with the assistance of an international advisory committee the membership of which was chosen in order to complement the expertise of members of the Editorial Board ([ref.8](#)).

3.1 Conference Planning

Planning for the conference was the responsibility of ICSU Press which, in collaboration with UNESCO, established a joint Programme Committee to work out the detailed programme. Corresponding members were invited to join this committee to form the Editorial Board that was responsible for the Proceedings. To ensure a common core of knowledge for all participants, speakers were chosen to review the major topics and issues detailed below, after which delegates were to be invited to participate in workshops for the discussion of key questions identified in the main sessions. It was expected that the responses to these questions would enable recommendations to be drafted for discussion and, if approved by the Conference they would be presented to the 25th General Assembly of ICSU and reported to the Director-General of UNESCO. This plan was adopted and came to fruition in February 1996.

3.2 Plenary Sessions

The subjects selected for the plenary sessions were the following:

- (1) Introduction-where are we now?
- (2) Electronic data storage, access and archiving;
- (3) Tools and standards for protection control and presentation of data;
- (4) Legal and ethical issues in electronic publishing;
- (5) Scientists' views of electronic publishing and issues raised, & Views of learned and professional scientific society publishers;
- (6) Economics and organisation of primary electronic publishing; and
- (7) Options for the future.

Rather than issuing a call for papers the members of the Programme Committee selected experts with established views on each of these topics to prepare and present summaries. These formed the basis for the drafting of questions to guide the Working Groups in their discussion of the important issues. In some sessions there was provision for short contributions by delegates from countries in the process of economic and social development. Comments on the outline plan were sought from members of the International Advisory Committee. The papers presented in the plenary sessions are published in the proceedings ([refs.2&8](#)) and summarised by Shaw ([ref.3](#)).

3.3 Selection of participants

The success of the workshop plan was dependent on achieving a satisfactory representation of participants from research scientists, publishers, librarians and information brokers. It was also important to attract scientists from developing countries. Delegates were nominated by ICSU Scientific Unions, Commissions and Committees, National Members and Scientific Associates; and nominations were also sought from UNESCO delegations. Invitations to those selected to participate were issued by ICSU Press and UNESCO in September 1995. Others, particularly publishers and information brokers with an interest in the conference topic, were invited to apply for a restricted number of places which were allocated when the main enrolment had been completed during the autumn 1995. As a result, a conference of 150+ participants was achieved with the composition shown in Table 1 below. The distribution of participants by country of origin shows a strong contingency from Europe and North America. There was a bias in favour of physics and related disciplines which was evidence of the progress in electronic publishing achieved by the International Union of Pure and Applied Physics and its member societies, together with other ICSU Unions such as the International Astronomical Union and the International Union of Crystallography. However, the fact that forty countries succeeded in nominating expert representatives, shows that international coverage for this Conference was achieved. It was generally agreed that the method of selection produced a valid world-wide conference of experts.

Country	Number	Country	Number	Country	Number
Australia	1	Italy	1	Poland	2
Austria	2	Ivory Coast	1	Russia	3
Belgium	2	Japan	1	Slovakia	1
Brazil	1	Jordan	1	Sweden	5
Canada	3	Lebanon	1	Spain	1
Denmark	4	Lithuania	1	Switzerland	2
Egypt	2	Luxembourg	1	Taiwan	1
Eire	1	Malawi	1	Tunisia	1
Finland	3	Mexico	2	Turkey	1

France	13	Morocco	1	Uganda	1
Germany	6	Nepal	1	UK	43
India	3	Netherlands	10	US	23
Iran	1	Nigeria	1	Venezuela	1
Israel	1	Norway	2	TOTAL	153

TABLE 1. Country of origin for Conference participants

3.4 Planning for the working groups

The *modus operandi* for the working groups, was determined by the Programme Committee two months in advance of the conference. At that time the composition of the conference body, in terms of discipline, interests, and experience, was clear. Thus, decisions could be made on such matters as the probable size of the groups, and how many questions should be addressed to each of them. Speakers were asked to provide long abstracts (circa 500 words) on their topics, followed by a first draft text of their papers including an indication of the essential issues they foresaw as arising. It was thus possible to identify several of the matters to be explored in discussion. Participants were notified of the broad subject areas selected for the five groups and were invited to express a preference.

4 Working Group Reports

There were five working groups, viz.:

- 1 Real Costs (Anthony Watkinson, Chairperson)
- 2 The Electronic Archive (Robert Wedgeworth, Chairperson)
- 3 Developing Countries (Ana Maria Cetto, Chairperson)
- 4 Implications for Training and Work-styles (John Rose, Chairperson)
- 5 Peer Review (Bernard Donovan, Chairperson)

Several new issues were brought up in the working group discussions which led to a wide ranging set of recommendations. These recommendations, were aimed initially at ICSU and UNESCO but must be addressed by a wider community of scientists and publishers. They represent the most important result of the conference and have been widely distributed. For ease of reference they are included in an Appendix. To implement these recommendations it was necessary to attract the attention and supporting skills of each participant and to achieve this end required the maximum publicity. Each delegate was asked to publicise the results and recommendations as widely as possible and this has been done by many. Two of the groups discussed topics of particular interest to IATUL and their deliberations are briefly review below.

4.1 Working Group 2: The Electronic Archive

New electronic technologies are continuing to alter the way science is done, the way science is taught and the way science is applied to the various aspects of our lives. There is little surprise, therefore, that these same technologies are continuing to alter how we document the record of scientific achievement and how we give access to that record. This group devoted a considerable amount of time to a number of perspectives on the electronic archive. While there is general agreement on the need to ensure that a permanent record of scientific achievement will be maintained, there were varying levels of agreement on the nature of the electronic archive; what its purposes are; how accessible it should be; who is responsible for maintaining it and who will finance it.

There is some difference of opinion as to whether an electronic archive should be a *static* collection (or network of collections) as distinct from an *active* record with assurances of the preservation of the file. There was even less agreement as to who should be responsible for ensuring the preservation of the scientific record. In some instances the scientific society is most likely to assume responsibility. In others, certain publishers will assume it. However, at some point, especially in developing countries, government responsibility for ensuring that provision is made seems appropriate. There was general agreement that authors, scientific publishers, learned societies and governments share some responsibility for financing maintenance of the record. The specific provisions are likely to vary among the countries. There are some strong national interests in maintaining the record of science, but the long term interests are clearly international whether viewed by scientists, users, publishers, societies or governments ([recommendation II.1](#)).

The concept of an electronic archive was based primarily on current experience rather than a more ambitious vision of what scientists and those who benefit from scientific achievements will need from an electronic record. However, the promulgation of standards is the key strategy for stimulating the development of electronic archiving of science. Standards are required for eligibility, for maintenance and for access, along with standards for the structure and content of electronic archives ([recommendation II.2](#)).

Consideration was given to what material should be eligible for the electronic archive and whether legal deposit carries some assurance that intellectual property rights will be respected. There was moderate agreement that only "published" material should be eligible for an electronic archive. However, this view held primarily due to lack of a clear concept of what types of "unpublished" material might be significant additions to the record ([recommendation II.3](#)).

The concern for restricting access to the record established by legal deposit was challenged by the need for scientists to have relatively free access to the record. The scientists also insist that the electronic record be operable to enable them to navigate between their current work and the electronic record quickly and easily. (See [ref.15](#)).

4.2 Working Group 4: Implications for Training and Work-styles

The first matter discussed by Group 4 was the extent of the diversity of information-gathering methods of scientists. Each scientific discipline has its particular methods for gathering and disseminating information, and the needs of scientists will also vary

according to other factors such as level of responsibility, place of work or language. A range of basic skills common to most scientists can nevertheless be identified. In particular good authoring skills, adapted to the electronic environment, will be required for rapid and efficient dissemination of information through electronic publishing techniques. In addition, supporting staff such as technicians, network specialists and managers should receive special training so that they can contribute to the development of scientific electronic publishing.

The skills for accessing and effectively using electronic publications should be seen as part of a broader required competency in information retrieval techniques and computer and network literacy. Additional skills are needed for preparation of electronic articles and for the organisation of mechanisms for their dissemination. All scientists should receive training in these areas. Training in information resources and library use should be a part of all scientific education, if possible as early as the undergraduate level, since students can learn these skills more quickly and naturally than scientists who have already acquired work habits. This training should stress characterisation of, and access to, scientific information including theory and practice of retrieval techniques, as well as general authorship skills including proper structuring of information for publication. Basic training should also aim at providing an understanding of the principles, main activities and tools (web servers, compression techniques, etc.) required for the electronic production and dissemination of information, but need not include detailed practice in this area.

All institutions of higher learning in science and all major employers of scientists should ensure that their students (and employees) receive appropriate training in use of information resources. Such training should take place so far as possible in a discipline or employment specific context, and should take full account of existing training opportunities including commercial courses. Information training activity should be co-ordinated at the level of each organisation, and libraries are often seen as the most appropriate institutional setting for this function ([recommendation IV.1](#)).

In considering what additional factors can facilitate access to and dissemination of electronic publications, it was agreed that adequate and reasonably priced network access is essential for scientific work today. Although cheap, high capacity, data communication provision is predicted for the future, there is a concern that available band-width will be insufficient in the medium term to take care of scientific information needs, particularly in the context of competition from non-scientific network applications. One, technically feasible, solution would be for national authorities to ensure priority network access for bona fide scientific usage. The introduction of a common system of meta-information to identify scientific information resources would not only facilitate access and retrieval, but would also reduce demands on network and server capacity caused by repetitive, "brute force" inventorying of electronic information resources. Cooperative research by the scientific, library and information communities will be essential in finding appropriate cooperative solutions to the organisation of electronic scientific information. If current trends continue, it may also become necessary for scientific communities to consider limiting access to their servers by general network probing programs [[recommendation IV.2](#)].

The Group then considered what new developments are likely and whether they

would require training. Clearly, further developments in electronic publishing will increasingly influence the work of scientists. The field of electronic information services, and of electronic publishing in particular is evolving so rapidly that it is probably not fruitful to try to anticipate specific developments. The use of specific tools and techniques can be taught as required, or even self-learned, once scientists have acquired a basic information culture.

It was also considered whether libraries should provide dedicated technical support for aspects of electronic information. The information resources required in and for science are becoming ever more numerous and complex, with the result that intermediaries will probably always be needed even as working scientists take more responsibility for gathering and dissemination of information. Other types of technical support are also needed to ensure effective access to, and use of, information: for example, advice on the development and interconnection of computer networks. Operational and methodological support in the handling of electronic information should be organised for individual scientists and scientific institutions. Libraries, which are increasingly assuming gateway and publishing functions in addition to their traditional roles in classifying, storing and disseminating documentation should help fulfil this role. This implies a new type of training for information professionals to be able to perform this function [[recommendation IV.3](#)].

As electronic publishing develops various scientific communities will increasingly be called upon to take more responsibility in the information transfer process, including some functions that have been traditionally the responsibility of print-on-paper publishers. The international scientific community should facilitate exchange of experience between scientists and scientific disciplines concerning electronic publishing applications, with a view to identifying best practice and encouraging cooperative research and development. This is currently under investigation by ICSU Press and it is planned to establish an information network to refer users to information resources, tools and standards relating to electronic publishing in science. Top level access to this information will be incorporated into the ICSU World-wide Web site ([recommendation IV.4](#)).

4.3 IATUL Participation

IATUL joined ICSU as a scientific associate in 1988. In 1993, as a result of a steep rise in annual dues requested by the ICSU Executive Board, it was decided to withdraw from membership. As a consequence, IATUL has not been able to participate in these developments. However, the ICSU Press Standing Committee has now agreed to invite interested parties to collaborate in its programme of implementation of the Conference Recommendations. It is appropriate that IATUL members should consider how they might respond to this challenge.

5. Reports of the Conference

The full text of each of the papers from the Conference is available on the World-wide Web in the ICSU Home Pages ([ref.7](#)) and has been published in hard-copy ([ref.8](#)). There have been seven summaries so far published since the Conference and these have all been prepared from different viewpoints. The article by Declan Butler ([ref.9](#)) was the first to appear the week after the conference and highlighted the discussion on Peer Review. Dennis Shaw ([ref.3](#)) emphasized the recommendations which were published alongside his summary of the papers presented in each session. Lex Lefebvre of STM International ([ref.10](#)) emphasized the importance of the various

recommendations addressed to publishers in general whereas Hans Sens ([ref.11](#)) concentrated on the way electronic publishing had already transformed the process of publishing and outlined the plans of physicists to re-engineer the whole scene by the construction of a seamless electronic web throughout the chain of processes leading to the final appearance of the definitive work. David Brown ([ref.12](#)) summarized all the contributions in the order they were presented. Ana Maria Cetto ([ref.13](#)) summarized the issues facing scientists in developing countries and, finally, the report of the Conference Chairman Roger Elliott ([ref.14](#)) identified those issues which are of concern to the four major constituencies; scientists, librarians, information brokers and publishers, and drew attention to the far-reaching nature of the recommendations.

6 Widening the consensus to cover the international scientific community.

As indicated in section 3.1, the recommendations were reported to the delegates at the 25th ICSU General Assembly in Washington DC and arrangements were made for a special open session for discussion. To set the scene, Scott Lubeck, Director of the National Academy Press explained the development of a Website publicizing the activities of the NAP which had been stimulated by his participation in the Paris Conference.

Roger Elliott continued with a brief summary of the Conference Recommendations in which reference was made particularly to the section which dealt with peer review and codes of practice. It was recognized that peer review would differ considerably if conducted electronically since a much wider audience could have access to a text submitted for publication before it was formally accepted. A code of practice was necessary to safeguard an author's intellectual property against plagiarism. It was also necessary to introduce coding to identify the status of a document ([recommendation L2](#)).

Dennis Shaw explained the need for the creation of an electronic archive the contents of which would have to be kept under review (as were other text archives) if they were to have a lasting value. It was recognized that Learned Societies could play an important role in the establishment and maintenance of archive material but funding was a matter of concern since the archive was unlikely to be commercially viable. This problem was particularly severe in those disciplines such as earth sciences and astronomy where modern techniques of measurement generated vast amounts of data. Reference was made to the plan for Elsevier to create a databank of all back issues of their science journals. This could be a major resource and its mention led to a discussion how to change the current practice of scientists in giving unrestricted transfer of the copyright of their publications to the publisher: ICSU was urged to address this problem. It was felt that the use of copyright to restrain the free dissemination of abstracts was particularly unfortunate. The matter has since been addressed by the World Intellectual Property Organization at a three-week diplomatic conference in Geneva in November 1996. One important agreement was that the existing criteria relating to copyright exceptions, in particular fair dealing for research or private study, in respect of printed works are to be retained for digitally stored works. A decision on copyright protection of databases was deferred until 1997 ([ref.15](#)).

Kai-Inge Hillerud in presenting the section on financial considerations asked how funding agencies could be persuaded to include in grants the costs of publication and accessing the results of research. It was agreed that this clearly needed action by the

international scientific community. The costs and benefits of electronic publication were to be the subject of a detailed study which would involve all sectors of the information creation and publishing chain. The need for such a study was accepted by the audience [[recommendation III.3](#)].

Howard Moore referred to the importance of training scientists in best methods for depositing and accessing information. It was agreed that advice on current practices should be collated and made available through the ICSU Press Home Pages. The Scientific Unions should be consulted to establish what was already available in each discipline. The needs of scientists in developing countries were very much the concern of UNESCO which was planning to give support to pilot projects in this field.

Ana Maria Cetto presented the special needs of developing countries and referred to ways in which the conference initiatives were being followed up. A summary of possible follow up activities has been prepared by Irving Lerch ([ref.16](#)).

It was concluded that the recommendations were clearly acceptable to the international scientific community and there was no dissension expressed in the general thrust of the conclusions from the conference. ICSU Press would accept responsibility for progressing and monitoring follow-up action on these recommendations. This was strengthened later during the day when the General Assembly included among the Resolutions the following:

The 25th General Assembly of ICSU, recalling Resolution II.9 adopted by the 24th General Assembly; thanks ICSU Press for having organized an Expert Conference on Electronic Publishing in Science, in February 1996; notes the Recommendations in the report of the Conference and invites ICSU Press to undertake appropriate follow-up activities, and to continue to monitor progress in this field, in particular with regard to developing countries, and to report to the Executive Board.

7. Subsequent action

To undertake the tasks laid on it by the General Assembly, the Standing Committee of ICSU Press has been strengthened under the chairmanship of Roger Elliot and the following members have been appointed with effect from January 1997.

Chairman: Roger Elliott (United Kingdom)
Hunk Spekrijse (Netherlands)
Scott Lubeck (USA)
Vitaly A. Nechitailenko (Russia)
Kai-Inge Hillerud (Sweden - ICSU Legal Adviser)
Howard J. Moore (United Kingdom - UNESCO representative)
Ana Maria Cetto (Mexico - TWAS representative)
Manager of ICSU Press Website: Dennis Shaw (United Kingdom)

It is proposed that ICSU Press should act as a focus for a programme of follow-up activities which will also involve a number of other international bodies. Discussions are already in progress with the International Council of Scientific and Technical Information (ICSTI) and the International Federation of Library Associations and Institutions (IFLA), the American Association for the Advancement of Science (AAAS) and the Advisory Council for Scientific Communication of UNESCO, and there are several other bodies with a similar concern. The three general issues of most concern to ICSU, deriving from the Conference, relate to the needs for a code of practice for electronic publication in science ([recommendation I.1-4](#)), the establishment of principles and guidelines for archiving ([recommendation II.2](#)) and the study of the economic costs and benefits of electronic publishing ([recommendation III.3](#)). ICSTI and IFLA have shown a particular interest in the archiving issues while UNESCO is particularly concerned with the impact of electronic publishing on developing countries ([recommendations V.1-4](#)).

Within the ICSU family itself, the Chairman of ICSU Press has instituted an inquiry to establish the use and experience of members with electronic publishing. In order to facilitate the dissemination of information about these issues it has been decided to establish an ICSU Press Website that will be accessible directly and also via the ICSU Home Pages ([recommendation I.4](#)). Discussions have also begun on how best to adapt the ICSU Home Pages to provide an information network ([recommendation IV.4](#)). Dennis Shaw has been appointed to manage this project

ICSU Press will seek funding to support a residential workshop for a technical study of the economics, costs and benefits of electronic publishing ([recommendation III.3](#)).

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Appendix: Recommendations from the Conference

The Conference Recommendations have been published in *Science International*, Newsletter No. **61**, 1-3. (ISSN 1011-6257 May 1996). They are also available online at the following URLs - <http://associnst.ox.ac.uk/~icsuinfo/recommen.html/>; http://www.lmcp.jussieu.fr/ICSU/Information/Proc_0296/recommendations.html; <http://www.surya.uiuc.edu/icsu/recommendations.html> and <http://eos.wdcb.rssi.ru/eps/recommendations.html>.

These recommendations focus attention on the actions which can and need to be taken during the remaining years leading up to the beginning of the 21st century to ensure that the maximum benefit is derived for all concerned with the progress of scientific research by the application of information technology to the distribution of scientific information. Action following the adoption of these recommendations by ICSU in October 1996 will be decided by members of the ICSU family in consultation with UNESCO where appropriate.

The Conference of Experts on Electronic Publishing in Science convened by ICSU and UNESCO in February 1996 discussed the broad range of problems and opportunities presented by the new technologies. It approved a number of recommendations, roughly grouped below under five headings, which are directed specifically to ICSU and UNESCO and through them to the scientific community in general, the learned societies and national academies and others involved in scientific information provision such as publishers and librarians, and to national governments.

I. Peer review and codes of practice

1. The Conference overwhelmingly recommends that strict peer review should be applied to all scientific material submitted for publication in electronic journals.

2. The peer review system should yield definitive authenticated and dated versions of papers for publication, although the subsequent attachment of tags indicating later developments or revisions of papers should not be precluded.
3. Attention should be given to the definition of acceptable ways of establishing priority of publication, for these appear to differ between scientific disciplines.
4. ICSU and UNESCO are encouraged to organize the most appropriate type of forum involving scientific societies in order to formulate codes of ethics and of conduct for electronic publication which would spell out the reciprocal obligations of the scientist and the community on such matters as peer review, citation, integrity and authentication of material and archiving.

II. Electronic archives

1. Given the traditional role of publication in science in providing an archive, it is timely and urgent that attention be given to ensuring the archiving of science in electronic formats. The malleable nature of digitized information requires the establishment of verifiable electronic archives including databases.
2. The Conference recommends that scientific societies, publishers and librarians come together to establish principles and guidelines for electronic archives covering, but not limited to: maintenance, content, structure, finance, eligibility, accessibility and compatibility. Consultation with the International Organization for Standardization (ISO) should be ensured concerning the use and development of appropriate international standards.
3. It is further recommended that a registry be created for electronic archives in scientific fields, together with the establishment of principles and guidelines for its operation.

III. Financial considerations

1. The Conference recommends that funding agencies regard the costs, both of the publication of research results and of access to required information, as an essential component of research funding.
2. The Conference recognizes that the availability of electronic information in a searchable form is potentially of great advantage to the world scientific community for the efficient conduct of research and education. Funds should be directed so as to allow full use to be made of the potential and development of this source of information.
3. A technical study of the costs and benefits of electronic publication should be carried out by an international committee established by ICSU in coordination with ICSU members and associates, and involving representatives of the library and scientific, technical and medical publishing communities.

IV. The scientist's working environment

1. Although each scientific discipline has its particular information gathering and dissemination methods, a set of basic skills needed by scientists can nevertheless be identified. All scientists should receive training in information resources and library use and in good authoring skills, adapted to the electronic environment, if possible as early as the undergraduate level. ICSU and UNESCO should assist those developing countries which do not have the resources and expertise to organize this training.
2. The Conference unanimously endorses the view that adequate and reasonably priced network access is essential for scientific work and scientific education. National authorities should ensure that appropriate infrastructure be established for

this purpose and that scientific data traffic receives appropriate priority. Scientists in all countries should have good access to computer communications to participate in information exchange needed for their work, and ICSU and UNESCO should promote such access with all available means.

3. In keeping with the increasing role of the scientists in the electronic publishing process, the international scientific community should facilitate exchange of experience between scientists and scientific disciplines in this field with a view to identifying best practice and encouraging cooperative training, research and development. This work should be facilitated by the international committee proposed in (III.3) above.

4. As a useful first step, an information network should be established to refer users to information resources, tools and standards relating to electronic publishing in science. Direct, immediate access to this information should be incorporated into the ICSU World Wide Web site and facilities should be provided for discussion groups and for E-mail access for those users without WWW capacity.

V. Developing countries

1. The scientific community in developing countries is becoming increasingly involved in all stages of electronic publishing, including locally published on-line journals, CD-ROM technology and appropriate databases. These scientists should assume greater control of the technologies involved. UNESCO, ICSU and the international community should take this into account in planning and implementing cooperative projects.

2. The scientific community in developing countries should become involved as a partner in the development of methodologies, tools and standards relating to electronic publishing and archiving so that these can be adapted to its needs. In particular, regional cooperation should be encouraged and language-independent systems adopted where possible.

3. UNESCO should be encouraged to support one or two developing country pilot projects in the area of electronic publishing.

4. The costs of infrastructure and information provision are particularly heavy for developing countries. This problem is ultimately the responsibility of the governments concerned. The assistance of UNESCO and other UN agencies in promoting solutions should continue, while better linkages to the local private sector, regional cooperation relying on local expertise, and competitive and flexible regulatory regimes, should all be fostered.