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ABSTRACT

The American Institute of Physics is working toward the development of a national information system for physics, whose objective is the organization of the flow of physics information from the producers to the users. The complete physics information system has several constituent subsystems, among which are: one for the management of the flow of primary information (documents), one for the generation of secondary information (abstracts, titles, indexes, etc.) and one for the improvement of the flow of tertiary information. This last is the result of the scholarly effort of evaluation and compaction of the primary information which becomes part of the storehouse of "Science Knowledge." The physics system is discipline-based in order to insure proximity to the producer; it will also couple with other discipline-based systems, with mission-based systems, and with disseminator institutions to fulfill the needs of its various potential users. This network of coupled information systems, institutions, and individuals, with its formal and informal links, when it is focused on physics producers and users, is the Network for Physics Information. This report outlines the anticipated characteristics and operations of the network and of various component systems. (Author)

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A NETWORK FOR PHYSICS INFORMATION

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A NETWORK FOR PHYSICS INFORMATION *

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Abstract

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A NETWORK FOR PHYSICS INFORMATION

1. Introduction

I am delighted to be here and have the opportunity of discussing some of the ideas which we at the American Institute of Physics have had regarding scientific information with the members of the American Society for Information Science. As you know plans for discipline-based information systems are being made in several disciplines with financial support from the National Science Foundation. Planning for a National Information System for Physics (NISP) began in January, 1968 at the American Institute of Physics. (1,2,) During the past ten months work has concentrated on the problems of communication links within the community of physicists, on the intellectual organization of physics information, on the nature of the files of such information, and on the general design of the system itself.

The work has progressed to the stage in the definition of the elements of NISP where we must raise our sights and consider the broader network into which NISP must fit. The inclusion of networks of systems in the AIP considerations should not imply that all elements of other science information systems are adequately defined at the present time. However, predictions can be made based on accepted terms and concepts that doubtlessly will be fundamental in the development of NISP as well as other systems, and on reasonable extrapolations of their implications.

Among the key concepts involved are: the two important components of learning (information and knowledge), the orientation of science learning (discipline, science, and mission), and the organizations involved in acquiring, organizing, and disseminating this learning. We will explore these concepts as an introduction to a preliminary and brief description of a National Information System for Physics as the core component of a Network for Physics Information.

2. Information and Knowledge

Science information has been defined as all written or oral, transmitted or received, communication in a particular science. It is news concerning facts or circumstances which are transmitted and received. Not all information is knowledge. Rather, information represents the bits and pieces out of which knowledge is forged.

Information is obtained primarily through communication, research, and instruction. It is obtained from a process of trial and error according to established, or extensions of established, experimental or theoretical methodologies--each such set of methodologies representing the hallmark of some small subdiscipline of science. Therefore, new information is found within a disciplinary context.

The individual who finds this information may be part of an organization which has a particular mission (all organizations, be they universities, laboratories, or corporations, have missions), but insofar as he is finding new information, he is doing so in a disciplinary context. The implication of this statement is that the primary documentation of the information, whether it be in the form of a report, journal article, or conference talk, belongs properly to the discipline encompassing the subarea in which the work is done. This poses a costraint on the individual worker to present his information in the appropriate disciplinary channel which processes such information.

The determination of which information constitutes knowledge is obtained through scholarship. The bits of information from particular and from neighboring subdisciplines are analyzed and synthesized until the scholars are convince of certain principles; they then attempt to convince the other workers in the subdiscipline involved until a consensus is obtained. This consensus is the basis of learning. The principles, facts, and truths that result from the consensus, the studies, and the investigations are called knowledge. (3)

The information itself is essentially private in nature, often couched in the arcane jargon of the initiates in the subdisciplines. The principal vehicles for communicating new information are the primary research journals of the disciplines. On the other hand, knowledge is public and is in the province of the textbook, monograph, review, or compilation, intended for the broader audience. (4)

Scholarship involved in determining knowledge is of comparable importance to the research and instruction involved in producing new information. In the humanities where scholarship has a long and honorable tradition, this point need not be belabored; however, in the sciences, where prestige has always gone with research, the point cannot be made strongly enough. It is important not only that more scientists be induced to engage in scholarship, but that information systems be geared to supply such scientists with the wherewithal for doing such work (germane information) and a means for making the products of their work public so as to facilitate the forming of a consensus.

3. Disciplines, Sciences, and Missions

Although information systems can be distinguished by many paramenters such as: hardware, file organization, management, etc., none of these is as critical as the distinctions which can be made on the basis of the producers of the information which is accessed, the users of the ultimate products, and the degree to which knowledge plays a role in the basic structure. In a system dealing with research information, the producers are researchers, and the system is discipline-oriented with respect to the producers. If the system makes no effort to organize the information intellectually except to carry descriptors in the producer's jargon, then its user community must be the same as its producers, and it is also discipline-oriented with respect to its users. It is then simply a discipline-oriented information system.

However, if the system intellectually organizes the information in a superstructure consonant with the knowledge available from the broader discipline, so that its users are potentially anyone in the broader scientific community, then it is science-oriented toward its users, and the system can be characterized as science-oriented. Finally, if the system selects the information which it makes available to its users according to its relevance for certain specific problems or missions, it can be characterized as mission-oriented.

Of the three types of systems, the one of central importance to this discussion is the science-oriented one, precisely because of its reliance on the state of scientific knowledge for its intellectual organization of the information which it processes. It is only because separate items of data, constructs, assumptions, etc., can be tied to a superstructure of publicly accepted scientific knowledge, that they can be communicated across subdisciplinary and even disciplinary lines. Thus the science-oriented information system is the only feasible "switching" center for the interdisciplinary use of research information.

With this in mind, one can now look at the overall information system, which is discipline-oriented with respect to its input, science-oriented with respect to its processing, and mission-oriented with respect to its output. In this last respect the concept of a mission has been extended to include that of doing research or teaching itself. In practice, such an overall system might be made up of individual systems which handle information within one broad, disciplinary context and which are connected to each other by means of appropriate channels, and are connected to systems which serve particular governmental or corporate missions.

In summary, science information is the daily intellectual product of work in the science disciplines, as depicted schematically in Figure 1. Information contributes daily to the human learning about our material world, which is knowledge. Science knowledge can be organized into various sciences, such as physics, chemistry, and biology. Therefore, the science of physics deals with the totality of our learning about physical processes and interactions; whereas the discipline of physics deals with the information contributed daily by active physicists to that learning. Also identified schematically on Figure 1 are the federal, academic, and industrial institutions whose purposes are the missions by means of which the institutions can be organized. The mission-oritented institutions are primarily users of science information and knowledge.

4. National Information System for Physics

Let us consider the present tentative plans for a National Information System for Physics as they are being developed by the American Institute of Physics. The Institute is uniquely qualified to develop the plans, and, eventually, to develop and manage the system because of its strong links to the producers of physics information in the United States.

The American Institute of Physics is a federation of seven scientific societies in physics: The American Physical Society, American Association of Physics Teachers, Optical Society of America, Acoustical Society of America, Society of Rheology, American Crystallographic Society, and American Astronomical Society. Through these societies, the Institute represents some 45,000 individual physicists, substantially all of those in the United States. As a service organization for its member societies, the Institute operates scientific meetings, publishes scientific journals, and generally engages in those activities designed to improve the dissemination of knowledge in physics.

The Institute's publication program is a large one, equal to the combined total in pages published per year of the American Chemical Society and the Institute of Electrical and Electronic Engineers. It publishes, on its own or for its societies, over 25% of the world's literature in physics (3/4 of the total U.S. output). It translates and publishes over half of the Russian output in physics (which adds another 10% of the world's total). It also markets all of the

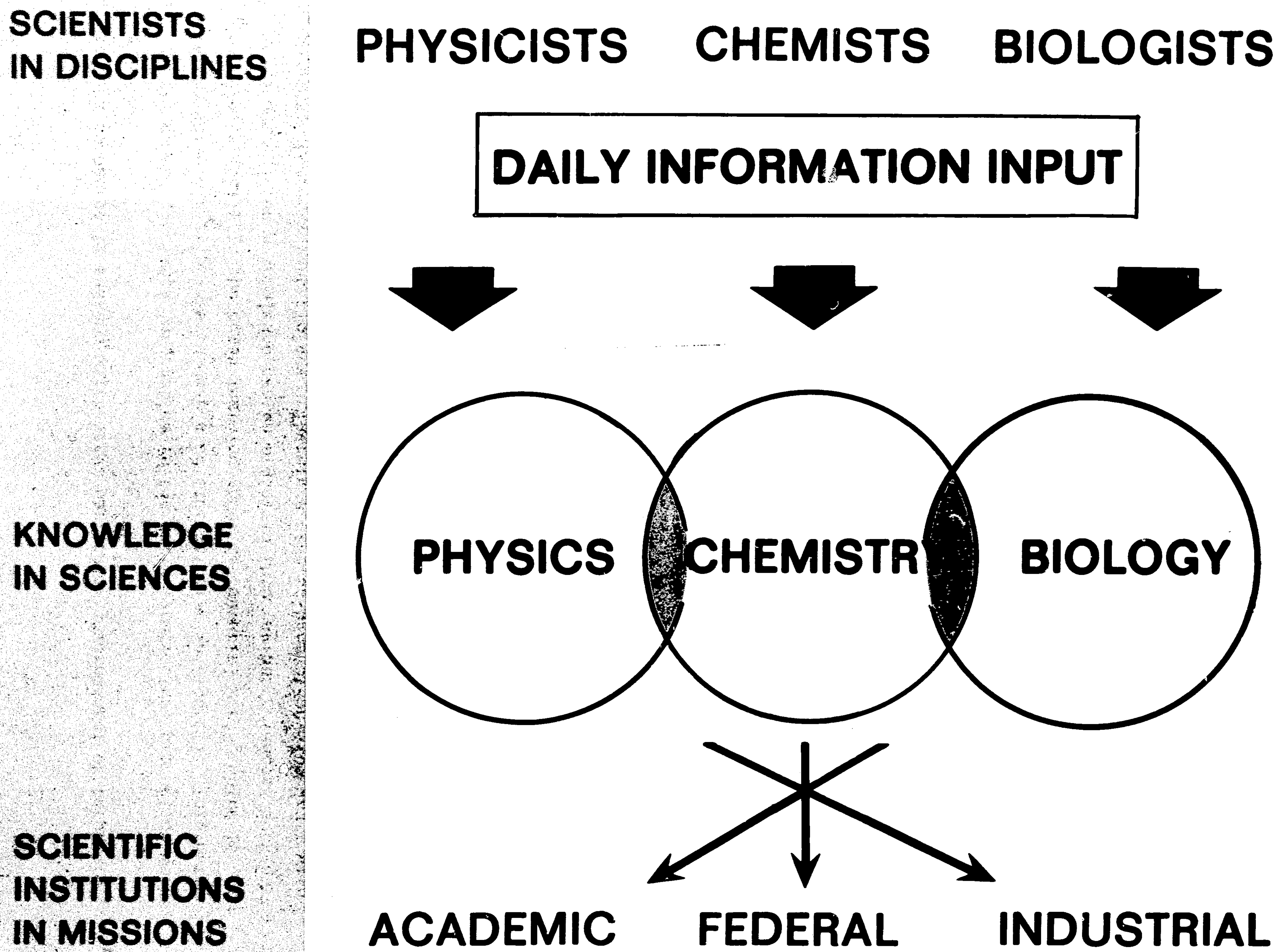


Figure 1. Schematic Representation of the Organization of Scientists, Information, and Knowledge

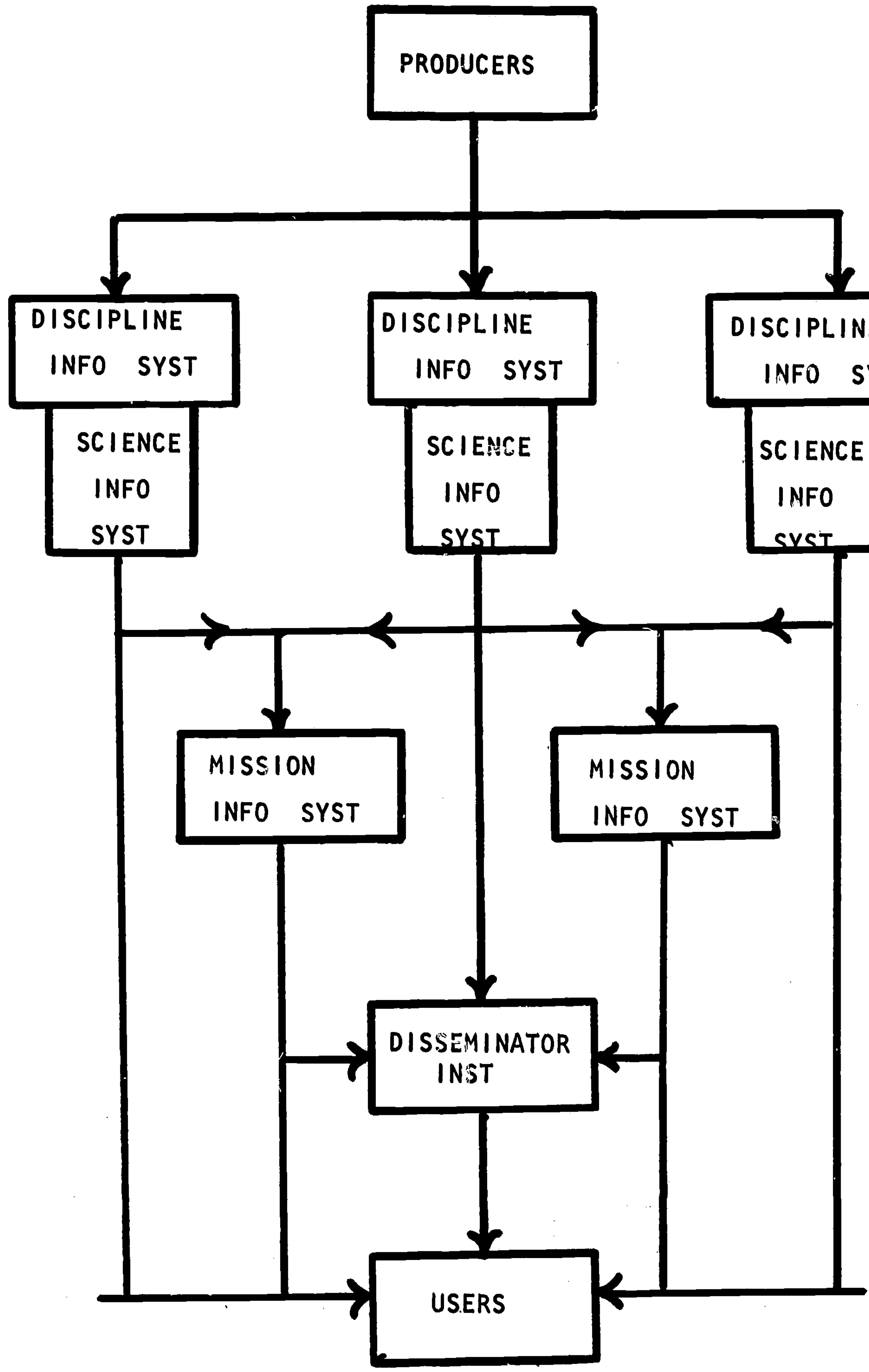
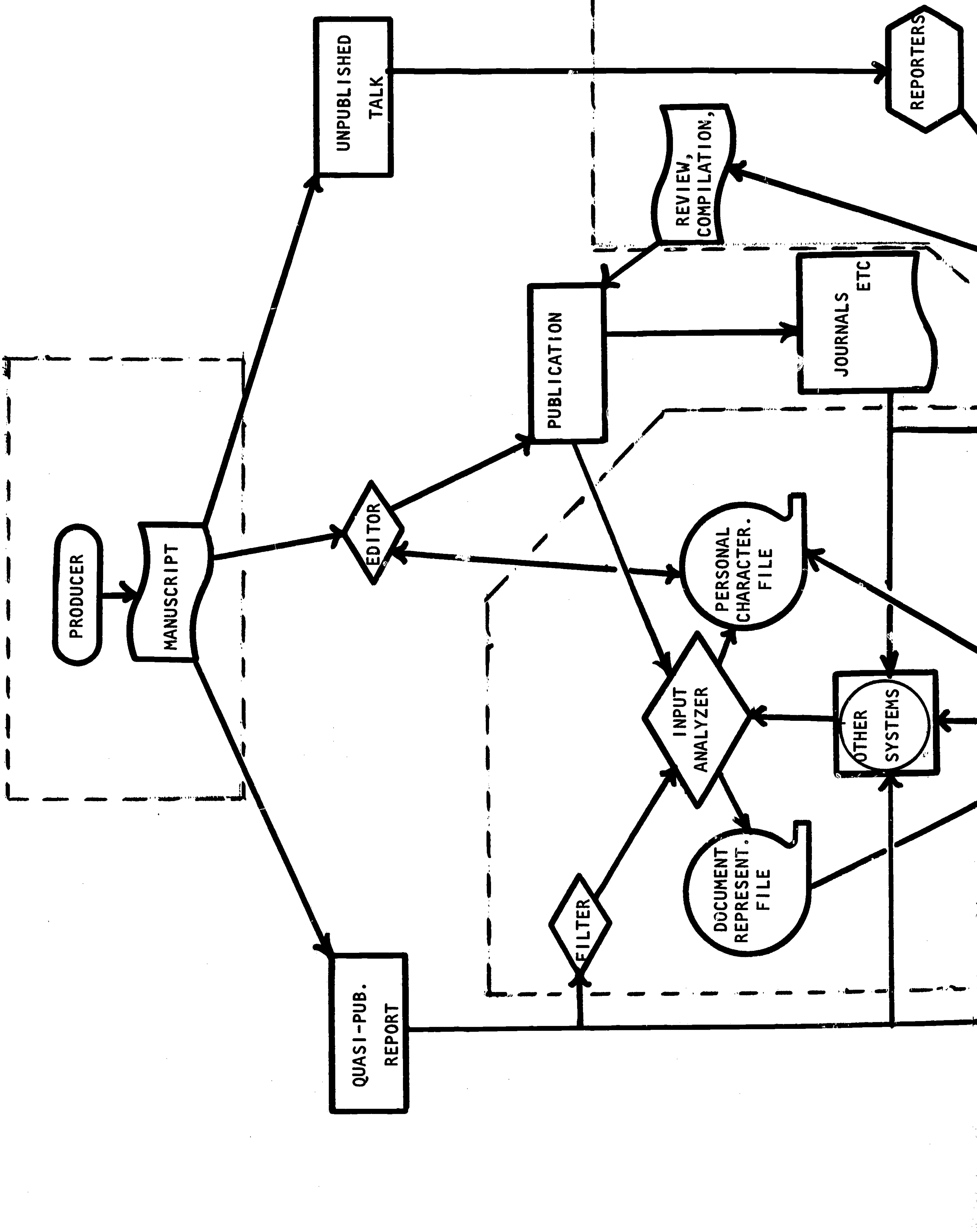


Figure 2. "Horizontal Network"
Interconnected roles of the components


PRODUCER
MANUSCRIPT
UNPUBLISHED TALK
EDITOR
PUBLICATION
QUASI-PUB. REPORT
REVIEW, COMPILATION,
REPORTERS
JOURNALS ETC
PERSONAL CHARACTER. FILE
INPUT ANALYZER
OTHER SYSTEMS
DOCUMENT REPRESENT. FILE
FILTER

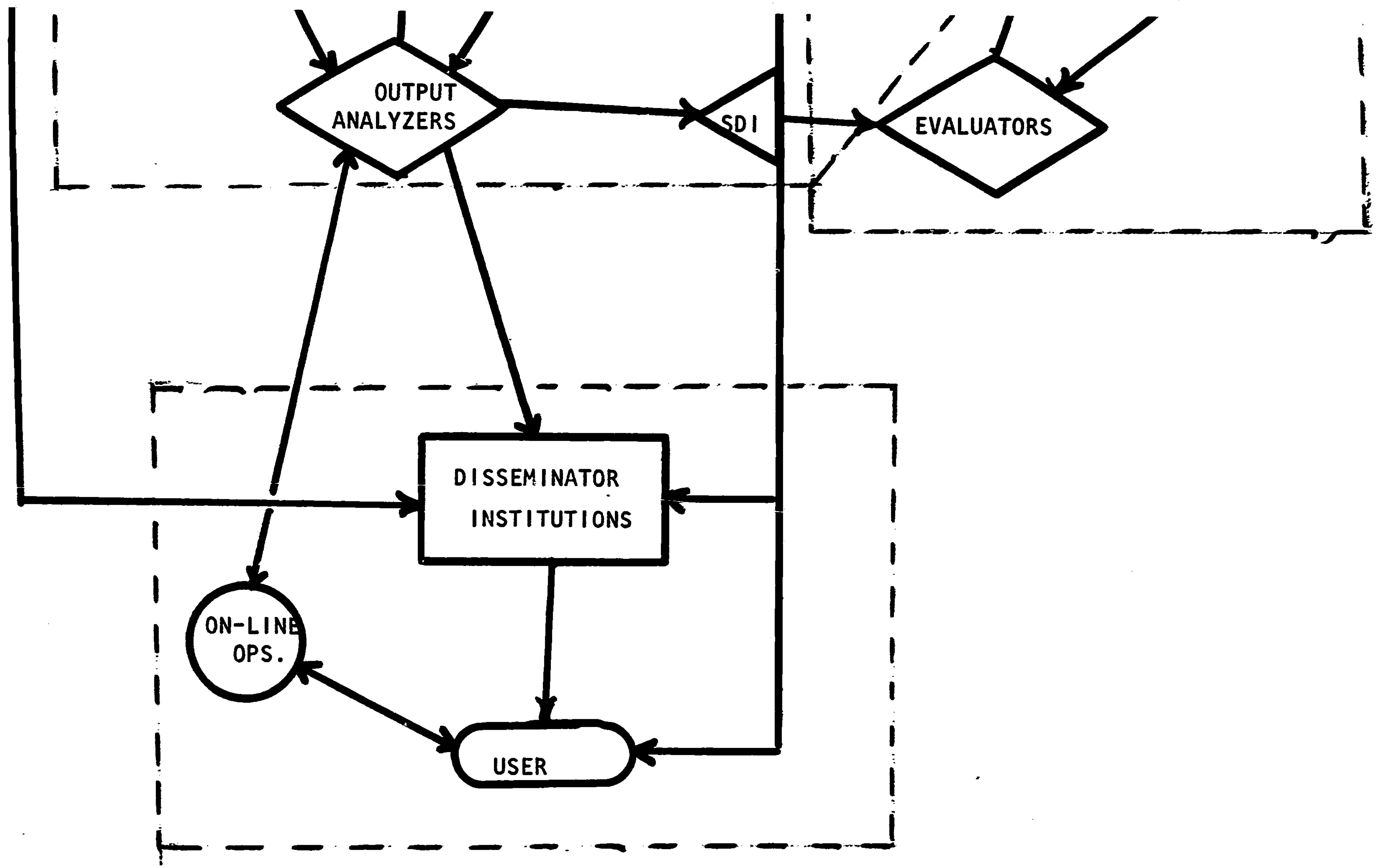


Figure 3. National Information System for Physics (NISP)

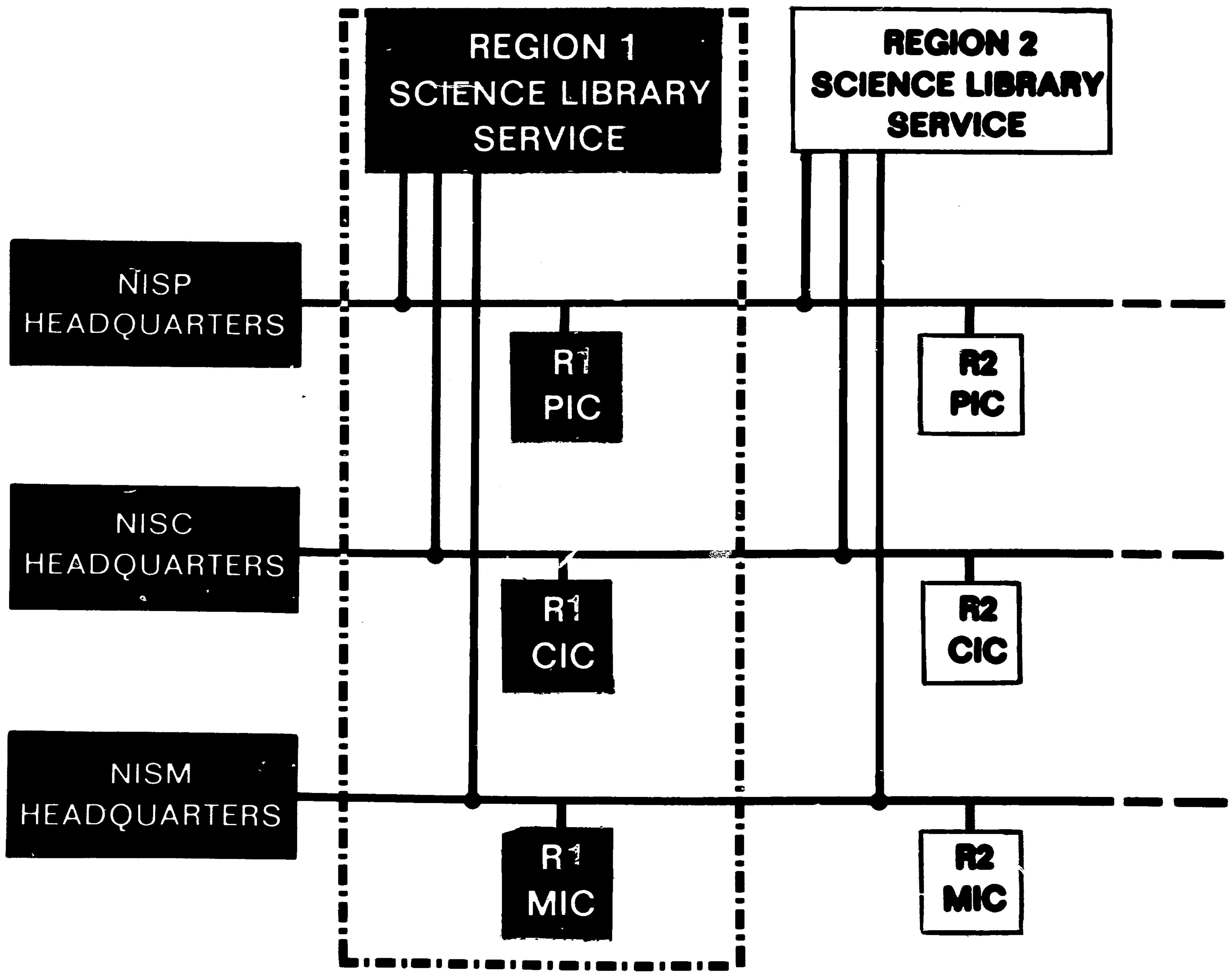


Figure 4. Relation of National Information System for Physics, Chemistry, and Mathematics (NISP, NISC, NISM) Headquarters with regional information centers in these disciplines. (PIC, CIC, MIC).

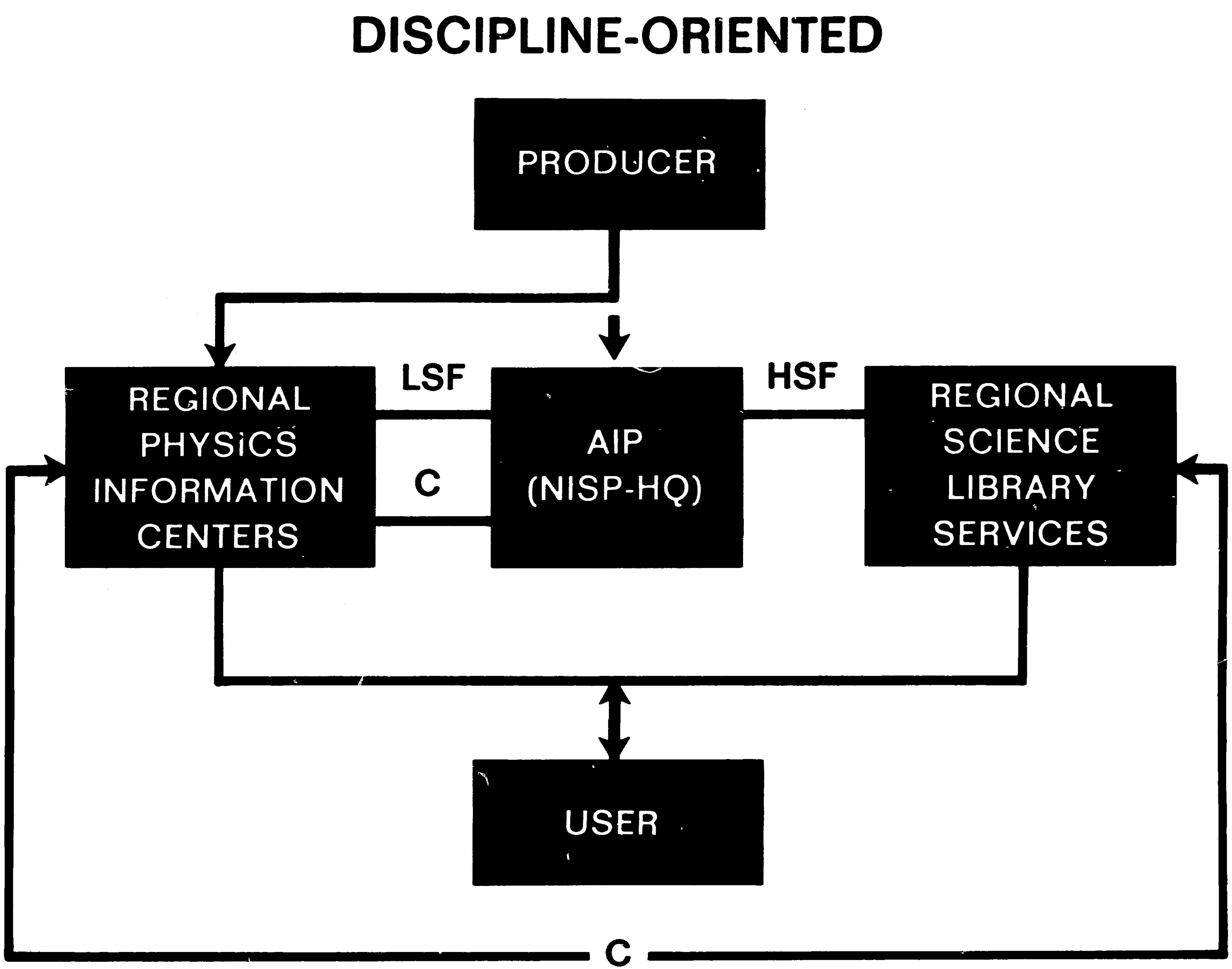


Figure 5. Complements of National Information System for Physics. (computer connections are shown by "C" and low speed and high-speed facimile links by LSF and HSF.)

journals of the British Institute of Physics and Physical Society (about 1/4 of the total British output or another 3% of the world's total). Thus the Institute markets about 40% of the world's physics literature in journal form. The publication program represents a very large factor in the disciplinary aspect of the physics information system.

U.S. Physicists produce physics information predominantly in academic institutions. Of the institutions which produce physics information, just under 50% are academic, 15% are governmental laboratories, and the remaining 35% are industrial. However, academic institutions account for 60% of the production, governmental for 20%, and industrial for just under 20%.

There are 160 undergraduate and graduate departments at universities and 600 undergraduate departments at four-year colleges that supply a physics major. A principal purpose of the NISP might be to provide direct communication links between the principal graduate departments, together with about half as many industrial, federal, and non-profit laboratories in physics, and with the various data and other evaluation centers as well as with the journal editors.

Building from the base of the AIP publication program, the Institute has initiated a substantial effort toward the design of NISP and toward the development of several of its key areas, including: a means for the intellectual organization of physics information according to the state of physics knowledge, a means for inputing to, and maintaining computerized files of document representations for all physics documents, and studies of the various parameters which will represent essential boundary conditions on the system (regarding producers, individual users, and other system users, etc.). The basic outline of the system as presently envisaged is given in Figures 2 and 3.

Figure 2 shows the relative roles of the various types (or aspects) of information systems in channeling the flow of information between producer and user and between each other. Note the special role which the science-oriented system (or aspect) has as the communication link between parallel channels. This aspect emphasizes the lateral connections between disciplines and might be termed the "horizontal" aspect for any one of the disciplines involved.

Figure 3 diagrams in considerable detail the component units of the physics system that is oriented both towards the discipline and the science of physics. The producer and user sub-units are drawn schematically at the top and bottom respectively. The internal or quasi-published report channel is at the left and the unpublished or oral channel is at the right. The two blocks in the center represent the published channel and the analysis operation which are coupled both at input and at output. The analysis operation is also coupled to other systems as indicated earlier on Figure 2. The block on the right bears special notice; this is the evaluation subsystem wherein the primary information is analyzed, evaluated, and creatively condensed to form critical reviews, evaluated compilations, etc.; the essential steps in scholarship from which knowledge arises. In the bottom block representing user activities, there is a small loop showing on-line use.

5. Network for Physics Information

Up to now we have been concerned with the functions and orientations of individuals, organizations, and systems involved with physics information and knowledge. However, to understand the network characteristics, we must also discuss the groupings among and communication links between these individuals, organizations, and systems. In order to be more concrete, let us consider the case of universitites as organizations of scientists and which, themselves, may be organized in regional groupings for information exchange and utilization of common facilities.

University curricula and departments are organized according to disciplines. Thus it is natural for the science departments on university campuses to serve as key elements in a science-information network. We might expect such departments to function as regional science-information centers, involved in the acquisition and dissemination of that information pertinent to its discipline and to its mission of instruction in that discipline. Here we must distinguish between the role of the national information system as wholesaler and of retailer of information. We envisage a situation in which certain products of the system, such as primary journals or sections of primary journals devoted to a specific discipline, current awareness journals, and bibliographies for specialized use, would be retailed directly to the individual user. However, we recognize that such things as broader based journals, abstract journals, and direct computer access to the information store, would be wholesaled to groupings of users such as the libraries of science-department information centers. In most cases we would expect that such libraries would contain relatively recent material of rather narrow interest. Material of a more archival nature and of more interdisciplinary interest would presumably be housed in the main university library, which we would expect to be linked not only to the various science-discipline networks but also broader information and library networks. A schematic rendition of these relationships is given in Figure 4.

In the case of physics departments as local or even regional information centers, we estimate that the relatively recent material would be the current literature in physics produced during the preceding ten years as well as a limited amount of older "classic" material. The updating of this store may involve daily input from the National Information System for Physics. This input would also include print-outs of group-profile material of interest to the departments major activities. We could imagine situations in which the department would also input to the store or at least to a restricted, non-public, part. This would be the case when original manuscripts and referee reports could be transmitted to the editorial operations of the journals by means of the system, where the network would act as the communication link between author, editor, and reviewer. At some remote period of time, publication might be effected through the transfer of material from the private to the public file. For information not of such currency and for information not directly in the main stream of the discipline and science of physics, access would be supplied through the main university library. Clearly these concepts are extendable to other types of institutions than universities, both industrial and governmental, and even to special regional centers established for the purpose.

A schematic representation of the interconnections among the various national information systems of physics, chemistry, etc. and with the regional science-information centers is given in Figure 4. The interconnections which are currently through postal and telephone links would ultimately be expected to be communication channels for facimile transmission and for computer connection to the various files involved.

The Network for Physics Information would have three key sets of institutions that facilitate the flow of information from the producer to the user and that are part of the totality of information systems of Figure 4. The three sets of institutions are schematically represented in Figure 5 as: 1. AIP which would be the headquarters of the network (NISP-HQ); 2. the regional physics information centers which would be located principally at the 160 graduate physics departments of the country; and 3. the regional science library services which would be principally the main libraries on the campus at which are located the various graduate departments.

Figure 5 shows the coupling between the various elements of a National Information System for physics. Because of the distribution of tasks among these elements, their coupling must be relatively tight. This coupling could be provided by facsimile transmission (low speed-LS for high speed-HSF) and connections to the AIP computer stores (c). The coupling would be essential to improve the speed and quality of the editing and refereeing of manuscripts, of writing review articles, of assembling and evaluating data compilations, and of consultation of document and membership files.

6. Present Progress on NISP

The AIP has undertaken the work of defining the characteristics of NISP, its relation to the networks of systems we have discussed, and the role to be played by the AIP itself. The work is projected to be complete by January 1970, and to date many prerequisites have been and are being examined. Most emphasis is being placed on developing a computer store that will contain on file all of the world's primary research literature in the form of document titles, authors, institutions, abstracts, indexings, and citations. The development and maintenance of this store requires a classification scheme suited to physics information that will permit the retrieval of information from the store. Additional AIP tasks are devoted to identifying systematically the producers and users of physics information as well as the institution involved.

Even when the work on prerequisites to a definition of an NISP has been completed and a concept of NISP has been developed, the program will have to be initiated with an interim plan in the event that other science information systems do not develop as expected by AIP. The interim plan must demonstrate how physics information flow can be improved irrespective of other information developments in other science communities.

A part of the plan to be proposed by AIP for NISP would probably include the location of computer consoles and low-speed facsimile transmitters at several of the graduate physics departments and other major physics producing institutions. Standards would be suggested for the primary literature holdings to be located at each of several regional physics information centers. Availability of hard-copy reproductions of the world's primary literature would be facilitated. Proposals from regional science library sources for high-speed facsimile reproduction and computer connection to various NISP files would be solicited and funding plans would be developed by AIP with the regional services.

7. Assumption on Future Developments and Implications to Other Networks

The work on NISP has demonstrated the need for the cooperative developments by many institutions of various phases of discipline-oriented and mission-oriented science information systems in the United States. The developments must be evolutionary and must not be dictated from the limited perspective of any one institution, system, or network.

We expect by analogy to the work on NISP that other systems--whether they be mission-oriented or discipline-oriented--will have regional centers, a core or headquarters organization, and a coupling mechanism to other systems. The precise methods by which the institutions and individuals would be coupled in, for example, to mission-oriented systems is not definable today by persons working on NISP. Indeed, persons involved in those systems must assume their own responsibilities, describe the results of their conclusions, and encourage the appropriate improvements to be made by the planners of the discipline oriented systems. The end result should be a logical and effective network of science information in which all of the component systems are providing and receiving their desired contributions.

References

1. H. William Koch, "A National Information System for Physics", PHYSICS TODAY, 21(4) 41 (April 1968).
2. Franz L. Alt and Arthur Herschman, "Plans for a National Physics Information System", AIP-ID 68-6 (March 1968).
3. John M. Ziman, Public Knowledge: The Social Dimension of Science (Cambridge University Press, 1968).
4. Conyers Herring, "Distill or Drown: The Need for Reviews", PHYSICS TODAY, 21(9) 27 (September 1968).