

order must be checked on receipt for availability and correctness of the order number and price, checks must be processed, invoices prepared, and later there must be follow-up billings on orders received without payment. These costs are in addition to the costs involved in preparing the master copy of the manuscript and in getting the summaries prepared and published in the beginning. Journal space itself is no small item of cost in the I&EC monthly budget.

As an experiment, the Research Results Service approach to a rapid, informal literature service provides a useful service for a limited number of users. Before we can estimate its place as a permanent feature of literature

distribution, we need to know more about the value to users of seeing papers in advance of publication.

We do know that about 70% of the orders are placed by libraries or information departments of companies. Also, we know that in the brief time that RRS has operated we have built up a clientele which makes regular use of the service. We are also well aware that the price paid by users of the service is not covering the costs involved. All of these matters are under study as part of the evaluation program of this experiment.

In many ways this paper is a tribute to the late Will Shearon, who as editor of I&EC shared so greatly in the development of the RRS concept.

Information Centers, Clearinghouses, and Referral Centers Which Offer Chemical Data*

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Because there is so much viable technical information in the world today, thoroughly intermixed with superseded data, most of us spend at least half of our time looking for information, or seeking it for other scientists, before they or we can apply it in our work or can proceed to develop new studies and data.

Dr. Morris Rubinoff of the University of Pennsylvania has remarked that these pressing needs of research workers in specialized subject fields for current information have frequently resulted in the establishment of *ad hoc* information systems which do not satisfy the need and thus remain unused.

The ex- and im-plosion of such centers is a separate study (1, 2). Here, however, I shall describe the nature of several useful clearinghouses as well as some novelties. While the functions and advantages of referral centers are, for accuracy, best discussed by representatives of the agency involved, it is of some value to give fresh publicity to the clearinghouses in this manner. It is also helpful at times to have user reactions.

As both Scott Adams and Herman Skolnik have pointed out, the root of current awareness problems resides in the condition whereby mission-oriented scientists must use discipline-oriented information services for their informational needs. The existing information centers and clearinghouses are of both types; but the majority of them are small, and specifically mission-oriented.

A clearinghouse, in the words of Senator Humphrey (3), "implies cooperative arrangements between a wide variety of sources both as to input and output." This typifies all the major governmental centers.

The five major governmental centers are surely familiar to all. At least four of them were discussed in detail before the Division of Chemical Literature at the 142nd National Meeting of the American Chemical Society in 1962. Probably the number of major centers will soon be ten.

This expansion is in part inevitable and in part perhaps a consequence of Weinberg's prodding. He has suggested that the ignored half of the scientific information crisis is how to transfer the contents of the many documents to the user's mind. He then urged (4) expansion of the present system of government-supported specialized information centers.

SPECIFIC CENTERS AND CLEARINGHOUSES

It is now timely to look at information on some specific centers and clearinghouses.

Basic Sources of Information. The National Referral Center for Science and Technology (5) at the Library of Congress Annex (John F. Stearns, Director) should be consulted for quick orientation, or when one is stumped. It will suggest likely places to get the information sought, on the basis of an inventory it has drawn up of sources of information. Its objective is to "provide comprehensive coordinated access to the nation's resources of science and technology information."

The basic reference in this field is NRCST's "Directory of Information Resources in the United States (Physical Sciences, Biological Sciences, Engineering)," U. S. Government Printing Office, Washington, D. C. (\$2.25, L.C. Card 64-62809). This lists, alphabetically, some 1100 information resources in the United States. It does not

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draw a distinction between libraries and other information centers. Because many libraries have special collections not widely heralded, however, this practice may be justified. Most of the industrial libraries listed therein restrict services to their own personnel, but will in some cases honor interlibrary loan requests.

The Directory is reasonably well indexed by subject. On glancing at the entries, however, one notices few or no clues to cooperative information exchange enterprises such as have been instituted in recent years, particularly in the fields of genetics and biochemistry. Allison has prepared another briefer reference listing (6) of some commercial services, exemplified by the *ASM Information Searching Service* in Metals Park, Ohio, and the *American Science Information Institute* in Detroit.

Other reference tools, treating on government agencies only, include the National Science Foundation's publication "*Federal Organization for Scientific Activities*," U. S. Government Printing Office, Washington, D. C., 1962. This book presents clues to each agency's organization, purpose, subject fields, dissemination methods, special services, and other aspects of respective information programs. A separate NSF series of brochures complements that publication by treating individually the policies and practices of Federal agencies which collect and disseminate data to the scientific community. Number 26 in this series, for example, reports in 17 pages on the scientific information activities of the Library of Congress and contains an annotated bibliography of the Library's relevant recent publications ("Scientific Information Activities of Federal Agencies," Library of Congress, NSF Publication 64-3, 15c).

The *Directory of Special Libraries and Information Centers* (A. T. Kruzas, Ed.), Gales Research Co., Detroit, Mich., 1963, \$25.00, has buried various information centers within a massive volume describing a multitude of specialized libraries of the United States. The compilation does possess a serviceable index if broad subject categories will do:

agricultural chemicals	food chemistry
arthritis	polymer chemistry
bacteriology	textile chemistry
biochemistry	documentation
chemicals	electrochemistry
chemistry	petrochemicals
chemists	science information

Major Government Clearinghouses and Centers. In addition to the National Referral Center for Science and Technology, already discussed, there are three major government clearinghouses.

The *Science Information Exchange* (Dr. Monroe E. Freeman, Director), located at the Smithsonian Institution, is a center which correlates information on the current research projects that are supported by grants from government agencies or private foundations. The information furnished by the SIE is often a great help (a) in determining whether to enter upon a proposed project; (b) in finding a scientist with specialized knowledge who can advise, act as a consultant, etc.; or (c) in learning where else similar studies are being pursued. This agency can provide to the scientific community, from its well-indexed, computerized files, information

concerning any combinations of individual, location, supporting agency, subject matter (8,000 categories), level of effort, and whether the project is continuing, for the work of approximately 100,000 scientists on 50,000 active projects. It deals only with research planned or in progress, and its information is for guidance, not for publication. It is management oriented.

The *Defense Documentation Center (DDC) for Scientific and Technical Information* has been well described by Vann (7). It has all the DOD's science and technical documents, in whatever category indexed, and distributes them. It maintains a clearinghouse index on current research and evaluative programs within the Department, and acts as a centralized directory to provide referral service on its sponsored activities. Among the subject areas included in the DDC's "Technical Abstract Bulletin" (TAB) are: chemical warfare equipment and materials, chemistry, fuels and combustion, nuclear chemistry, photography and other reproduction processes, and propulsion systems. There is the further advantage that the DDC has established numerous regional sub-centers for information analysis at which many of its nonsecret documents are available for consultation by qualified scientists within these districts.

Beyond this, the Defense Department has announced (8) the creation of 22 specialized information centers. Several of them are already going enterprises, such as those for Human Engineering and for Entomology Information. These centers have responsibility for gathering the world's information in their given limited field; analyzing, evaluating, and organizing it; and then providing portions to users on demand.

The DOD does not spell out who its customers may be. Indeed, in its release it did not specify which of the 22 special centers would be open to the public. Although most of them operate on a "need to know" basis, and serve only representatives of government agencies and their contractors, their unclassified reports are available through the Clearinghouse for Federal Scientific and Technical Information. For other material one proceeds through channels. For example, the *Chemical Propulsion* agency does not serve the public, but the *Military Entomology Center* does.

The *Clearinghouse for Federal Scientific and Technical Information, Technical Documentation Center, Department of Commerce* (Bernard M. Fry, Director) is primarily a clearinghouse for all the unclassified government technical reports and translations generated by government agencies that do not contain proprietary information. Comprehensive catalogs and indexes are available. The Center is linked to the Smithsonian's Science Information Exchange and the Library of Congress's National Referral Center as the central core of information routing and service. As such, plans are being developed to provide current awareness information at the Clearinghouse on who is doing what research in what location and with what Federal funds (information that the Science Information Exchange normally handles and disseminates). On request for explicit scientific and engineering information this Clearinghouse will make referrals to appropriate information centers elsewhere (the objective of the Library of Congress National Referral Center). Presumably, this considered arrangement is intended to

provide the solution to the old query, "Why can't I get an answer to my question by consulting just one federal agency instead of having to put a succession of repeated inquiries to all of Washington 25 and environs?" A fourth function of this clearinghouse will be to prepare literature searches (for a fee) on the open literature, to which may be added such "classified" literature as the requestor is entitled to see.

Some Other Centers and Clearinghouses. Within the province of chemistry and the chemical sciences is the *Chemical Propellant Information Agency* of the Johns Hopkins Applied Physics Laboratories. Several of the Materials Sciences centers also bear on chemical information, e.g., (a) *Ceramics and Graphite Technical Evaluation Section*, R. T. Division, Wright-Patterson Air Force Base; (b) *Defense Metals Information Center*, Battelle Institute; (c) *Radiation Effects Information Center*, Battelle Institute; and (d) *Plastics Technical Evaluation Center*, Picatinny Arsenal.

The *Military Entomology Information Service* located at 7 Forest Glen in the Walter Reed Complex in Washington, D. C. (senior officer: Captain E. De Coursey, Medical Service Corps) is operated on a tri-service basis for the Department of Defense. In press releases, the AIBS has been mentioned as operating this center. In fact, however, the AIBS is offering technical assistance, while the DOD actually operates it. It uses a Termatrix system. A group of Ph.D. entomologists reads the original journals to prepare, article by article, the data for storage and retrieval. The data include title of article and author; a standard thesaurus has been developed, involving 1500 descriptors. The Service is open to the public.

The data stored by this service does include chemical information, inasmuch as several of the descriptors used apply to either broad classes or specific types of insecticides, e.g., organic phosphates, amino acids, larvicides, DDT, chlorinated hydrocarbons. Physical state is also considered, e.g., aerosols, diluents, dust.

It is possible to ask the file about "insecticides used for destroying *anopheles* in the Sudan, and resulting effect on subsequent incidence of yellow fever." This is a practical working file, but, while logical, it is not comprehensive from the scientific viewpoint.

Meanwhile, in a world cluttered with journals that are all too frequently cited by using terse, undecipherable, and unidentifiable abbreviations (9), or are otherwise inadequately described, there has appeared the *Biological Serial Record Center* (10) of the AIBS (Miss Mildred Benton, Chief, 2000 P. St., N. W., Washington 6, D. C.). This Center forms a part of the AIBS's Biological Science Communication Project. It collects descriptive records, using edge-notched cards, on serial publications of the world related to the life sciences. Its prime function is to enable a scientist to locate a copy of an obscure biological publication he seeks. The Center furnishes titles of newly published journals to the AIBS Bulletin as a more direct channel to the user than "New Serial Titles" would be. Eventually, the Center staff will have a sufficient volume of material to permit analysis by subject content, place of origin, etc. In its files today are some 45,000 titles on which bibliographic abstracts have been compiled. Its first publication has been "Aquatic Biology Serials." The Center's working file includes entries drawn

from five cooperating national libraries in the Washington area (Library of Congress, National Agricultural Library, National Library of Medicine, and libraries of the Department of Interior and the Smithsonian Institution). It may, in time, publish a listing like that of the Midwest Information Center (11).

A survey made by the *Japan Information Center of Science and Technology* during 1963 indicates that the number of primary scientific periodicals (UDC classes 5-7 and UDC 77) published in Japan is nearly 2500. The number of secondary (i.e., abstracting and indexing) periodicals has increased greatly during recent years, and there are now over 50 periodicals publishing abstracts exclusively or mainly of Japanese primary literature. A few of these are in English. There are also, of course, abstracting services primarily covering world literature. As part of its future development program, the JICST is planning to extend its abstracting coverage of Japanese periodicals to 100%.

The *Nuclear Safety Information Center* (NSIC, ORNL, P.O. Box Y, Oak Ridge, Tenn.) has been established at the Oak Ridge National Laboratory to assist in coordinating the U. S. national effort in nuclear safety research and development. The services of the Center will include the compilation of bibliographies and the interpretation and evaluation of information or the preparation of reviews on specific subjects in 19 categories. Ninety per cent of this material is unclassified.

Since 1960, when it began to function, the *International Occupational Safety and Health Information Center* (% International Labor Office, Geneva) has sent to its subscribers abstracts, on standard format cards, that provide up-to-date information on the various aspects of accident prevention and occupational health. These abstracts are also issued in bulletin form, grouped under broad subject headings; Vol. 1, No. 8 for 1963, for example, includes about 210 abstracts. Translated material is indicated appropriately.

The *Pacific Scientific Information Center* (B.P. Bishop Museum, Honolulu) is designed to serve the research needs of scientists working in the Pacific. Data, maps, photographs, and other source material accumulated there are being organized for use.

The *Materials Research Center* at Northwestern University (Evanston, Ill.; Malcolm Dole, Director) has operated since 1960 under a contract with the Advanced Research Projects Agency of the Department of Defense. Its purpose is to carry out fundamental research on the solid state (and, incidentally, to encourage interdisciplinary work in the field). Results of its research are published in scientific journals, and the Center issues annual reports. It is open to visitors for consultation on its data. Typical studies have dealt with spinodal decomposition, tungsten carbide ductility, the specific heat of wool, and diene formation in irradiated polyethylene.

The *National Clearinghouse for Poison Control Centers, Poison Control Branch* (U. S. Public Health Service, Washington 25, D. C.; Henry L. Verhulst, Chief) dispenses information dealing primarily with the toxicity and possible treatment of poisoning by the various preparations now on the U. S. market. Its regional branches are open for consultation 24 hours a day to help in emergencies. The agency publishes a bimonthly bulletin. That for July-

August 1964 takes up some further aspects of the glue-sniffing problem.

Centers under Development. The *Houston Technical Information Center* is now engaged in Phase 2 of its program: drawing plans for financial backing. When operative, its activity in machine retrieval will have a strong slant toward petroleum chemistry. Its list of periodical holdings in 70+ cooperating libraries is being revised and updated for publication in 1965.

The *Pesticides Information Center*, which has been established at the National Agricultural Library (Washington, D. C. 20250), will issue a biweekly publication, computer-produced and keyword-in-context indexed.

DISCUSSION

Information centers and clearinghouses are currently receiving considerable attention as regards functions and operations. For example, Dr. Frederick Walker has predicted that, just as scientific journals publishing full papers will disappear, leaving papers to be disseminated as separates, abstract publications may well be replaced by information-center services. The latter would presumably be mechanized or computerized to yield rapid answers to queries submitted. At that stage the chemist would subscribe to a service in order to be provided with the working literature he may need. It would certainly test the ingenuity of chemists, then, to convey to such centers clear instructions on the type of material that should be sent to them to keep them informed. The art of browsing would likely bite the dust, also.

Jahoda (13) has described some of the functions that an information center in industry might be expected to provide in terms of SLA standards and both the Weil and the Bedsole surveys of current practices within 430 organizations. Better than 90% of these units handle reference questions of the "information" type, but only about 35% prepare abstract cards for a subject file as an aid in the process, whether these files are hand-sorted or mechanized. Jahoda concludes that the good information-science man will need to know his centers and that the creation of these many new special sources will be as great a cause for change in reference work as the computer has been to the technology of retrieval.

The larger and more complex a collection of data, books, reports, or what-choose-you becomes, the more need for intramural organization by sub-units, with concomitant specialized staff in greater numbers in charge of them. Only a person who understands the nature of the inquiry can be of real help to the inquiring chemist. These specialized information centers within major agencies and those created anew by trade or scientific bodies understand the premise and hope to have that virtue.

Hubert (14) makes the point that "acceptance of any conclusion, valid or otherwise, by an individual who is not familiar with the observational data on which it is

based and the logic by which it is derived, is a negation of science and a return to authoritarianism." I hope he did not include the seeking of data from referral centers in this condemnation. At some stage cooperation between scientists becomes necessary. A chemist is still free to question data provided from any source and to test or verify it.

Shilling (15) has posed a list of practical questions to be considered in planning a mission-oriented information center as well as its BAIT-ed services.

SUMMARY

Current information activity both within and outside governmental agencies has created congeries of clearing-houses and referral centers. These services usually do not alert chemists to new developments, but they do provide them, on direct inquiry, with: (1) pertinent data, or (2) referral to a fresh prime source of information at another location. Approximately 100 such centers now exist or are in process of formation. Some prime examples have been discussed.

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