Toxicology Information—Retrieval and Dissemination at the Toxicology Information Response Center*

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The search procedures and techniques employed by the staff of a specialized information response center in relation to the materials and resources available to them are described. The computerized information systems and traditional resources used in the retrieval of toxicological information as well as the types of search requests received are delineated. The origination and classification of the search requests are evaluated.

In recent years, there has been a growing interest in toxicity data on the substances to which humans, animals, and plants are exposed. Both increasing interest in and need for these data have been expressed by governmental, industrial, and academic organizations.[1] In response to this need for toxicity information, the Toxicology Information Response Center (TIRC) was established at the Oak Ridge National Laboratory (ORNL) in the fall of 1971 (Figure 1). TIRC is sponsored by the National Library of Medicine (NLM) within the framework of the Toxicology Information Program (TIP). This program resulted from a presidential study on "Handling of Toxicological Information."[2] The purpose of the Center is to build toxicology data bases; to collect and disseminate toxicity information in the form of bibliographies, reviews, and state-of-the-art reports; and to answer specific search requests from the scientific community.

DESCRIPTION OF TIRC

The TIRC staff presently consists of six information scientists, one of whom is a toxicologist, two are chemists, and three are biologists, and two secretarial staff members.

At ORNL, TIRC is a component center of the Environmental Information System Office (EISO). EISO is a scientific and technical information division which was organized at ORNL in July 1971. It coordinates the functions and activities of environmentally-oriented information units within ORNL. This association affords a unique opportunity for extensive scientific and technical interactions. EISO also assists, initiates, and develops data bases and specialized services as information needs arise.

EISO is composed of topical, mission-oriented environmental information centers, a variety of data base groups, scientific and other special projects, and several specialized retrieval and referral services. Some of the other information centers either comprising this system or coordinated by it are the Toxic Materials Information Center, the Environmental Mutagen Information Center, the Biomedical Studies Group, the Ecological Sciences Information Center, and the Eastern Deciduous Forest Biome Information Center of the International Biological Program.

TIRC is a requester-oriented information center. Before initiating search strategies, the scope of the search is discussed with the requester. This discussion determines the:

(a) Degree to which computer bases and traditionally searched sources will be used
(b) Time period to be covered
(c) Languages of references to be included
(d) Specific sources to be examined
(e) Format of the bibliography

The bibliography may be either annotated, abstracted, keyworded, or limited to simple bibliographic citations chronologically arranged.

TIRC conducts searches on a partial cost recovery system based on search units. A search unit consists of computer searches and traditional source retrieval for the last 5–10 years in a single subject area and the compilation of the results in a bibliography. Multiple search units may be charged when the request consists of several compounds, a large subject area, an extensive time period, or an annotated bibliography.

TIRC publishes bibliographies, which are selected from completed search requests, and state-of-the-art reviews in areas of general interest. After the subject for a state-of-the-art review has been chosen, it is written by a TIRC consultant, who is an expert in that particular scientific field. These documents can be obtained as either microfiche or hard copy through the National Technical Information Service (U. S. Department of Commerce, Springfield, Virginia 22151). Examples of available bibliographies are listed in Figure 2. Examples of state-of-the-art reviews are listed in Figure 3.

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ORNL-DWG 73-8782R

TOXICOLOGY INFORMATION RESPONSE CENTER
HISTORY

1966 - *PSAC PANEL PREPARES REPORT ON "HANDLING OF TOXICOLOGICAL INFORMATION" WITH RECOMMENDATION TO ESTABLISH IN DHEW AN ORGANIZATION FOR BUILDING COMPUTERIZED FILES FOR TOXICOLOGY INFORMATION.

1967 - THE TOXICOLOGY INFORMATION PROGRAM (TIP) WAS ORGANIZED IN THE NATIONAL LIBRARY OF MEDICINE.

1968 - A TOXICOLOGY INFORMATION PROGRAM COMMITTEE (TIPCOM) WAS FORMED BY THE NATIONAL ACADEMY OF SCIENCES AS AN ADVISORY PANEL FOR TIP.

1969 - BECAUSE OF RESTRICTED RESOURCES, TIPCOM ADVISED TIP TO CONCENTRATE ON PESTICIDE TOXICOLOGY AS A FIRST STEP.

1970 - TIP EXPANDS ITS ACTIVITIES TO ENVIRONMENTAL POLLUTANTS, DRUG INTERACTIONS, ETC.

1971 - A TOXICOLOGY INFORMATION RESPONSE CENTER (TIRC) IS FORMED BY TIP AT THE OAK RIDGE NATIONAL LABORATORY.

1972 - TIP INITIATES "TOXLINE", A NATIONAL, ON-LINE, INTERACTIVE TOXICOLOGY INFORMATION RETRIEVAL SYSTEM.

* PRESIDENT'S SCIENCE ADVISORY COMMITTEE

Figure 1. Toxicology information response center history

ORIGINATION AND CLASSIFICATION OF TIRC SEARCH REQUESTS

For the first seven months of 1973, of the 337 search requests completed, the majority (45.1%) dealt with organic chemicals (Figure 4). Since many of these chemicals are employed in various industrial processes, concern over their environmental impact and the hazards of occupational exposure requires in-depth investigation of the literature. The second largest group of search requests consisted of metals, both elemental forms and various compounds, such as oxides and salts. An approximately equal number of searches was received on pesticides and drugs.

An analysis of the searches processed from November 1972 through April 1973, a total of 312 requests (Figure 5), shows that governmental agencies accounted for the majority (33.9%) of these searches. The second largest user population was comprised of research institutes, universities, and hospitals (31.2%). Approximately equal numbers of searches were received from industry and the Oak Ridge National Laboratory.

TIRC BIBLIOGRAPHIES

AUTHOR	TITLE	REPORT NO.	NO. REFS.	PRICE
H. B. Gerstner	Effects of Insecticides on Enzyme Activity	ORNL-TIRC-73-1	457	$8.00
K. C. Miller	Toxicity of Tris(2,3-Dibromopropyl) Phosphate and Tris(2,3-Dichloropropyl) Phosphate	ORNL-TIRC-73-2	18	5.00
K. C. Miller	Toxicity of Zinc Phosphorodithioates	ORNL-TIRC-73-3	19	5.00
H. B. Gerstner	Trace Element Profile on Human Blood	ORNL-TIRC-73-4	117	5.00
H. B. Gerstner	Toxic Effects of Bee and Wasp Venoms	ORNL-TIRC-73-5	173	5.00
H. B. Gerstner	Diseases and Toxicologic Phenomena in Psittacine Birds	ORNL-TIRC-73-6	55	5.00
H. B. Gerstner	Toxicology and Environmental Effects of Polychlorinated Terphenyls	ORNL-TIRC-73-7	32	5.00
H. B. Gerstner	Toxicology of Eugenol	ORNL-TIRC-73-8	55	5.00
H. S. Warren	Toxicity of Potatoes	ORNL-TIRC-73-9	466	7.00
M. G. Gerrard	Toxicity of dl-Mandelic Acid in Animals	ORNL-TIRC-73-10	28	5.00
F. H. Holland	Toxicity and Metabolism of BHT (2,6-Di-tert-Butyl Hydroxytoluene)	ORNL-TIRC-73-11	180	7.00
F. H. Holland	Toxicity and Metabolism of BHA (2 and 3-tert-Butyl-4 Hydroxytoluene)	ORNL-TIRC-73-12	81	5.00
H. S. Warren	Biological Effects of Saccharin	ORNL-TIRC-73-13	119	6.00
K. C. Miller	Toxicity and Adverse Effects of RDX	ORNL-TIRC-73-14	20	5.00
K. C. Miller	Toxicity and Adverse Effects of Trinitrotoluene (TNT)	ORNL-TIRC-73-15	71	5.00
K. C. Miller	Toxicity and Adverse Effects of Ammonium Picrate	ORNL-TIRC-73-16	18	5.00
K. C. Miller	Toxicity, Adverse Effects, and Environmental Control of Ordnance, Explosive Compounds	ORNL-TIRC-73-17	71	5.00
K. C. Miller	Diagnosis, Treatment, and Occurrences of Radionuclide Contamination of Wounds	ORNL-TIRC-73-18	164	5.00
H. B. Gerstner	Toxicity of Palladium, Platinum, and Their Compounds	ORNL-TIRC-73-19	98	6.00

Figure 2. TIRC bibliographies

State-of-the-Art Reviews

PAST

Quinby, G. E.
Polychlorobiphenyls (PCBs) and Related Chlorophenyls: Effects on Health and Environment. I. Bibliography 1881-1971
ORNL-EIS-72-20 (April 1972)

Verbiscar, A. J.
Metabolism of Foreign Compounds: An Annotated Bibliography
ORNL-TIRC 72-VB1 (June 30, 1972)

Autian, J.
Toxicology and Health Threats of Phthalate Esters: Review of the Literature
ORNL-TIRC 72-2 (August 1972)

Environ. Health Persp. No. 4: 3-26 (June 1973)

Verbiscar, A. J.
Metabolism of Foreign Compounds: An Annotated Bibliography
ORNL-TIRC 72-VB2 (September 12, 1972).

Verbiscar, A. J.
Metabolism of Foreign Compounds: An Annotated Bibliography
ORNL-TIRC 72-VB3 (October 1, 1972)

Verbiscar, A. J.
Metabolism of Foreign Compounds: An Annotated Bibliography
ORNL-TIRC 72-VB4 (December 29, 1972/March 1973)

Verbiscar, A. J.
Metabolism of Foreign Compounds: An Annotated Bibliography
ORNL-TIRC 72-VB5 (March 29, 1973/June 1973)

Verbiscar, A. J.
Metabolism of Foreign Compounds: An Annotated Bibliography
ORNL-TIRC 72-VB6 (June 14, 1973)

Svensson, C. T. and Katz, M.
Polynuclear Aromatic Hydrocarbon Compounds in the Aquatic Environment and Their Ecological Impact
Authors to select and publish in a journal (August 1973)

American College of Veterinary Toxicologists (Buck, W. B.)
Proceedings of the Veterinary Toxicology Training and Review Workshop
Held on February 21–26, 1972 at the Iowa State University, Ames, Iowa (August 15, 1973)

PRESENT

Autian, J.
Toxicology Education in the USA – A Review and Assessment

Buck, W. B.
Epidemiology of Lead Poisoning in Animals and Its Relationship to Public Health and the Environment

Kaiser, H. E.
Animal Models for Toxicological Research: An Overview

Michaelson, S. M.
Effects of Exposure to Microwaves – Problems and Perspectives

Newberne, P. M.
Toxic and Carcinogenic Aspects of Mycotoxins

Umberger, E. J.
Products Marketed to Promote Growth in Food-Producing Animals: Steroid and Hormone Products

PROPOSED

Guidotti, T. L.
Toxic Effects of the Inhaled Higher Oxides of Nitrogen

Hodge, H. C.
Neighborhood Fluoride Exposures and Human Health

Lawrence, W. H. and Autian, J.
Toxicity of Acrylic and Substituted Acrylic Monomers and Polymers

Figure 3. State-of-the-art reviews

TIRC TOXICOLOGY INFORMATION RESOURCES

When responding to search requests, the TIRC staff utilizes a combination of computer data bases, traditional abstract and index journals, information collections of other area information centers, and information obtained directly from investigators located at the research facilities in the Oak Ridge area.

The on-line computerized search systems primarily used are the Toxicology Information System on-Line (TOXLINE) and the Medical Literature Analysis and Retrieval System on-Line (MEDLINE). TOXLINE contains six literature data base files consisting of toxicological references with abstracts and/or indexing terms (Figure 6).[3] TOXLINE was designed by the NLM's Toxicology Information Program to make toxicological data available by direct interaction of a computer-based store with a remote terminal. TOXLINE uses a whole-text search system with word-proximity retrieval capability. The five principal files are periodically updated.

The other routinely used computer search system, the MEDLINE, Compfile, and SDILINE system, is also provided by the National Library of Medicine (Figure 7). The MEDLINE and Compfile portions of the system presently include all citations and indexing terms contained in *Cumulative Index Medicus* from January 1970 through the

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GENERAL CATEGORIES OF SEARCHES CONDUCTED BY TIRC
JANUARY 1, 1973 – AUGUST 9, 1973

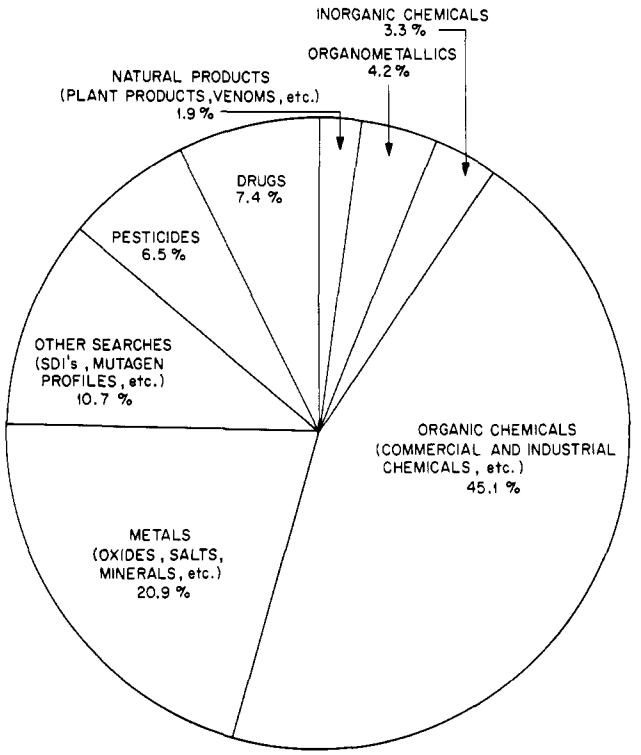

Figure 4. General categories of searches conducted by TIRC January 1, 1973–August 9, 1973

ORNL - DWG 73 - 8778

ORIGIN OF TOXICOLOGY SEARCH REQUESTS PROCESSED BY TIP/TIRC
NOVEMBER 1, 1972 – APRIL 30, 1973

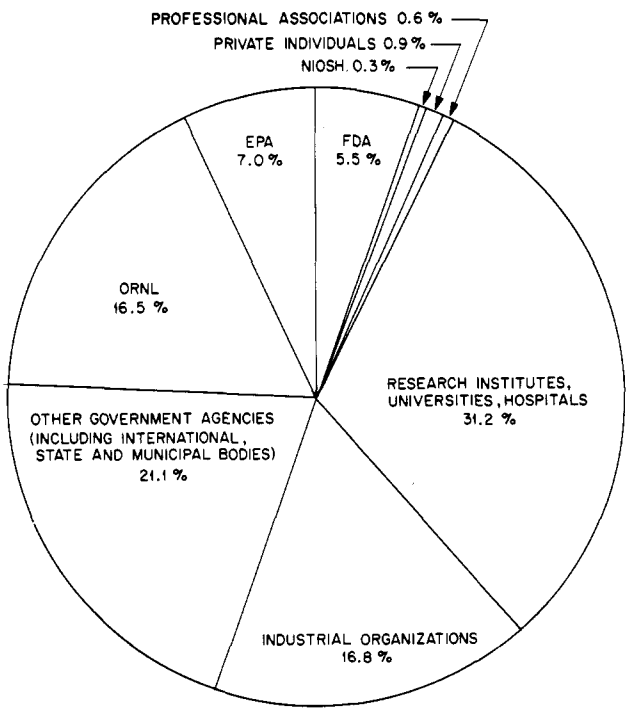

Figure 5. Origin of toxicology search requests processed by TIP/TIRC November 1, 1972–April 30, 1973

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TOXLINE BIBLIOGRAPHIC FILES

TOXICITY BIBLIOGRAPHY (1968 - present)
68,000 citations with MeSH Terms

HEALTH ASPECTS OF PESTICIDES ABSTRACT BULLETIN
(1966 - present)
13,000 abstracts, CAS numbers

CHEMICAL - BIOLOGICAL ACTIVITIES
CAS Tapes (1965 - present)
118,000 abstracts, CAS numbers

HEALTH EFFECTS OF ENVIRONMENTAL POLLUTANTS
(1972 - present)
10,000 abstracts, CAS numbers

INTERNATIONAL PHARMACEUTICAL ABSTRACTS
(1970 - present)
15,000 abstracts

HAYES FILE ON HEALTH EFFECTS OF PESTICIDES
(1930 - 1966)
10,000 citations

Figure 6. Toxline bibliographic files

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INDEX MEDICUS	MEDLARS	MEDLINE AND COMPFILE
1960-	Jan 1964-	Jan 1970-
2400 journals	2400 journals	2873 journals
Priority 1,2,3 journals	Priority 1,2,3 journals	Priority 1,2,3 journals
no Check Tags	Check Tags	Check Tags
no Provisionals	Provisionals	Provisionals
no deleted terms	deleted terms	deleted terms
no geographic terms	geographic terms	geographic terms
cross-references	no cross-references	limited cross-references
main heading/subheading combinations		
personal authors	no author search permitted	author search permitted
anonymous articles grouped	anonymous articles retrieved	anonymous articles retrieved
same citation elements		

Figure 7.

present. The SDILINE provides selective dissemination of information (SDI) service by duplicating the current monthly update of MEDLINE in a separately searchable file. MEDLINE and Compfile now contain approximately 850,000 citations and cover 2873 journals in the medical and biomedical research fields.

The MEDLINE system uses a controlled vocabulary (Medical Subject Headings, MeSH) as search terms. In addition to these terms, certain items routinely indexed from each article, such as "human, animal, male, female, case report," etc. are designated as Check Tags and may also be used as search terms. Author searches are permitted in this system, and limited cross-references are provided.

Other computerized data sources accessible to TIRC include ORNL Data Files, *Biological Abstracts, BioResearch Index, Government Research Announcements,*

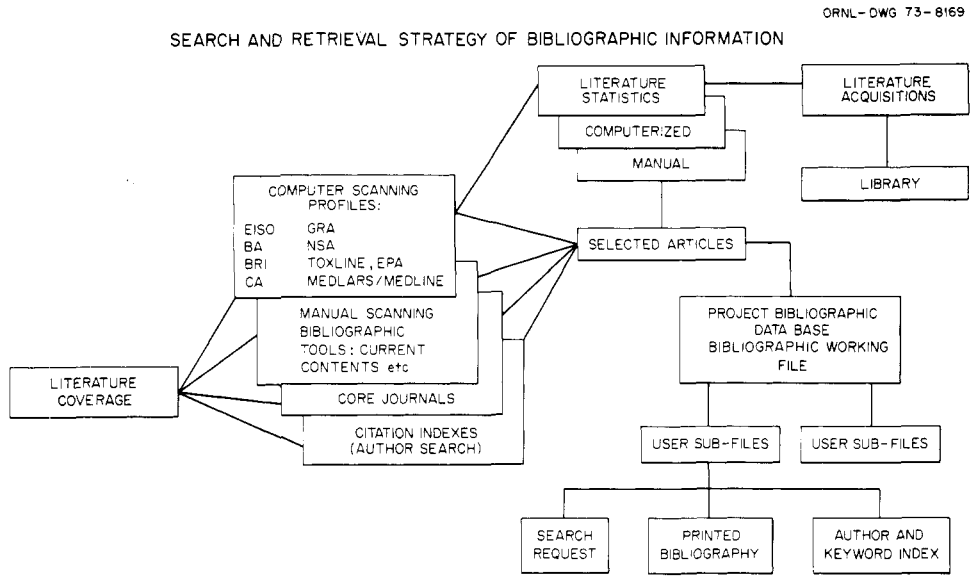

Figure 8. Search and retrieval strategy of bibliographic information

Metal Abstracts, Nuclear Science Abstracts, and *Searchable Physics Information Notices.* To aid in identifying compounds, TIRC can also access the ORNL-modified version of the Chemical Abstracts Service's (CAS) Name-Match System, which provides the preferred Chemical Abstract (CA) index name, synonyms and/or trade names, and the CAS Registry Number.

Since most computerized data bases contain only a few years information, TIRC relies heavily on traditional data sources. The principal abstract or index journals used are *Chemical Abstracts, Biological Abstracts and BioResearch Index,* and *Cumulative Index Medicus.* Other frequently used sources are *Nuclear Science Abstracts, Excerpta Medica,* and primary journals which emphasize toxicological information, such as *Archives of Industrial Health, Food and Cosmetics Toxicology,* and *Archives of Environmental Health.* Other sources used are *Science Citation Index* and "Beilstein's Handbuch der Organischen Chemie." TIRC also maintains an extensive collection of toxicology and pharmacology reference texts and handbooks and builds subject files in areas of current interest. The bibliographies prepared in response to the approximately 1300 previous search requests are also available.

The third large source of information is that obtained from the approximately ten additional area information centers and the ORNL Library System. This system contains 313,000 bound volumes, 346,000 reports, and nearly 600,000 microfiche, and the information is routinely available to TIRC within one day.

Because of its location, TIRC is often able to obtain information directly from ongoing research projects. Through personal contact with the individual investigator, the most recent and authoritative data are immediately available in such fields as mutagenesis, carcinogenesis, radiation effects, environmental pollutants, immunology, cancer therapy, and other areas of interest to TIRC. As a result of such mutual interaction, the interest in TIRC and its products has resulted in seminars presented to scientific groups by the TIRC staff. The facilities which are accessible to TIRC include: Oak Ridge Associated Universities; Oak Ridge Gaseous Diffusion Plant; Union Carbide Defense Plant; the main campus of the University of Tennessee; the University of Tennessee Memorial Research Center; the University of Tennessee-Atomic Energy Commission joint agricultural research project; the Atomic Energy Commission's Technical Information Center; and, of course, the Oak Ridge National Laboratory, particularly its Biology Division.

CATEGORIZATION OF SEARCHES

When retrospectively classified by search strategy, the approximately 1300 completed search requests can be grouped into three categories. The first and largest category consists of requests for all of a specific type of information, such as toxicity, metabolism, or analysis of a simple element, compound, or family of compounds. For these questions, computer searches of the appropriate data bases are initiated, and, while awaiting the results, the computer information is augmented by a traditional search of the most suitable additional sources. Examples of some of these requests are (a) metals, such as cadmium and lead; (b) pesticides, such as carbaryl and parathion; (c) industrial or environmental toxicants, such as asbestos and printing inks; (d) food additives, such as BHA and diethyl pyrocarbonate; (e) drugs, such as Innovar and Ergotrate.

The second category is comprised of searches requesting information about substances that are complex or undefined in composition, such as (a) nephrotoxic effects of volatile citrus oils, or (b) toxicity of wasp venom; those with several search parameters, such as the toxicity of oral, antidiabetic drugs in children; or those requests asking for a general class rather than specific compounds, such as (a) toxicity of plasticizers and flame retardants or (b) toxicity, environmental impact, and waste treatment of ordnance compound manufacturing. In these cases, the information analyst must first properly identify the substances. This identification is accomplished by a TOXLINE search, by using the CA Desktop Analysis Tool for the Common Data Base, or by reference books such as "Merck Index." Additional search parameters may consist of metabolism, pathophysiology, pharmacology, or analytical methodology, and these are then incorporated into the profiles constructed for the search. If information about a general class of compounds is requested, they must be identified or, if the class is inordinately large, the requester and analyst must agree on the specific compounds to be included.

The third and smallest category of searches are those which are more suited to computer searching than to traditional searching. These requests may be author searches or SDI's. They may have such complex search logic that traditional searching is precluded, or the requester may want only a small portion of information about a compound which is covered extensively in the literature that traditional searching is inefficient. Some searches which

fall into this category are (a) effects of polluted drinking water on the cardiovascular system, (b) inhibitors or potentiators of lead poisoning, (c) embryotoxic or teratogenic effects of amphetamines, and (d) relationship of race and/or inner city dwelling to toxemia of pregnancy.

SUMMARY

Because of the unique location, with its access to extensive library facilities, computerized data banks, other information centers, and research facilities, TIRC is in an ideal position to collect and disseminate toxicology information (Figure 8). TIRC disseminates information by (a) compiling bibliographies in response to search requests, (b) providing selected bibliographies to the public through NTIS publication, and (c) contributing to the toxicology review literature through state-of-the-art reviews.

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LITERATURE CITED

(1) Weinberg, A. M., "Science, Government, and Information," A Report of the President's Science Advisory Committee, 52 pp., The White House, Washington, D. C. (January 1963).
(2) Hornig, D. F., "Handling of Toxicological Information," A Report of the President's Science Advisory Committee, 21 pp., The White House, Washington, D. C. (June 1966).
(3) Kissman, H. M., "The Toxicology Information Conversational On-Line Network (TOXICON): A Status Report," Presented at the 8th Middle Atlantic Regional Meeting of the American Chemical Society, Washington, D. C. (Jan. 17, 1973).

SPEEDI—A Better Information System*

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We propose an improved scientific information system involving dissemination of abstracts to individuals by core abstracts services followed by publication and distribution of individual articles. Our scheme would be fast, selective, give good coverage, permit easy access to pertinent information, permit efficient retrospective searching, and be economical. The need for each of these attributes is discussed. Problems of the chemical literature are emphasized but our proposals are applicable to other disciplines as well.

As a result of deficiencies in existing information systems, proliferation of scientific literature, and associated rising costs, better ways for publication and dissemination of technical information are being actively discussed by many organizations. A three-day symposium on the future of scientific and technical journals was sponsored by the IEEE in May 1973. The American Chemical Society has a broad interest in this subject and has established the Committee on Improved Publication Formats to study many aspects of the problem of devising alternatives to the traditional journal. Part of the program of the Special Library Association's 64th Annual Conference concerned the future of the scientific journal; one paper was devoted specifically to the need for speed in information dissemination.

Many proposals for change have been advanced,[1-6] but most appear to solve problems faced by publishers and libraries while assuming that individual users will adapt to the changes. We believe that reforms should be aimed at better service to users and, therefore, should result in a system which primarily is very fast but also is highly selective (relevant), gives good coverage, allows easy access to complete information, permits retrospective searching with high reliability, and is economical. To accomplish this, we propose a new system SPEEDI—acronym for System for the Publication and Efficient, Effective Dissemination of Information—that will be superior to previous proposals for change. The degree to which SPEEDI satisfies the above criteria will be discussed in more detail later. SPEEDI would operate stepwise as follows:

(1) Articles submitted to journals would carry abstracts suitable for sending to a core abstracting journal upon receipt by the journal of the final version of each article accepted for publication.

(2) The core abstract journal would assign an identification number to each abstract and this would appear on the original article.

(3) Abstracts would be disseminated selectively to subscribers to the abstract service, by matching the abstracts to keywords to be provided by users as descriptive of their specific interests.

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