Another is a printed dual-dictionary coordinate index, published three times a year with annual cumulation. The third is a computer search tape, also distributed three times a year with annual cumulation.

Each system is based on a unique subject authority list, or thesaurus, typical of those associated with most information retrieval systems. Each resulted from several years of intensive committee and staff work.

Development of these indexing services and information-retrieval programs is another example of cooperation and support by the subscribing companies. Except for actual computer programming, most of the development was carried out by the subscriber advisory committees and special groups and study teams which they set up. Joint committees, made up of representatives from the committees of both organizations, worked diligently to achieve the greatest degree of compatibility possible, since some technical information departments and libraries will be using both services. All told, many hours, days, and even weeks of company and personal time were contributed by the subscribers and their representatives.

These abstracting and indexing services of the American Petroleum Institute and the University of Tulsa for the petroleum industry illustrate what can be done on a centralized, cooperative basis. The cost to each subscribing company is not inconsequential, but it is only a fraction of what it would cost the company to do an equivalent job on its own.

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Cooperation within an Industry*

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The classic tradition of information exchange among scientists has undergone several subtle and some radical transformations in recent years. As a consequence of this, chemists now must select and evaluate not only primary publications, but also secondary sources designed to announce or to display research findings. In chemistry, these publications have generally employed one of two criteria. The first is the "all chemistry" approach, in which the alerting publication attempts to announce or display all chemical subject matter. The other may be thought of as mission or field-of-interest oriented, involving some form of selection of the chemical articles. From the point of view of an industry, both types are required in order to inform chemists employed therein as chemists in general and as chemists devoted to the specific requirements of that industry.

The development of alerting systems to meet the needs of the pharmaceutical industry has taken the general form of support to ventures providing one or both secondary forms. In the past, support has been largely voluntary on the part of pharmaceutical companies, with their trade group, the Pharmaceutical Manufacturers Association, providing member companies with information on proposed services. This has been accomplished through PMA's Literature Subcommittee of its Section on Research and Development. This group, presently chaired by Mr. Eliot Steinberg of Warner-Lambert Research Institute, is charged with the responsibility of surveying developments in information technology and services. Reports are made periodically to the parent body, and annual open meetings have been held since 1962 to acquaint chemists with developments (as evening sessions in conjunction with national ACS meetings). Member companies with problems in this area may approach the Subcommittee for information. The compositions of the Subcommittee was historically limited to company representatives whose area of responsibility was something other than information science. This was done deliberately to provide an overview approach uncolored by expertise or personal preferences. Recently, however, three information specialists have been added. In contrast to some other industries, then, the pharmaceutical industry has not developed permanent, association-sponsored, technical-information activities. As will be seen, cooperative efforts in this area have been mostly supported on a per-task basis by individual companies, groups of companies, or individuals with company approval.

In order to understand the services in this report, it is important to inventory the needs of the industry in

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supporting one or the other of the types of services mentioned. The chemist in the pharmaceutical industry needs to be informed, generally, of new developments related to chemical processes, analytical methods, and reaction mechanisms, in much the same manner as his fellows in other industries. However, he is specifically concerned with new compounds and with the biological properties claimed for or attributed to them. His need for timeliness in information services is perhaps the greatest of all industrial chemists. This stems from the relatively long period required from synthesis to marketing, the high rate of attrition in both the biological-activity and clinical-testing phases, and the relatively short duration of the useful life of the end product.

In common with his fellows, the pharmaceutical chemist prefers information presented as structural diagrams, with retrieval entries in chemical terms. His company is further interested in alerting services which provide information on patented compounds, in addition to those described in the technical literature, and is also interested in services which provide information on competitive products. Ideally, then, the pharmaceutical chemist desires a fast alerting service which displays structures, biologic properties, and competitive products, and which takes as its source both the world's journal and patent literature.

PATENT SERVICES

An example of cooperation through consultation was an effort on the part of Information for Industry, Inc., publishers of the Uniterm Index to U. S. Chemical Patents, to provide a pharmaceutically oriented key to the world's patent literature. This called for central-group collecting, encoding, and abstracting pertinent patents, then sale of the material to pharmaceutical or other interested companies. The interested companies provided this organization with an advisory board of chemical-information specialists, and offered the use of chemical and biological codes. While a sample was eventually produced, the service did not appear. However, it was later replaced by another similar technique offered commercially by Derwent Ltd. This has been very well accepted and is now in its second year of operation.

Derwent's *Farmdoc* covers the patent literature of 14 countries including the United States, with emphasis on pharmaceutical applications. After acquisition, patents are checked against existing files to determine possible prior filings. If none are noted, the patent is called a "basic" patent, and a punched card, abstract, and full specification are provided to subscribers. If a prior patent is noted, the patent is treated as an "equivalent," and notice in the form of a listing of equivalence is sent. Reproductions of abstract IBM cards are provided for alerting purposes, the unpunched abstract cards may be filed for look-up, and the punched cards are available for retrieval. Each basic patent is given a unique number, and structural, preparation, and other data are displayed. Full filing information is also provided, including priority and convention dates and assignees. While a code for companies does provide the chemist with knowledge of who has patented what, other competitive-product information is lacking. Basically, this service meets all the needs of the pharmaceutical chemist with the exception that it does not cover literature other than patents.

LITERATURE SERVICES

New Drug Alerting. In 1958, two companies began an experiment which was to lead to a large-scale project in the cooperative exchange of information concerning new drugs. For a long time, individual companies had each been scanning the open literature to locate compounds of interest. These were usually recorded on 3 × 5 or 4 × 6 in. cards and were usually distributed with, or as part of, the company's abstract bulletin. Abbott and Schering, in 1959, agreed to exchange their respective abstract publications and this set a pattern. At the Gordon Conference in 1961, further discussions took place relative to extending such exchanges. Dr. J. Clark, of Lederle Laboratories, agreed to coordinate this activity. The first step was a study of coverage. At that time, none of the companies was willing to depend on another to cover a key journal, so it was finally decided to allow duplicate coverage. This led to an onerous checking procedure and imposed a penalty on the fastest and most efficient literature operations. Fortunately, however, the two most concerned were willing to go along for a time. A more or less uniform format was developed for the cards which were the medium selected for exchange instead of the full abstract journals.

Data were printed on IBM or other cards. The molecular formula was given; code numbers; available chemical, generic, or trade names; a statement as to the activity; and the reference citation. An extensive analysis of this experiment has been reported by Bohr and Owen (*1*). Early in the game it was decided to encourage the development of a commercial version of this cooperative venture.

Mr. Paul de Haen undertook such a service in 1962, calling it "Drugs in Prospect" (*2*). These cards contain essentially the same information as did those in the New Drug Information Exchange. However, positions for the various descriptors are fixed, and the de Haen–USP classification codes are employed. Although some deficiencies were apparent in this service, most companies preferred to buy it after studying its efficiency and, one by one, companies withdrew from the cooperative exchange in favor of the commercial service.

Documentation Ring. An international "Documentation Ring" (which contained only one U. S. based company) was an effort that provides an example of pharmaceutical-industry cooperation on a much more sophisticated level than the cooperative New Drug Information Exchange. The participating companies decided that their common interest in the pharmaceutical literature could be met on a cooperative basis. A core of journals was selected for page-by-page coverage. Most articles were committed to the system. Each company assumed responsibility for about 25 journals, and their information staffs wrote informative abstracts for each. Punched cards containing a chemical fragmentation code and a biological activities code were produced for each compound.

In 1963, members of the Ring proposed that Derwent Ltd. assume the abstracting and coding operations on a centralized basis, producing all abstracts in English and

offering the service for wider sale, thus lowering the price. At this reduced price, this arrangement proved attractive so the "Ring's" operation was turned over to Derwent in July 1964, with about 50 companies participating. Subscription cost is now about $8000 per year as compared to an estimated previous cost of $50,000 per year to each of the original eight companies.

In *RINGDOC*, a detailed, informative abstract is given which displays structures, additional indexing terms, and full bibliographic data. In addition to this master abstract, a 4 × 6 alerting abstract is provided for dissemination to scientists. By printing on two sides of these 4 × 6 cards, most of the master abstract information is given.

Index Chemicus. In 1960, Eugene Garfield Associates, later the Institute for Scientific Information, conceived of a new information tool for chemists, *Index Chemicus*. This tool provides an example of a form of industry cooperation which may be thought of as limited financing.

The *Index Chemicus* was proposed to cover the journals reporting new compounds, using an abstract form based on structural features and formula characteristics, with textual matter minimized. Original estimates were that 30,000–50,000 compounds per year would be included. After a request for NSF support for the project was unsuccessful, a number of individual pharmaceutical companies were approached. When 15 pharmaceutical companies agreed to commit $2000 per year to the project, the publication was launched, in 1960. The remaining capital was obtained from other industrial and academic subscribers, at a $500 subscription price. By the third year of operation it was found that about 100,000 compounds per year were involved and that additional financial support was required. The subscription price became $700 per year (educational rate $350) enabling *Index Chemicus* to continue publication. About 75% of *Index Chemicus* subscriptions now arise outside the pharmaceutical industry.

Index Chemicus provides full bibliographic information for each article, with the addition of a detailed mailing address for the first author. When available, abstracts are given and structures and flow charts are displayed. A molecular formula is given for each new compound reported in the article and appropriate substituent indications or Markush groups are shown and keyed to the proper diagram. *Index Chemicus* appears every two weeks, with each issue containing subject, author, and molecular formula indexes. Two additional indexes are given in the quarterly and annual index cumulations. One, the Rota-Form (*3*), provides permutations of molecular formulas, enabling look-up from any element entry. The Journal Index lists all issues of all journals processed to that date. *Index Chemicus* examines over 175 key chemical journals on a page-by-page basis and covers 1000 additional journals by title to uncover articles reporting new compounds.

Chemical Titles. The inexpensive, computer indexing method of Luhn (*4–6*) has enabled the Chemical Abstracts Service to produce *Chemical Titles*, a "keyword-in-context" publication which fills in the time gap between publication and eventual abstracting and indexing by *Chemical Abstracts*. Eli Lilly has cooperated with the Chemical Abstracts Service in determing if the magnetic tapes used to produce *Chemical Titles* could be employed in an alerting service. Rice has done this on an experimental basis for scientists at Lilly (*7*). The Lilly experiment provided enough utility to encourage CAS to offer the tapes of *Chemical Titles* for sale.

Steroid Project. The pharmaceutical industry has obtained information tools in still other manners. An example was the Steroid Literature project, in which the Pharmaceutical Manufacturers Association contracted with Eugene Garfield for the encoding of steroid chemical literature (*8*). This project, which eventually reported on 11,000 compounds, was later taken over by the United States Patent Office, which still maintains the service, providing punched cards and microfilm listings on the literature and patents of this class of compounds.

NEW SERVICES

New services for alerting chemists to developments in the pharmaceutical and related fields have appeared. *Chemical-Biological Activities* (*9*), published by the Chemical Abstracts Service, appeared in 1965. The pharmaceutical industry again acted as consultants, cooperating throughout the development of this publication, providing surveys and the like for the benefit of the CAS research staff. *Chemical-Biological Activities* provides, in a digest section, structural information and abstracts, including bibliographic data and molecular formulas. Each issue contains keyword, molecular formula, and author indexes. Cumulations will be offered.

A follow-up system to *Drugs in Prospect* appeared in 1964. Called *Drugs in Research*, it is a card system which each month provides cumulative references to products through the research stages until they are marketed. Studies are also in progress with a view to providing the *Drugs in Prospect* information in machine-searchable form. New information, as it becomes available, is added; citations are cumulated.

The Institute for Scientific Information introduced in 1965 a new service based on the *Science Citation Index*. Called *ASCA (Automatic Subject Citation Alert)*, this new service provides subscribers with weekly, personalized listings mailed directly from the computer. The listing describes the current published articles or patents that have cited any items entered in the subscriber's profile. The previously published works in the profile constitute highly specific subject concepts which define the user's present areas of interest. Those subject citations which have been cited in that time period are listed, with the citing references given in full. Notification is provided in weeks when no citation is forthcoming.

CONCLUSION

From the foregoing discussion we note that industry's cooperative efforts can take many forms, from the support of a commercial service to cooperation with a professional society, to the complete operation of a complex system. By and large, the trend to purchase of services is indicated, even in those cases where extensive effort and investment has been made in research and development by the companies involved.

It is noteworthy that in no case has the pharmaceutical industry shown any interest in industry-wide centralized efforts such as those in the petroleum industry. This may be attributable to the high level of competition and proprietary secrecy. Note, for example, that in no existing service is there a centralized searching facility. On the contrary, there is a definite preference to have a set of searching tools "in house," to be manipulated by company information personnel.

The design characteristics of the alerting services bear marked resemblances. In most, the chemical structure dominates the display mode, with a variety of index entry points. Those services which do not supply such a display output have employed the storage and speed of manipulation characteristics of computers to provide, through scope and rapidity of action, bodies of information not available through more conventional techniques, counterbalancing the lack of topological entries.

The cost of these alerting services is highly variable with a general trend to higher-priced services. The individual chemist is in a difficult position if he is without recourse to a collective information source able to afford these rates. One may hope that future technological developments will allow for individual services at individual prices, and that industrial cooperation will help to pave the way for these as it has for collectives in the past.

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The World Literature on Psychopharmacology*

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INTRODUCTION

A comprehensive retrospective search of the available pertinent literature for the origin of the term "psychopharmacology" disclosed it was first used in 1935 by Thorner (*1*) who discussed the psychopharmacology of sodium amytal.

Since that time, and particularly during the last decade, this area of research has developed rapidly. This activity has resulted in a large rapidly expanding literature. It is difficult to estimate the size of the total number of papers in this new field, but a figure of 20,000 does not seem to be excessive.

Despite the difficulty in defining adequately the term "psychopharmacology," many definitions have been attempted. A short, useful definition is the "effect of chemical substances upon normal and abnormal behavior." A more detailed description is that applied to the activities of the Psychopharmacology Service Center which was set up by Congress in 1956 within the National Institute of Mental Health. The mission of this group was "to establish a special research program on the clinical effectiveness, liabilities, and basic mechanisms of action of the tranquilizers and other drugs used in psychiatric treatment."

Since we are dealing with behavior and the behavioral sciences, it is obvious that this subject-matter area is extremely broad. In fact, it is an excellent example of the interdisciplinary approach to research. Psychopharmacological agents are synthesized by the organic and medicinal chemist, studied and tested by the neurophysiologist, neuropharmacologist, and experimental psychologist, and evaluated clinically by the clinical psychologist and by the psychiatrist. Students of cultural anthropology, social and educational psychology, and even comparative religion are also involved. As a result, the pertinent literature is scattered widely among a diverse group of scholarly journals and other publications.

These substances have been and continue to be popular prescription items. Many drug firms have had to include the dissemination of psychopharmacological information among the major services of their technical information centers.

For the past three years, our group has been developing a detailed informative indexing system in this field, that is,

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