Organization and Management of R&D Information Activities at SK&F*

A. DOUGLAS BENDER
Research and Development Division, Smith Kline & French Laboratories, Philadelphia, Pa. 19101

Received February 13, 1969

Science Information at Smith Kline & French Laboratories is responsible for a number of information programs and services in support of both scientists and R&D managers. Information research and analysis services are designed to support chemical, preclinical, and clinical research, drug development, and medical and regulatory activities. Documentation activities include development and maintenance of chemical, biological, and clinical information systems. Network planning and scheduling of R&D projects and R&D long-range planning and forecasting are examples of management information services. The primary objective of these activities is to provide information that is useful in the decision-making process. Factors which have contributed significantly to the success of this operation have been R&D management's interest and commitment to the programs, participation by Science Information personnel in all phases of the R&D enterprise, and sensitivity on the part of Science Information to changing information requirements on the part of the division.

This communication describes Science Information at Smith Kline & French Laboratories, its objectives, its organization, and its major responsibilities and functions. Some management guidelines and practices which have served to establish Science Information as an integral and contributing partner in all phases of the R&D enterprise are also considered.

Today, the rapid pace of scientific and technological progress and the complexities of the industrial management environment demand information which is current, relevant, and timely. This is true of both technical problem solving and management planning and control functions. If this challenge is to be met, it is necessary, first, that all phases of the information transfer process, from collection to use, be thoroughly understood; second, that steps be taken to make each phase as economical and efficient as possible. Information programs at SK&F are committed to this challenge, and the commitment is implicit in our over-all objective, which is to seek, evaluate, analyze, and distribute information to scientists and R&D managers which is relevant to their responsibilities and their decisions regarding current activities, and which supports their search for new research options and product opportunities.

If this objective is to be pursued successfully, we must consider three factors. First, the user of information must be integrated into the information system, not merely as a customer, but as a planner and designer. A user's involvement and participation in the design and continuing operation of a system or a program not only aids in identifying information need, but also develops a commitment on the part of the user which works to maximize the return on the investment made in the system, no matter how complex or simple it is.

Second, elements in the information base must be matched to the user's requirements as they reflect his responsibilities, functions, and decisions. This matching requires a thorough analysis and understanding of the research or management system, which describes how these responsibilities are carried out and what decisions are made. To complete the analysis, the system must be evaluated in terms of the information required to support it.

Third, the relevance and the value of different pieces of information to the decision system that has been defined must be determined. All information, unfortunately, is not equally valuable, relevant, or useable; therefore, information must be sifted, reviewed, evaluated, and synthesized before it can be properly employed. An extension of this role is the alerting of users to the meaning or the implications of isolated pieces of information.

Another important consideration is the environment in which information operations are conducted. To provide information which is meaningful and relevant, it is necessary for management to create an environment which supports and seeks the active participation of Science Information in all phases of R&D activity, particularly in the decision-making process. In response to a participative atmosphere, Science Information commits itself to providing information services and systems which are useful, of high quality, and responsive to the changing needs of divisional personnel. These considerations will

* Presented in a Symposium on "Management and Operation of Information Groups and Centers," 4th Middle Atlantic Regional Meeting, ACS, Washington, D. C., February 13, 1969.

be reviewed in more detail in the discussion of management practices.

ORGANIZATION AND FUNCTIONS

R&D divisional responsibilities at Smith Kline & French are divided among four principal areas: Research, Development, Medical, and Support. As shown in Figure 1, Science Information is included as a support function.

Figure 2 shows that of the 100 staff members, 63% are technically trained: 14 have doctorate and 17 have masters degrees; the rest have bachelor degrees. The areas of training of those with advanced degrees include pharmacology, biochemistry, organic chemistry, microbiology, information science, library science, statistics, business administration, and finance.

Each major area of responsibility in Science Information, shown in Figure 1, is listed below, with a description of its important responsibilities and activities. None of these areas operates or can operate independently of the others. Indeed, cooperative ventures and activities are common.

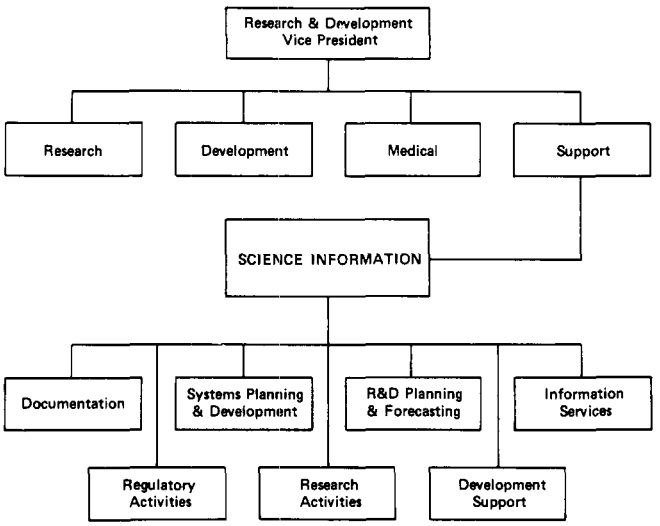

Figure 1. R&D organization

FUNCTION	Level or Skill			Totals
	Secretarial and Clerical	Technical Staff (B.A., M.S.)	Senior Technical Staff**	
Information Reduction and Systems Design*	24	20	12	56
Analysis, Interpretation and Evaluation	12	8	22	42
Management and Administration	1	–	1	2
Totals	37	28	35	100

*Includes R&D Library, Technical Documents, R&D Data Systems.
**Ph.D., or equivalent in training and responsibility.

Figure 2. Description of science information staff

Documentation. Documentation is responsible for the acquisition, storage, and retrieval of recorded scientific information, published and unpublished, including the maintenance and operation of established R&D data systems, and the services provided by our Information Center.

The systems maintained by this group deal with chemical, biological, pathology/toxicology, and clinical data from studies conducted by SK&F. The members of this group are not only responsible for entering the data into the system, but also for linking the user directly to the information base by phrasing and translating user requests into the language required for efficient retrieval. They must also continually evaluate the capabilities and performance of our data systems to insure that they are consonant with existing technology and responsive to current user needs.

The base of our chemical data system is a file of 40,000 compounds coded for retrieval on the characteristics of structural components.[1] About 1100 "fragment" codes have been used in this structural analysis. This material is stored on magnetic tape and is used for generic and functional group searches. Output from the system includes the SK&F number and chemical name of all compounds meeting the criteria indicated by the person making the request. Experience with this system indicates that 80 to 90% relevance can be expected in a typical generic search. In the near future, compounds will be entered into the system by tape from a chemical typewriter, and the output will include structure, in addition to the SK&F number and chemical name.[2]

The biological data system includes data from 120,000 preclinical studies and experiments conducted in our laboratories. These data are recorded on magnetic tape and include a description of the test and the preparation, the species of animal, the dose and route of administration, and the activities observed. This file is searched for compounds which exhibit biological activities of interest to the research program. Output from the system includes the test results on a particular compound, as well as the SK&F number of each drug. The SK&F number links the biological and chemical data systems; thus, biological data are usually printed out accompanied by the chemical name.

The pathology/toxicology reporting system records clinical laboratory data from studies of more than 2000 animals. The data include blood chemistry, urine analysis, hematology information, etc. The information is used in the periodic reporting of study progress, as well as in the preparation of final reports.

Our clinical data system is fairly complex, and was designed to provide information on drugs under current clinical evaluation.[3] Complete data from each study are entered into the system without restriction on input. Data include diagnosis, dosage, adverse reactions, concomitant therapy, and laboratory determinations, as well as comments made by the investigator during the course of the evaluation. The system provides for the retrieval of sets of individual records, summary tabulations, and correlations which are of interest to the project monitor.

The Information Center consists of our Research Library and the R&D Technical Files. The Library

receives approximately 800 journal titles and has a collection of 20,000 volumes (8000 books and 12,000 bound journals). A small branch library is maintained for one of our suburban research facilities. The 3,000,000 pieces of paper housed in the Technical Files include correspondence from clinical investigators, laboratory test reports, literature searches, technical memos, unpublished manuscripts, and so forth. Both the Library and the Technical Files provide a quick reference service for the user.

Systems Planning and Development. This group is responsible for the central coordination of all R&D activities related to electronic data processing, systems design and development, and laboratory computer applications. One of the principal jobs of this group is to initiate studies designed to evaluate the need for an extension of present systems or the need for new systems and computer applications within the division. Following an assessment of user needs and requirements, system or application objectives are defined, a system is designed which best meets these objectives and, with the help of our corporate information group, the system design is finalized. The corporate group is responsible for programming the system and providing the computer hardware and software needed to maintain the system once it becomes operational. The Science Information systems group is responsible for monitoring project status and offering suggestions to accelerate the implementation process as quickly as conditions permit.

Planning and Forecasting. Our Planning and Forecasting group is engaged in four major activities. First is the application of network scheduling techniques to project management and control. Thus far, this technique has been used for 19 development projects, each of which has comprised 300 to 750 activities. We have found that this level of detail is essential to the definition of resource conflicts between projects. Each network is updated monthly to assure the system's responsiveness to the management environment. After each update, computer status reports are distributed to project and divisional management. Each member of the project team also receives a report indicating his particular responsibilities in support of the project. Every report issued includes a miniaturized network diagram, which graphically displays critical activities and provides a vehicle for evaluating the project plan as a whole. These reports are also used to evaluate critical functions in terms of the resources required to meet the demands of multiproject environment. If insufficient resources are available, management is provided with the information needed to determine and resolve the conflict.

An additional responsibility of the staff is the definition of what we call an Information Management System for our division. This is an attempt to relate the use of information to our management system.

A third function of the Planning and Forecasting group is the development of simulation models for project planning and the allocation of resources among a number of deserving programs. For example, R&D management has used such a model in its allocation of funds and manpower to a number of different proposed research programs. The model considered such factors as the cost of running the program, the probability of getting a marketable product, and possible reward in terms of sales, should the program be successful.

This group is also involved in a long-range planning program dedicated to highlighting areas of research which offer the greatest scientific promise and commercial opportunity. Specifically, the long-range planning program is concerned with forecasting the needs and wants of society during the next 15 to 20 years. Data about tomorrow is vital to planning today's basic research programs. Both normative and exploratory technological forecasts are developed in an effort to determine what society's needs will be. Regarding the normative approach, a Delphi study of the future of medicine has recently been completed.[4] In this study, a group of experts gave their opinions on future developments in biomedical research, diagnosis, health care, medical education, and medical therapy. We also sought their views on the medical need, the social and ethical desirability, and the probable timing of these developments.

Regulatory Activities. Regulatory Activities extends Science Information services to those concerned with the safety and efficacy of marketed products, and with federal regulations pertaining to the pharmaceutical industry.

Regulatory Activities personnel assist physician monitors in setting up clinical studies of our marketed products and evaluation of data from the studies, evaluating published and unpublished data on the use and misuse of marketed drugs in monitoring reports of adverse reactions to our drugs. Users of their services include the Medical Staff and the Marketing Division.

This group also advises on the format and content of reports prepared for government agencies, and coordinates the preparation and submission of such documents as investigational new drug exemptions, new drug applications, and post-marketing reports. In order to provide these services, the group must be cognizant of changing regulations and evaluate the probable impact on our over-all R&D activity.

Development Activities. The development of a drug is the responsibility of the Development Staff, an organization which includes a number of clinical pharmacologists. These physicians are responsible for the planning and strategy of a development program which leads ultimately to the demonstration of a compound's clinical utility. To maximize the probability of success, an extensive and dynamic information system must support the Development program. The focal point of this information system at SK&F is Science Information—the Network Planning and Documentation staffs already described, along with a group of scientists who assist the Development Staff in its evaluation of proposed development projects, pharmaceutical and nonpharmaceutical, and in its management of information about drugs already under clinical study. The information with which these scientists deal includes not only that generated during the course of our own clinical evaluation of an investigational drug, but also what has been reported in the published literature which may influence the strategy of our studies, or the evaluation of the data derived from them.

In short, it is the responsibility of the scientist in Science Information to assist the development project director in establishing his plans and in making decisions affecting the project's future. Vital to the role of the staff scientist is his ability to adapt the information at his disposal to the requirements of three distinct user groups: the

project team, management, and the Food and Drug Administration. To do this requires considerable interaction and cooperation with other elements of Science Information, including Documentation and Regulatory Activities. All of their resources are brought to bear when the scientist refines his information system to produce, ultimately, a new drug application for review by the FDA.

Research Activities. The Research group, composed of highly skilled scientists, is responsible for the information segment of our current research programs. As members of research program teams, Science Information scientists play a positive role in meeting short, as well as long-range research objectives.

Information support for short-range programs is met primarily by members of our chemical staff. They assist laborabory chemists on the team in the design of molecules to be synthesized, and in the selection and scheduling of compounds to be tested in specific biological systems.

This short-range support includes not only the evaluation of structural leads from the published literature, but also involves acquisition of compounds from academic contacts here and abroad for testing and evaluation in our own laboratories.

Further, some members of our chemical staff are studying the application of various predictive techniques to enhance our ability to design molecules exhibiting specific biological activities. This program uses multiple parameter analysis to correlate biological activity with physical properties such as partition coefficients, pK_a data, dipole moments, etc.

Support of longer-range projects is approached on an interdisciplinary basis, and involves members of our biological and chemical staffs. Their basic responsibility is the evaluation and interpretation of published and unpublished test data in support of program plans and strategy.

This group also spearheads the search for alternative approaches to the achievement of long-range research objectives. In basic research, there are usually a number of alternative approaches which vary in technical feasibility and appropriateness to the organization's resources. It is the responsibility of our research group, either on its own initiative or that of the laboratory program director, to review alternatives and to establish the probability of their success. This research requires a thorough analysis of the proposed alternatives within the framework of research objectives and available technology.

Another phase of this program involves participation of the information scientist in laboratory research on a limited basis. His work on a research topic is designed to be consistent with over-all program objectives, and it is mandatory that the results of these studies contribute directly and significantly to the development of the over-all program.

Information Services. Our Information Services group provides three basic services. First, it makes retrospective literature searches to support each of the Science Information programs, particularly Research, Development, and Regulatory Activities. This group also provides information to other areas of the Division and Corporation as required. Individuals performing these literature searches not only provide references and bibliographies, but also analyze and summarize the selected literature before it is presented to the user.

Second, the Information Services group is responsible for alerting members of our scientific staff to recently published reports pertinent to their current interests. At the present time, our SDI system depends mainly on the Automated Subject Citation Alerts (ASCA) of the Institute for Scientific Information. In addition to this alerting service, three bulletins are generated internally and distributed each week. One bulletin is intended to furnish our staff with information on general technical and scientific developments, and another presents abstracts of recently issued patents. The other bulletin summarizes newly published reports on our marketed or investigational products, along with selected information on competitive drugs. To facilitate the retrieval of literature on our products, indexes and bibliographies are also prepared.

The third phase of this program is the translation of technical and scientific reports and correspondence.

MANAGEMENT CONSIDERATIONS

Because of the variable nature of the responsibilities and activities of information centers, it is difficult to propose management guidelines and principles which are universally applicable and appropriate. The observations made in this report are derived directly from our experiences with information operations at Smith Kline & French.

These observations are, however, necessarily general, because of the diverse nature of our operations. As illustrated by the above examples, Science Information is directly or indirectly involved in every major divisional activity, and many of its activities are related to a number of corporate functions. Further, the users range from individuals to groups, and from laboratory technicians to those responsible for decisions which affect the future course of research.

Dedication to Service—Participation. Without exception, major decisions which affect the direction and progress of research are based on information, and it follows that the soundness of decisions made by scientists and managers is related to the way in which information is handled, processed, and distributed. Thus, by definition, an information system is integral to the decision-making process; the question of need for information is not an issue.

What is variable is the extent to which information operations are integrated into the total decision-making process, and this variation is directly related to the services rendered to the user. It is obvious then, but perhaps not mentioned frequently enough, that the over-all objective of any information operation or system is service; specifically, information services of high quality, efficiency, and responsiveness. If this objective is achieved and maintained, management's confidence in the corporate role of the information service is continuously reinforced, and involvement extends far beyond mere organizational recognition and token use. Scientists and managers now expect active participation by the information group in the totality of the research and development operation. It is this integral involvement which characterizes information operations at SK&F. In return for this role, the information operation is committed to the development of

efficient programs and services which directly support the decision-making process itself. This further improves our ability to make information more useful and useable.

Reciprocal Participation–User Involvement. The discussion above has considered the integration of information operations into the total R&D decision-making system. This active participation also tends to stimulate users and user groups themselves to seek a role in the planning of information systems and to influence their operation. The information group should take advantage of this user interest to integrate him into its programs, with the recognition that his involvement is indispensable to the success of the total system; he must be a dedicated partner. It is the continuing interchange and dialog between operational and technical service personnel that leads to an effective and efficient transfer of information. It also serves to eliminate natural communication barriers that result when either the operating area or the technical service area views the other as essentially distinct within the total package. When such is the case, both are losers.

Statement of Objectives, Goals, and Plans. There are always more ideas and more projects than there is time to work on them. This disparity requires decisions of priority on the importance of current programs and services, as well as on any new applications and projects which are suggested. The importance of these choices and decisions clearly supports the need for establishing, in clear and realistic terms, the objectives and goals of an information program. This should lead ultimately to the development of a plan which is sound and realistic.

Goals and plans should be jointly developed among those responsible for various phases of the information program. Because of the diverse nature of our operations, it is absolutely necessary that all participate and communicate their objectives, needs, and goals with one another. Following review and agreement by the group involved, plans should be submitted to management for review. The development of an over-all plan serves to alert management to what it can expect in the way of information services and programs, and how they are related to other divisional operational commitments.

Communication. Much has been written about the relationship of adequate, rapid and accurate communication to the achievement of management objectives. In this discussion, reference is made to a three-dimensional communication system, with the focal point being Science Information management, which includes the director and those reporting directly to him. The first two dimensions of the system, R&D management and user groups, have been discussed. The third is communication within the organization itself, particularly with regard to the people who are responsible for the actual mechanics of current systems and programs.

The emphasis on effective communication stems from the recognition that people are after all the working parts of any organization, and that a participating role stimulates contribution. The mechanics of this type of communication can vary, but it is essential that management be open and free in communicating goals, policies, problems, and decisions.

Staff. Staffing an organization like Science Information poses unusual problems, but we believe that we can get and keep good people if we can demonstrate that Science Information is a vital and integral part of R&D activities and that it contributes to the achievement of goals and objectives established by R&D management. Individual reward systems must of course include opportunities for development within the organization, and for development within the professional community through publication and participation in outside professional activities. A feeling of participation and opportunity to contribute significantly to R&D goals and objectives is very important. These represent more or less traditional requirements. The special attraction of Science Information lies in a versatility which opens a wide range of career development opportunities. Scientists can develop professionally through direct contact with R&D activities, but in addition, they are exposed to and involved in many management functions and activities less likely to be encountered in a strict laboratory environment.

Individuals who are successful participants in research and development programs are those who are well trained scientifically and able to communicate effectively with those in research as well as those in management positions. Further, they must be able to evaluate and synthesize information and make judgments regarding the implications of information for the total operation. On this latter point, information is a powerful tool and, like any other, it can be used to build or destroy. More so than in any other area in our division, individuals in Science Information must be sensitive to, and aware of, the ways in which information can be used.

THE FUTURE

Today the status quo is change. The rapid pace of scientific and technological change and the growing complexity of our management and business environment is widely acknowledged. One prerequisite of success will be a willingness and an ability to adapt to change, and to innovate to meet the opportunities created by tomorrow's new technology and new knowledge. The information operation, as indeed any technical service, must assume its share of responsibility in meeting this challenge. Certainly the present approach to information activities at SK&F, as described here, represents a change from the early descriptions of this same operation.[5, 6] These changes in organization and in responsibilities reflect the changing needs and interests of R&D management.

What can be said about the future of industrial information operations? One extrapolation into the future seems sound. Industry will need to make greater use of the increasing wealth of information. The rapid growth of scientific knowledge will continue, and greater emphasis will be placed on communication of knowledge between disciplines. This will require information programs which can consolidate this knowledge to generate new ideas. Thus, information operations will continue, but it is safe to say that they will progress toward a more intellectual pursuit of ideas, leaving the traditional services of awareness, searching, and indexing to responsive automated information systems.

The increase in knowledge will certainly stimulate the introduction of new secondary services. With the increasing cost of providing these services internally, industry will turn more and more to outside services to

deliver current scientific information. Further, computers will become an integral part of the laboratory complex, permitting research data to be entered directly into large memory banks. Thus, the total information base, composed of data received from outside secondary services and laboratory data generated by current industrial research programs, will be directly accessible with a minimum of manual manipulation. To translate our growing base of knowledge into new ideas, a new breed of information scientist will emerge. He will be highly skilled in his field and possess a unique ability to refine a large body of data and information into constructive ideas that lead to new products and new services. The information scientist will work very closely with his laboratory counterpart, who will begin to recognize the true potential of information work. There will also be a greater professional recognition of the information scientist, and the opportunities open to him.

Both scientists and managers will want and need closer interaction with the information base. Advances in computer technology will permit them to interact with current information on a conversational basis. The use of remote terminals will be commonplace.

Computers will also have their impact on management. One significant application of computers will be in the simulation of decision situations. The manager or businessman will be able to test the consequences of his decision before he proceeds to implement them. He will draw upon current information which will be continuously updated in a large memory bank. Computer technology will also permit direct interaction between the manager and his information. Further, not only will information be provided by the computer system, but it will alert the user to the need for decisions regarding current operations.

These represent but a few considerations of the future. They suggest, however, that while information operations will remain an important part of the total research and management process, their character will shift from what is more or less a service orientation to one which is directly keyed to planning and control functions and the decision-making process and, in turn, to the planning, implementation, and maintenance of even more sophisticated information systems.

LITERATURE CITED

(1) Craig, P. N., and H. M. Ebert, "Eleven Years of Structural Retrieval Using the SK&F Fragment Codes," 156th Meeting, ACS, Atlantic City, N. J., September 8-13, 1968.

(2) Gottardi, R., "A Modified Dot Bond Structural Font With Improved Stereochemical Notation Abilities," 157th Meeting, ACS, Minneapolis, Minn., April 13-18, 1969.

(3) Hayne, R. L., A. S. D'Eustachio, and A. D. Bender, "Use of a Computer-Based Information System for Processing Clinical Data," *Drug Inform. Bull.* **2**, 32-9 (1968).

(4) Bender, A. D., A. E. Strack, G. W. Ebright, and G. Von Haunalter, "Delphic Study Examines Developments in Medicine," *Futures* **1**, 289-303 (1969).

(5) Longnecker, H. C., "The Role of Science Information Department in Industrial Research and Development," *J. Chem. Educ.* **33**, 633-5 (1956).

(6) Rockwell, H. E., and H. C. Longnecker, "Information Services at Smith Kline and French," *Percolator* **35**, 32-6 (1959).

Operation of Du Pont's Central Patent Index*

LESLIE E. RASMUSSEN and JAMES G. VAN OOT
Information Systems Division, E. I. du Pont de Nemours & Co., Wilmington, Del., 19898

Received July 3, 1969

The Central Patent Index is one of many information centers constituting Du Pont's Information Network. The development of this index and its relationship with other centers in the network is followed by a description of its operation: input, storage, and search techniques.

A description of the operation of Du Pont's Central Patent Index is best preceded by a brief description of the corporate structure of Du Pont, since the services of this Index are provided at the corporate level.

Du Pont's Corporate Structure. Each of the twelve industrial departments of Du Pont (Figure 1) operate with considerable autonomy, but under the general policies set by the Corporate Executive Committee. These industrial departments all have research, manufacturing, and sales organizations for Du Pont products. Most of these products—e.g., synthetic fibers, molding resins—are sold to other processing companies before they reach the ultimate consumer; some others—e.g., paints—are produced directly for retail sale.

The thirteen staff departments centralize activity in fields which, as in the case of the industrial departments, are largely defined by the name of the department. While most of these functions are carried out directly by the industrial departments, each of them finds that it is to their advantage to have much of this activity performed on a centralized basis.

* Presented at the 4th Middle Atlantic Regional Meeting, ACS, Washington, D. C., February 13, 1969.