Timing and Form of Researchers' Needs for Technical Information*

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Of 195 projects listed in "*Current Research and Development in Scientific Documentation*," [1] only 22 are studies of information needs and uses. Of these, only 5 involve direct study of the behavior of the users of technical information. Four others employ questionnaires or interviews to get limited data on use and opinions from users.

In an article on the current status of research in this field, Mrs. Helen L. Brownson,[2] program director for documentation research, Office of Science Information Service, National Science Foundation, comments:

"... it goes without saying that the information needs of the scientific community should determine the character of new information services and techniques. Although there is a good deal of intuitive and subjective knowledge about the various ways in which scientists communicate the results of their own work to others and learn about the work of others, there is very little precise, objective knowledge of the inadequacies in the present flow of scientific information and of the cost to scientists and to society of those inadequacies. A deeper understanding of the role and the mechanics of communication within the sciences and of the information problems and needs of scientists would be of assistance to scientific societies and all other organizations involved in planning and maintaining publication programs and scientific and technical information services. Such understanding is also needed for the design of information-handling systems and procedures that will provide the sort of help scientists can use to best advantage."

Mrs. Brownson then refers to studies made over the past 10–15 years in this field and concludes:

"... the current studies of communication practices and information needs of scientists are concerned with pieces of the problem. Plans have been discussed for a thorough "systems analysis" of communication within certain scientific disciplines, but no such study has yet materialized.

An observer of the rapid pace of development in the mechanical handling of information sometimes gets the peculiar feeling that in this rush toward more efficient handling of information, many information technologists are overlooking what should be the key element in the picture—the researcher who needs and uses the information. Our knowledge of coding, handling, storing, and retrieving information has far outdistanced our understanding of the relation of information to the research process and to the working patterns and requirements of individual researchers.

In this paper I will comment briefly on several aspects of this problem and hope to point up the need for more study of and knowledge about actual user behavior.

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The comments will rest on two basic assumptions, one of which may appear obvious and the other unacceptable in many organizations. The first assumption—the apparently obvious one—is that the technical information service in a research and development organization is established and maintained as a direct, personal service to the researcher.

Although many people in the information business will become indignant at any implication that this is not precisely the way things are, my studies and informal observations of research laboratories suggest that this is far from the case in many organizations.

Like any other service to R. and D., one may expect that problems of communication, status, informal personal relations, and influence will affect the efficiency and usefulness of the information service. And, as with any other service, one finds that the principle of direct, personal service to the researcher is often modified greatly until, in extreme instances, it almost appears reversed.

Although this may be a severe indictment, evidence for it is available to anyone familiar with the way reseachers do their work and the pattern of their needs for technical information. More will be said about this later.

The second basic assumption—the apparently unacceptable one—relates to the true economics of technical information services. The literature on technical information services contains some fairly good estimates of the *direct* costs of maintaining such services.[3] There is very little in the literature on the true *total* costs of such services. The major components missing in most cost estimates are the economic or "opportunity" costs which are incurred or would be incurred in the absence of an "adequate" technical information service.

No precise figures are possible for this component, since such costs would be very rough estimates, based on "what might have been," rather than "what is" the situation. These costs are real, nevertheless, and should be accounted for in computing the economics of information services.

The opportunity costs arise in a number of ways, including: the costs of duplicating work that has already been done in the organization, but which is not accessible to the researcher at the time he needs it; the costs of undertaking experimental work that has been done elsewhere and found to be fruitless; false starts on new projects or project phases as a result of not having a firm grasp of related prior art; and delays in getting research groups or individuals started on a project while a literature search or a search for required documents is in progress.

A familiar phrase in some large R. and D. organizations is that "it is cheaper (or easier) to repeat a piece of work than it is to find the information on the same job done earlier." Although these costs are difficult to measure, and perhaps impossible to defend in a budget meeting, they should included if one is attempting to rationally design or operate an information service.

This attempt to develop a realistic cost criterion can be phrased in another way—in terms of an effectiveness criterion. In order to design an optimal or even a "good" information service, one must have some idea of what constitutes optimality or goodness. In other words, measurement of the value of an information service must rest on what it is supposed to and actually does accomplish for the users or sponsors.

For example, discussing one component of information services, Robert E. Maizell, Director of Documentation Research, American Institute of Physics, indicated in a recent article[4] that:

> "It would appear that there is no well-organized body of literature specifically devoted to methods for the evaluation of technical libraries in research laboratories comparable to the literature that exists for public and university libraries."

He then proceeds to present a five-point program of evaluation, which includes a Performance Index and an evaluation of the Impact of the Library and its Personnel on the Research Program and Personnel.

Both of these assumptions strongly imply the need for more research on the actual requirements for information service and the behavior of users. The first kind of data needed relates to the time characteristics of requirements and uses of technical information. This includes:

1. *The statistical frequency of needs and requests*, to give some idea of the volume of service to plan for. This kind of data, at least on overt requests, is widely used in planning information services. Frequently, however, such estimates are based on historical demand for service. If prior service was adequate (which the very fact of redesign would tend to belie) these data may be adequate. Probably, however, they do not come close to reflecting accurately actual need for information service, which includes non-overt need as well as active demand. In other words, how many more researchers actually would use a new or improved information service, based on their actual needs for technical information, if the service were significantly better than the one it superseded. The only good source for this information is a thorough, well-designed study of the researchers themselves. Extrapolated historical records in this case may be very misleading.

2. *Actual time patterns of need for technical information.* Good measures of the statistical frequency or total requests per unit time may tend to obscure significant time patterns of need and use. For example, some researchers may schedule their work (or if you are skeptical about whether researchers *do* schedule their work, tend to fall into work habits) so that they work on a day, a week, or a longer time period as the "problem unit." That is, when a problem unit divides roughly into segments that might be labeled "search," experiment," "analysis," "write-up," *etc.*, their needs for technical information may follow cycles related to the "size" of the problems worked on or the length of a problem unit.

3. *The relation of need and use to project phasing.* This is related to the previous point, but now refers to the behavior of research teams or groups, rather than individual researchers. In this category we find demand patterns which result in swamping the information service personnel at the start of major projects or project phases and which leave them less than fully occupied during later phases. This "phase effect" in research and development projects is nicely illustrated in the work of Peter V. Norden[5] and the Study Committee for the Analysis of Research, Development, and Engineering.[6]

These two series of studies are aimed at discovering regularities in the time patterns of application of effort to development projects. So far they have turned up a number of distinct families of such time patterns which are believed to vary with factors such as: size of project, nature of the technology, and position on a continuum from pure research to engineering design.

In many types of projects, the needs for published information and general "state of the art" knowledge are greater in the earlier phases and the need for internal company information and cross-project information is greater in later stages.

There are very few studies of the time characteristics of researchers' needs and uses of information. Apart from rough questionnaire techniques, methods of behavioral research have not been fully adapted to this problem, although the basic techniques of studying intra-company communication have been widely used in other contexts.[7]

Several intensive studies have been made of the gross communication behavior of researchers. At the Case Institute of Technology a large-scale survey was made of how chemical researchers spend their time. Certain regular patterns were ascertained on a statistical basis.[8] A study of Team Research at Columbia University yielded statistical data on the communication behavior, both intra-team and extra-team, of half a dozen R. and D. groups in several different technologies.[9]

A study of idea flow within and between the laboratories of several companies resulted in data on the paths taken by new ideas, the content of ideas in terms of scope and time perspective, and their ultimate disposition.[10]

Several limited studies also have been done on the use of scientific literature by scientists.[11]

Most of the studies just mentioned do not include an analysis of researchers' actual information requirements related to the specific problem on which they are engaged. Such a study was carried through a pilot phase several years ago in two electronics laboratories, as a follow-up to the study of Team Research.[9] But it still remains in the category of projects to be undertaken when time, funds, and people are available. The pilot study involved self-kept records of incidents of the need for technical information and the action taken to get it.

The closest, to my knowledge, that any recent studies have come to this analysis of actual researcher needs is a study sponsored by the National Science Foundation of the flow of information among a sample of academic biologists and chemists.[12] This study penetrated, by means of a very long depth interview, into some of the fundamental issues underlying a researcher's needs for and uses of technical information.

The fundamental issue in this discussion of the need for more knowledge about the researcher's actual behavior

is concerned with the basic limitations on his information-handling characteristics. He is extremely limited in his abilities to take in, absorb, store, retrieve, collate, and apply large amounts of information. Hence he needs mechanical and human aids. The application of these aids should be based on his actual requirements.

The second kind of data we need about researchers' information needs relates to the form in which he uses or would like to receive technical information. A number of the studies cited previously present data on this subject. They show relative frequency of using and preference for various kinds of information media—personal contact, books, journals, memos, symposia, *etc.* Much of this observed behavior and these expressed preferences, however, are the result of the media that have been available historically and have little to say about optimal or ideal media and forms for information transfer. Much work needs to be done in educating researchers about the currently and potentially available new forms of information exchange, such as IBM's recently announced experimental system for Selective Dissemination of Data.[13] When they are acquainted with the possible range of form and media, researchers' preferences and behavior may change radically. In addition, and perhaps prior to such education efforts, much work needs to be done on evaluating the effectiveness of such new systems from the users' viewpoint.[14]

Among the possible forms in which researchers need and use information are:

1. *Conventional published forms*, including abstracts.

2. *Correspondence and personal visits* with fellow researchers. For specialists in some very esoteric fields, this may have to be an individual matter; but in many fields, information technologists can help locate fellow researchers through directories and summaries of "who knows what" or "who is doing what" in particular fields. For example, there is now in preparation a directory of who is doing research on the management of research.[15] A major undertaking was announced recently by the Air Force in an attempt "to provide a source for quickly identifying and locating the scientists and engineers working in the technical fields of interest to the Air Force."[16] Such informal exchange played a major role in the early days of modern science and is still an important factor in some fields.

3. *Bodies of data* that are not available in conventionally published form. The rate of compilation of such data in particular fields, such as gunnery and operations research, has been greatly increased by the availability of large scale digital computers.

4. *Quick answers to specific and general technical questions* that ordinarily take hours to look up in conventional reference sources.

5. *Arrays of possible research strategies and past experience* with techniques and approaches that have failed. This kind of information rarely gets into the published literature. The need for such "non-standard" technical information is pointed up by a fascinating study of the decision alternatives available at each step of two development projects.[17]

The investigator succeeded in constructing a decision tree showing the available alternatives at each sub-stage of a problem.

Other informal sources of information need to be studied intensively, if they are to be integrated into the total information service activity. Among them is the no-man's-land of personal files, which play a major role in the research of some individual scientists. Rather than treat them as subversive, as they are in many organizations, the information specialist should seek ways of augmenting them and making them even more useful to the individual researcher, if they are important to his work. It is here that the first assumption underlying my remarks may receive its severest test.

Suggestions to this effect resulted from a study within the United Kingdom Atomic Energy Authority. The recommendation was:

> "In view of the considerable amount of work which is put into personal indexes of data by R. and D. staff, some guidance on systematic arrangement and indexing should be given by libraries and information staff, to improve their usefulness both to their compilers and those who consult them."

Another form of information presentation is the reprint system as a possible alternate to the periodical system. This was discussed in a recent article in *Science*, by J.A. MacWatt.[18]

My final point relates to the possibility of assigning information specialists directly to project staffs or research groups, as a part of the team. In the aerospace and electronic industries, the assignment of specialists to projects has reached an extreme; they include many varieties of technical specialists, draftsmen, purchasing agents, and accountants. Although such assignments are often inefficient in terms of direct costs, they are extremely effective in terms of accomplishing the mission.

The recent development in establishing technical information on a high status in the laboratories of Esso Research and Engineering[19] and elsewhere is a partial step in this direction. What may be needed, however, is a direct assignment of information specialists to projects in order for them to get to know the actual research problems and the men working on them—their working patterns and their thinking habits. Such a system is reported to be in operation at Smith, Kline, and French laboratories. A team is customarily made up of an experimental researcher in the laboratory, a clinician, and an information specialist from their large information staff. No information is generally available, however, on the success of this arrangement or its potential applicability to R. and D. in other fields.

Information specialists can provide a degree of filtering for the bench researcher. In some cases information technology appears to have gone too far in the direction of mechanization and abstracting. After a period of appearing to converge on the needs of the individual researcher, recent developments suggest a divergence in some respects, away from his real needs and behavior. The need for studies of this phenomenon is urgent and perhaps the assignment of information technologists directly to projects for extended periods can help.

I conclude with a plea to design information services with sufficient flexibility so that they can be adapted to the needs of the individual researcher.

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Measuring the Value of Information Services*

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Introduction.—Obviously, any discussion of information services by a member of the management of a laboratory will be influenced by the specific characteristics of that laboratory. It is, therefore, appropriate to describe the environment in which the following ideas on information services were generated.

RCA Laboratories probably is at the more complex end of the spectrum of industrial laboratories when considered from the point of view of information services. The 450 professional staff members to whom we would provide information services are working on more than 150 clearly identifiable projects. These projects involve at least 15-20 scientific and engineering disciplines. The research is primarily applied and exploratory but includes a substantial amount of basic work. It includes relatively little advanced development and no engineering.

In RCA Laboratories we have an outstanding but conventional technical library to satisfy the information needs of our technical staff. It is somewhat "outgoing" in that it does distribute to the technical staff copies of the tables of contents of all the current technical journals received. Recently we have been considering the possibility of establishing a more formal type of information service. Making a commitment to prepare a paper on the evaluation of information services is timely and has provided an additional incentive to give some serious thought to the subject. Unfortunately, the one result of that thought has been to raise the author's estimate of the complexity of the problem by several orders of magnitude and to uncover some significant dangers in an uninformed experimental approach. Incidentally, the conclusions reached here, largely on theoretical grounds, are very close to the conclusions reached in careful independent studies by individuals looking at the practical side of the problem in our laboratory.

In this paper an information service is considered to be an organization with a responsibility to take *positive* action toward satisfying the information needs of the technical staff it serves. It is distinguished from information retrieval systems (machine or manual) which are considered as responsive only to *requests* for specific information. A middle ground is possible, of course, in which the individuals providing information services to a specific research project are an integral part of the technical team working on the project.

A study of literature on the subject has been both confusing and disappointing. These seems to be a tendency to pick out a small part of the problem and make an intensive study of that part. This is a valid scientific approach, provided there is a good understanding of the whole problem and of the relationship the part bears to the whole. Unfortunately, the problem is too often vaguely described as "satisfying the user's need for information" without defining the need or appearing to