services, recommendations for new services, and elimination of unnecessary overlaps; and

3. A secretariat that implements plans and requirements of both the advisory committee and managers' council or that operates the network coordination.

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There is little doubt in anyone's mind about the information explosion. An abundance of printed paper is produced in increasing amounts every year. The bill for this material is rising to staggering amounts. Subscriptions to the proceedings of professional organizations run into hundreds of dollars annually. Worse still, the pressure for growth remains unabated. There is much talk about the problem, but little is being done about it.

One approach toward the solution of this problem might lie in the slumbering capabilities of automated information-handling systems. Automated systems offer "instantaneous" access, even over long distances. They use abstracting effectively; they allow easy interaction nationally and even internationally. But these advantages alone merely aggravate the documentation flood. The real benefits of automation lie in the opportunity for selectivity and feedback. We must harness the quantity of the flood to satisfy specific needs of the user, and we must improve the quality of the information flow through feedback from the user. Although the first of these needs is being tackled through the development of improved search procedures, the ultimate utility depends on both selection in quantity and improvement in quality.

The work of the TRISNET committee during 1973 focused on the user through a user subcommittee. The most important result of that committee's deliberation is the call for much deeper and more conscious involvement of users in the development of an information system tailored to their needs. As in the political process, everyone complains about it, but few get involved. Everyone complains about the problems of information management, yet few take the time and effort to spell out their complaints and to detail their wishes. Maybe this is so because users themselves do not know what they really want. Nevertheless, it is important that interested researchers and practitioners of transportation get seriously involved in the solution to the information problem and make their needs known where it counts.

The TRISNET user subcommittee identified, among others, 3 suggestions for better recognition of user needs: a user conference, a market survey of information users, and evaluation by user feedback.

USER CONFERENCE

"If you don't know what I want, how can I?" Most librarians know this question only too well, even if few researchers or students ask it quite that bluntly. But it strikes at the heart of the problem: How can we define what the user wants, if no one, including the user, knows?

One approach suggested is a user needs conference, which brings together some sympathetic professionals who are users of information. Their needs and preferences, both expressed and implied, are essentially the criteria that ultimately decide the success or failure of any information system.

The conference must encourage the participants to think for some time about their information interests and needs. Most people come with a vague notion of an information problem. Often they do not even know precisely what question they need information on. The initial question is immediately modified by the available information. The user conference is intended to focus on this problem and to encourage the user to formalize his or her needs into what might be called an ideal set of information requirements. It is hoped that such ideal information criteria will provide an important step in developing a responsive information system for the future.

MARKET SURVEY

In contrast to the "idealistic" orientation of the user conference, a market survey is a down-to-earth inquiry into the potential use of information as it will be provided by TRISNET. Who wants it? At what price? In what form? More basic still: Who is willing to incorporate a new approach of information management such as TRISNET? And what must TRISNET learn about these markets to be able to appeal to them?

Initially, of course, the market survey is primarily concerned with heavy users of transportation research and development information: manufacturers of transportation products, operators of transportation systems, managers of transportation policy (government), and research and educational organizations. The market survey must try not only to identify the present needs of these users but also to test their reaction to future systems, such as those TRISNET intends to provide.

The market research should accumulate the needs of the major users of transportation information and disseminate the capabilities of TRISNET.

EVALUATION BY USER FEEDBACK

Probably the most important need for future information systems is the upgrading of information quality. This requires evaluation of stored information at various levels. Automated systems allow direct user feedback, thereby offering the best possible evaluation, namely, by the interested information user. The automated information system offers the development of a formal and responsive review process closely intertwined with the document search and display procedure (Fig. 6). This would take 3 increasingly complex levels.

The first is a passive review that merely records whenever the document is requested by a reviewer and judges the appeal of the title by accumulating for each document the number of calls for review.

The second kind of review asks the reader to make a judgment on the material he or she has searched and reviewed. After the document abstract has been displayed for reading, the reader is asked to record his reactions in a multiple-choice statement as follows:

> For our evaluation of the utility of the document abstracts we have stored in this system, we would like to have your own reaction to the document abstract you have just seen. Please help us by checking the appropriate response below:
>
> | | |
> |---|---|
> | Title alone already indicated that document is of no interest to me. | 1 |
> | After reading the abstract, I found the document to have no relevance to my present inquiry. | 2 |
> | I read the abstract and got relevant information, but need no further input from this document. | 3 |
> | I found the document very important and request a look at the source document. | 4 |
> | I want to have a discussion with the author. | 5 |

These reactions, when accumulated for many readers, will be useful for abstracting, file updating, and for the author.

The third review applies whenever the reader requests the full document. A follow-up questionnaire is supplied with the document, and the questionnaire results are collected in conjunction with the document record in the automated file for use by the author and file manager (Fig. 7).

These relatively simply evaluations could help provide a sound file management procedure, and, even more important, would provide valuable feedback for authors. An example of level 1 and level 2 evaluations is outlined in the following paragraphs.

Figure 6. On-line document evaluation.

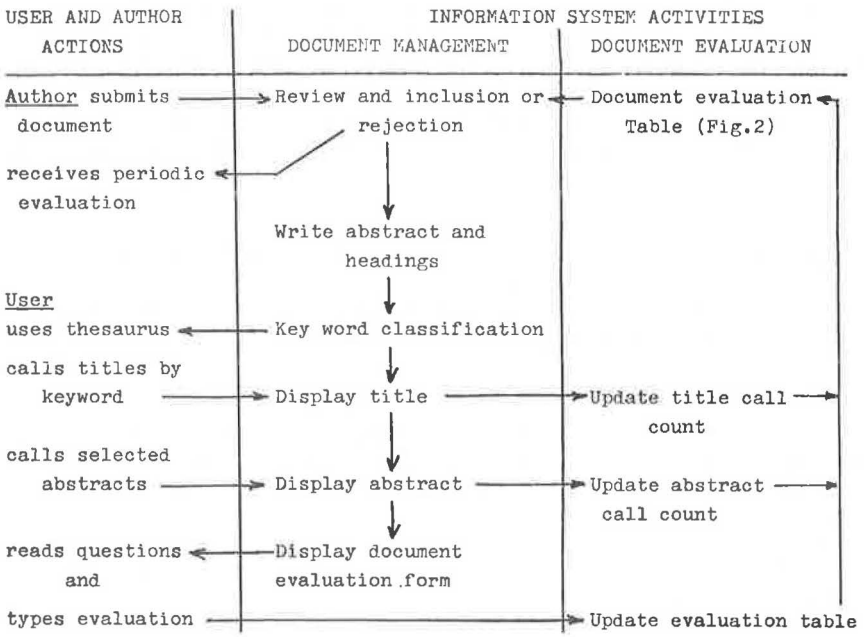

Figure 7. Hypothetical document evaluation table.

KEY WORDS BY WHICH DOCUMENT IS CLASSIFIED	NO. OF TIMES DOCUMENT HAS BEEN CALLED FOR IN THREE MONTHS ENDING: 3/74	6/74	9/74	12/74	TO DATE CUMULATIVE USER REACTIONS (BY KEY WORD OF RECALL) UNINTERESTED AFTER SEEING: TITLE	ABSTRACT	INTERESTED AND ACTION TAKEN: REVIEW ABSTRACT ONLY	REQUEST SOURCE MATERIAL	CONTACT AUTHOR
1) Highway Safety	12	8			9	4	4	3	-
2) Intersection	3	7			10	-	-	-	-
3) Accident Analys.	2	5			-	3	1	1	2
4) Acc.Prevention	31	35			62	3	-	-	1
5) Comb.: 2+4	11	6			8	5	3	1	-
6) Comb.: 2+3	3	4			-	3	3	-	1
	62	65			107		20		

Characteristics of Stored Information

It is assumed that stored information contains the following:

1. Information about report content, as stored in the title and the abstract;
2. Information as to the person or organization that did the work, as stored in authors' names, research or publishing house, sponsoring agency, legal authorization;
3. Size of the underlying activity effort, such as number of pages of report, amount of dollars spent, number of man-years invested;
4. Timeliness, as reported by the date of publication, possible references to previous works; and
5. Relation to other related activities as reported in bibliographies, reference list.

Characteristic of Evaluation

Each information item stored in the system has a value to the user community. This value is initially unknown but estimated by the author and those deciding to put the document in the system. Supposedly the information is introduced on the basis of a subjective evaluation by one of the officers of the system or by a review committee. Such an evaluation is both expensive and likely to be very superficial and subjective and should be replaced or strengthened by a more objective evaluation that is being undertaken as the user reacts to the material in the system itself.

There are essentially 2 aspects of evaluation. One relates to the general interest in the subject matter to which this piece of information belongs. In other words, how many times will this information be called by a keyword search? The second evaluation is one undertaken after the user has reviewed the abstract and evaluated it as to its utility for his or her own purposes. This then would evaluate the specific abstract retrieved from the file. This evaluation would tell whether the user is at all interested in the information and whether the user requests the source document or contacts the researcher who did the work. Figure 6 shows the role of proposed evaluations.

Title Recall Tally

The first check on stored information should be made on the number of times it is recalled in a search process. Since such calls are being made on keywords that have little, if any, relation to the information itself, this tally evaluates the popularity of the title but not of the document itself. It, therefore, is a check on the keyword structure and on the popularity of the general subject matter to which the document is addressed.

A tally should be kept of the number of times a document is called. Preferably this should be broken down by the keyword and by the quarter or month of the year in which the call is made. Thus, there would be a table of keywords and months with entries as to the number of calls in each spot (Fig. 7). This evaluation could be helpful in improving the keyword structure and in the application of keywords to information abstracts.

Instantaneous User Evaluation of Displayed Document Abstract

When a search is made, the user may look at each information entry and scan as much or as little of the information contained on each record as needed. When the user thus reviews each abstract, he or she takes one of the following actions:

1. Rejects the title because it obviously does not contain the information expected from the use of this keyword or keyword combination;
2. Rejects the document because a scan of the abstract reveals that it did not contain the specific information needed;
3. Reads the abstract and gets satisfactory information out of it;
4. Is definitely interested in the information and requests to see the source document; and
5. Plans to explore this reference further and to talk with the author.

These 5 decisions are reached quickly and often almost subconsciously by most users. It should, therefore, be easy for the user to check on a list like that given above one of the 5 uses for each document reviewed. The user reaction could be stored in the evaluation table at the bottom of each document (Fig. 7). In any case, the appropriate reaction of all users should be related to each document.

The array of the evaluative information should be related to the keyword rather than to the date. It is conceivable that a document may be more useful for one keyword than for another, and it is less likely that a document changes utility over time. Consequently, an evaluative matrix should contain the evaluation codes from the users in line with each keyword, as shown in Figure 7.

Evaluation

We now have user reactions that evaluate the keyword structure and the stored abstracts as to their utility for user-inquiry procedures. But this may be an enormous amount of information, especially for systems with 50,000 entries. Therefore, automating the evaluation of the user reactions is absolutely essential. Some suggestions for such evaluations to be developed as we work with the system are as follows.

Key Word Reject—Keywords are the basic components of the classification system; they are intended to lead the user as quickly and as easily as possible to the desired information. To do so, keywords must strike a balance between generality and specificity. Too much or too little use of a word is bad. Thus, each quarter the computer should sum total uses of each keyword and print out an (ordered) listing by number of uses. The upper and lower end of such a list should then be carefully reviewed for omission or subdivision of the word.

Keyword Structure Hierarchy—An effective classification system needs at least a minimal hierarchical structure. This implies combinations or nesting of keywords. Such combinations could be evaluated first as to number of requests (Fig. 7) and second as to the number of positive uses (items 3, 4, and 5, Fig. 7) obtained for each word combination. An automatic evaluation might, for instance, compute the ratio of positive user responses to total requests for each word combination. This might then be printed as an ordered list and evaluated by the system staff as to the success or failure of certain word combinations. More specifically, improvements in the classification structure should follow the word combination concepts that demonstrated the highest utility ratio.

Document Classification Correctness—Each document is classified by a list of keywords. Some of these words are likely more appropriate for the document than others. This becomes obvious when one looks at the evaluation table (Fig. 7). Keywords that are consistently negatively evaluated by the users (such as "intersection" and "accident prevention," Fig. 7) are obviously not appropriate for this document. To detect such wrong classifications, we might ask the computer to compute for each keyword the ratio of positive versus total responses and to provide an ordered list of all ratios below a certain cutoff value, say, 1/100. This would show, for instance, that "intersection" was not a useful keyword for the document. "Accident prevention" had at least one positive response and, therefore, a ratio of 1/66. The appropriate cutoff value should, of course, be determined from actual experience with the system.

Document Value—There are, of course, good and bad reports. And it is one of the agonies of librarians to have to decide what is bad and should be left out of a collection. The evaluation matrix should provide a definite, albeit limited, help. If a document is reasonably well classified and abstracted, it should draw at least a certain amount of positive user responses.

The evaluation of user responses has various aspects. It combines the number of calls for the document with the user evaluation. If the document is not called for at all, we can say something about its limited interest utility but nothing about its quality. A small number of requests with a high utility might combine effective classification, a good abstract, and a high-quality document. This might be a desirable overall goal. A high number of requests with a low utility ratio could imply poor classification or a poor document or both.

We may wish to look at those documents that receive no requests and those that have a low utility ratio. We could program the computer to provide us with an ordered list of these.

For true quality evaluation, we definitely need a further step: the user evaluation of the source document. Although I judge this to be of highest importance, it is clearly outside the scope of this topic.

User Utility Characteristics—The 5 types of user reactions to the document abstract allow some judgment as to the type of use made of a document. How much is a title worth? How often is an abstract sufficient? When does the user want to talk to another author rather than read a report? Some of these questions may be answered by the evaluation table. First, summation might be made of all responses, both absolute and per document. This may lead to a result such as the following:

	Responses per Document	
Item	Reject	Useful
Title	89	
Abstract, not relevant	11	
Abstract, relevant		11
Source document		5
Author		4

Among other things, this shows a high reliance on title, a high ratio (107/20) of rejection to utility, and a large reliance on the abstracts.

SYSTEM IMPROVEMENTS

Looking back over the achievements of the TRISNET user subcommittee, one can be both elated and disappointed—elated by the very specific recommendations that were developed, but disappointed by the slow progress of information system improvement in general.

Something drastic must happen to our information system if we hope to improve its effectiveness. But effectiveness is more important than ever to ensure the technological development that many current social problems require. Energy shortages, environmental constraints, safety, and the question of social desirability of increased mobility are emerging broad interdisciplinary problems. To solve these problems, the storehouse of organized knowledge on design, construction, operation, and management of transportation systems seems gravely inadequate. We have both too little and too much information. What is needed is an all-encompassing structure for information collection, cataloging, evaluation, and redistribution.

Several important developments become necessary for the information inundation to become once again beneficial.

1. A reversal of emphasis from the author to the reader is needed. The present emphasis is on documentation of an author's work. This should be changed to emphasize the presentation of facts that might be useful to users of the information.
2. More overviews and state-of-the-art reports are needed. The existence of so much information requires that it be summarized and coordinated so that it is more readily usable by those who are not willing to invest a large amount of time and effort in literature searches. These kinds of research summary activities need a fundamental change in evaluation by the research and development community. They must be considered not only acceptable but truly desirable and worthy of the effort of serious and intelligent professionals.
3. Data and facts must be included in a centralized information system. The system should be able to retrieve facts and to assemble compatible facts in detailed data files. This development is clearly a long way in the future, but should be considered even at this stage since it depends not only on an adequate information handling system but, more important, on an intelligent breakdown of the pertinent material into retrievable facts. This approach depends critically on the dictionary or thesaurus de-

veloped for its use. For the user, this kind of system provides instantaneous access to both text and important facts needed.

The development of automated information systems has not yet affected critically the quality of information as perceived by the user. The ones most vitally affected by these automated systems are intermediate users, such as libraries and information offices that obtain easier referral service. But the expense and complexity of the system are much too large to be outweighed by this somewhat simplistic benefit. The potential advantages of the automated information system are much larger. The TRISNET system must be recognized and promoted actively by those who know or suspect its value. The information user who has in the past despaired about ever getting good information service must speak up and be heard. He or she cannot rely on the limited community of professional librarians or information managers to do the entire job. Users pay for the service and are the ultimate recipients of its advantages. They must make their preferences and interests known. More users must participate in the development of this exciting new resource for transportation research and development.

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My paper has 2 parts. The first provides a brief summary of TRISNET rationale and expectations, and the second suggests actions that should help to translate TRISNET concepts into reality.

TRISNET ENVIRONMENT

From a broad perspective, the rationale for TRISNET stems from an information crisis; a crisis that arrived shortly after World War II and that, despite efforts of many people and vigorous application of computers, has not yet begun to abate. Although this crisis is nothing like the environmental or energy crisis, nevertheless it is real and of major proportions. It has many dimensions, but I will mention only four.

First, there is the dimension of volume, better known as the paper blizzard. The volume of papers that accompany modern transactions is slowly getting out of hand. For example, the paperwork in the U.S. international trade alone is estimated to exceed 800 million documents and 6 billion copies per year (1). In the area closer to our technical interests, the accumulated stock of some 25 to 30 million documents is increasing by an annual addition of 1½ million of articles, reports, and books. Add to this thousands of millions of raw observations, miscellaneous measurements, and basic data that require special processing before they are converted into technical reports (2) and the problem acquires truly serious proportions.

Second, the dimension of experience has created a sort of "technical literacy gap" (3). The introduction of computers to deal with the paper blizzard has brought a gap of competence, which shows in many instances between the top management and the providers of information services, between generations of managers, between information users and information providers, and between transportation researchers and transportation planners. My department, for example, is spending considerable resources for the development of computerized planning and decision models. In most instances, these models will land in musty document repositories because very few users are currently capable of applying them in real-life situations. Similarly, advanced computer programs that can simplify and speed up the organization and use of technical and managerial information exist, but their full exploitation depends as much on the background of the user as on the efficiency of the computer.

The third dimension is that of information quality. Despite the progress that has been achieved in screening large data bases against technical keywords and despite many fine "selective dissemination" schemes, we have yet to find a way of discrimi-