This paper discusses the area of the question—its generation, its relation to the retrieval system, and its effect on the inquirer. Four levels of question formation may be isolated and analysed: the actual, but unexpressed, need for information; the conscious within-brain description of the need; the formal statement of the question; and the question as presented to the information system. Input and output characteristics of systems are examined for their effect on the inquirer's decision to ask a question and on the form the query takes. Investigation of six parameters governing question type and ambiguity argues that we may be placing too much emphasis on syntactic matching of inquiry and store of answers. The inquirer's state of readiness is defined as the "state of mind" which allows a selection to be made from a series of messages. A question is seen as an indication of inadequacy on the part of the inquirer who hopes to remedy that inadequacy by calling on the information system. A major objective of information systems is to make commonplace the point of maximum usefulness where three coordinates cross: level of question, state of readiness, and available answer.

The Process of Asking Questions

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• Introduction

In the concern of the past decade for the storage and retrieval of recorded information, relatively little attention has been given to the area of the question—its generation, its relation to the retrieval system, and its effect on the inquirer. To be sure, many pious words have been heaped on that paragon of virtue, the user. On occasion, however, an uneasy voice asks if the systems we are designing may be technically too advanced (but socially maladjusted) for present use. The user has thus been faced with two choices: "wanting what he gets", or setting up his private information system which excludes information beyond his familiar sources.

It is not the purpose of this paper, however, to discuss the criteria for information systems. Its objective is to explore the territory of questions and answers to mark out the major features, the limits, and the areas that might be fruitfully investigated. Instead of offering an analysis of *the culture of man-system* relationships, we will examine the individual's approach to question formation, question asking, and answer receiving. This is a rhetorical paper, posing more "questions" than "answers."

Before exploring the area, we should examine the luggage we carry, for some of it may impede our progress. Although we probably cannot discard any at the moment, we can at least scan it to determine what may be suspect.

Despite the words "information retrieval", we deal with discrete things—books, reports, papers, drawings, etc.—rather than with information *per se*. This may be the problem, although there is little we can do about it now except to note the fact. We want information, although our questions are molded by the anticipated receipt of physical items. This relationship between what we want and what we expect to get is crucial to the discussion of questions.

Approached from the complex of communication, these physical pieces are seen as coupling devices between the generator and the user of information (2). Our ideal is to bring two people together through the printed page. We assume that man talking with man is the best possible form of communication. A high level of noise exists in person-to-person communication. We seem, however, to be able to separate signal and noise in oral communication better (on a short-term basis) than in written communication. The latter, however, enjoys a higher esteem in the traditions of Western civilization. It is worth considering whether the rigidities of print impose an excessive restraint in reducing noise at the expense of communication. Although such an analysis is not part of this paper, it exists as part of our baggage.

Within the limitations imposed by the discrete item and the possible rigidities of print, our systems aim at exhaustive answers. The exhaustive answer is seldom required in research. Capability for a spectrum of answers to a stated need requires closer attention. At the present time, filtering for the answer spectrum depends on (a) the analytic and interpretive skill of the inquirer before asking the question; (b) a middleman; or (c) the inquirer himself after the retrieval process. Of these, (a) and (c) are not considered part of the information system, and often the middleman is excluded. We tend to think that when we have "answered" a question, via the system, the process is completed. From the inquirer's side it has only begun. His need for information is not at an end; it has only changed. Our traditions and the present necessities of information handling force both designer and user to think in terms of a series of separate fixed demands without attempting continuity.

At the same time this concept of discrete demand and exhaustiveness is reflected in the approach to the question by both user and designer. Several inquirers may, for example, ask the same question—or what is assumed to be the same question—and each receives, as answer, the same set of messages. However, on scanning, each person picks out a different subset of the total package (S_1, $S_2 \ldots S_k$) as relevant to his question. Although their verbally stated questions were the same, it is obvious that each inquirer must have had a different need. Yet we prescribe the same medicine for each. It is therefore necessary to examine this range of ignorance from inchoate need to the question asked of the system.

• Question Formation

There are in general four levels of question formation. In separating this process into a series of categories, we are performing two actions which may distort reality. In this exploratory examination, however, our only method is to scan large areas in the hope that more specific analysis in the future will blunt the edges of our classification. In the first place we are assuming that a need for information is something distinct and traceable. And secondly, though we talk of process (meaning movement), we are disregarding the infinite variations and combinations, both pertinent and impertinent, that impinge upon the mental image of a concept as it develops.

1. First of all, there is the conscious and unconscious need for information not existing in the remembered experience of the investigator. This comes at a variety of stages in an investigation (8). It may be only a vague sort of dissatisfaction and may, in fact, be disregarded as the investigation develops. If it assumes eventual importance in the inquirer's mind, it is probably inexpressible at this stage, except as a dissatisfaction. This need will change in form, quality, concreteness, and criteria as information is added or as it is influenced by analogy. In terms of the query range, this level might be called the "ideal question"—the question which would bring from the ideal system exactly what the inquirer needed, if he could state his need.

2. In progressing toward the concrete, the next form of need is the conscious mental description of an ill-defined area of indecision. Such a description will be an ambiguous and rambling statement. It is worth noting that, at this point, the inquirer might talk to someone else in the field to sharpen his focus or even to get an (the) answer. When he asks a question of someone else in this manner, he does not think in terms of discrete blocks of information or of an organized message. He is ambiguous in his descriptions and statements. He qualifies his area of doubt by various oral and physical means. He presumably hopes that two elements will be present: (a) an understanding of the ambiguities by his receiver; and (b) the gradual disappearance of these ambiguities in the course of the dialogue. In fruitful dialogue he can expect constant feedback, something a formal information system cannot yet provide.

3. At this level a researcher can form a properly qualified and rational statement of his question. Dependent on the type of need and requirements, he may be able to state this query with little awareness of the inchoate processes of levels 1 and 2. This statement is a rational and unambiguous description of his doubts. This question is what we like to believe the information system answers. It may not be, however, and probably is not, the question asked of the system.

4. The question is recast in anticipation of what the inquirer thinks he will get out of the system. Here he must think in terms of the discrete messages he hopes to retrieve—books, reports, papers, drawings, etc. The question must fit the "idiot" system, in which nuance, subtlety, and qualification are not recognized, only gross verbal surrogates. Further consideration of these problems follows in the discussion of man-system interaction.

In summary, these four levels of information need may be outlined in the following form (6):

Q_1—the actual, but unexpressed, need for information (the *visceral* need);
Q_2—the conscious within-brain description of the need (the *conscious* need);
Q_3—the formal statement of the question (the *formalized* need);
Q_4—the question as presented to the information system (the *compromised* need).

A number of changes can be noted in this transition from Q_1 to Q_4: from psychological to logical; from ambiguity to rigidity; from complex to simple. How much does each of these transitions affect the capability of Q_4 to serve the actual need?

• Man-System Interaction

Three categories of problems exist in the interaction between inquirer and information system.

1. Organization of the system, including input and output characteristics;
2. The type, complexity and subject characteristics of the question (Q_t);
3. The state of readiness of the inquirer.

Each problem has a wide range of variables which influence the degree of success. Like all attempts to pigeonhole social interaction, none of the categories is independent. They interact with each other; change in one variable may affect several others. But as a tentative grouping they form the basis for the discussion which follows.

SYSTEM ORGANIZATION

There are variables within any system which affect the question and its formation. For convenience, these are divided into five groups: general aspects; system input; internal organization; question input; and output.

1. *General.* The factors here are physical and geographical. Of importance is whether the system is manual, completely automatic, or some combination of these two. How many steps are there between the original request and the final receipt of material, and what is the time span? The amount of work the inquirer must do himself may be crucial, as well as the physical distance from him to the system. Distance and work will affect the type of question put to a system by filtering out questions the inquirer may feel are not worth the trouble. Expected extensive time lapse from query to receipt of answer will also filter out certain inquiries.

2. *System-input.* What type of material is put into the system, and what is the unit item? Letters, equipment description, and engineering drawings affect the type of question in quite a different manner than theoretical papers. The degree of grossness of the basic input unit, from book to atomic sentence, will affect the inclusiveness of the question and the anticipation of the inquirer. From experience with the system, the inquirer builds an image of the skills and substantive knowledge of the indexers and analysts who control the input. This image, whether it is in fact valid or not, influences his confidence, or lack of confidence, and therefore the size and shape of his question.

3. *Internal organization.* Here we are dealing primarily with classification, indexing, subject-heading, and similar access schemes. What is the degree of sophistication in the use of terms? To what "depth" is the unit analysed and indexed? To what level of specificity and refinement do the terms go? A system serving a number of different disciplines, under present cost conditions, has less depth and refinement than a system designed to serve a small and specifically defined subject. This level influences the grossness of the inquiry. The extent and directiveness of interconnection among the terms determines the degree of allowable ambiguity, sophistication, and qualification in the inquiry. Such interconnections range from "see" and "see also" references to the assignment of quantitative relevance indicators, and from simple subject-heading lists to intricately designed thesauri with careful vocabulary control. All of these internal refinements will increase the capability of distinguishing between superficially similar queries which require different types of answers.

4. *Question Input.* What part do human operators play in the total system? In the question-answer cycle, there may be extensive and skilled interviewing, or "negotiating" the question, preliminary to actual searching. The degree and success of such negotiation will sharpen and qualify the query. If there is no preliminary interview, then the crucial factor in successful question formation is the simplicity in the translation process from the inquirer's language to that of the system. Success is measured by the level of pertinency and completeness of the answer with least amount of semantic noise and irrelevant information.

5. *Output.* A most important form of output is interim feedback, which will sharpen the focus of the question after the search has started. Interim feedback is a type of "is this what you mean?" question, the answer to which guides the system in setting limits to the search and the inquirer in defining his terms. What is the physical form of the output? Address numbers, bibliography, simple to extensive abstracts, a series of papers in microform or in normal readable form—all of these will have a bearing on the personal decision to ask a given type of question. If it means tedious searching for the physical piece, many questions will be filtered out as not worth the trouble. A point of importance often overlooked in the output cycle is the ability of the system to produce analogous or negative information. Such system capability influences the intricacy of the question and its analysis preliminary to searching.

QUESTION TYPE AND COMPLEXITY

This section includes discussion not only of the formal syntactical characteristics of the question but also of the expected type of answer. By asking a question, the inquirer imposes limits on the information acceptable as an answer. The converse of this statement is the postulate that knowing what counts as an answer is equivalent to knowing the question (1, 7). In imposing limits, i.e., asking the question, the inquirer defines and qualifies terms, hoping to reduce ambiguity in order to match the system language efficiently. These rather simple concepts assume a single correct answer to a question, or a single subset of the answer universe. Unfortunately, the process is not this simple, not only because of multiple interpretations but also because the inquirer himself is indecisive. The former produces ambiguity; the latter, in skilled hands, produces what might be called controlled imprecision.

The concept of acceptability, i.e., what counts as an answer, is an important approach to the question-answer process. Future analysis will, we feel, prove fruitful in the process of negotiating the question. However, what is acceptable within the confines of Q_1, the question asked the system, may not be acceptable (or only partially so) to the expectancies of Q_2 or Q_3, the levels closer to actual need. The information system with present design characteristics can, of course, only be concerned with Q_1. Our ideal, however, is to allow Q_1 to move in the direction of the actual need. Further discussion of this point is relevant to the comments on the concept of readiness in the next section.

The limits which define the acceptability of answers may also serve some purpose in determining the type of question. We attempt here a tentative listing of the grosser parameters governing question type.

1. The *subject matter* has an influence on expected answers in various ways: level of formal classification; amount of quantification; accepted definitions; theoretical concepts; relations to other fields; size of the specific field of knowledge; controversy or differing schools of thought; and the traditional habits of research and literature use in the field. The extent of influence of these factors on the question has never been analysed.

2. Assuming a multi-dimensional space with coordinates ranging from *empirical data to theoretical concepts*, the question can be located as a point. The coordinates of that point would serve to define the general level of anticipated concreteness in the answer. Such coordinates might include descriptive data, experimental evidence, historical material, analysis of results, and similar descriptive categories of information interpretation.

3. The *degree of ambiguity* of question terms specifies the level of concreteness in a different way. A substance with a given number of measurable quantitative attributes is quite different from a social concept such as "peace", regardless of the number of words used to define and limit the latter. Examples of this type of ambiguity are obvious. What is not so obvious is the role that ambiguity plays in the question-answer cycle.

4. The *size* of the anticipated answer can range from a single number to a state of the art review. The size of the answer is determined by the inquirer's approach, from a rigidly defined question to one that is purposely imprecise in order to "fail-safe".

5. The amount of *research*—particularly experimental—by someone else in the field *known to the inquirer* and incorporated in the question gives direction to the query and may define a subsidiary strategy such as a citation search.

6. The *intrinsic syntactic structure of the question* will certainly influence both search strategy and answer success. It is made up of the following variables:

   a. number of significant terms;
   b. number, type and direction of verbs, modifiers and connectives;
   c. the level of logical complexity in the interrelationships among terms;
   d. degree of similarity between the question language and the system language.

These syntactic variables, when considered together, form what we might call the structure-index of the question—its degree of formal complexity. This index imposes the final form on the question and sets the specifications for the search. With its attributes, this is what is matched with the set of answers in the system. The extent of matching determines the success of the system *at the formal level*. This match is the usual test of system effectiveness. The argument of this paper is that, although this may be one valid criteria in the judgment of success, it is neither the only one nor the most important one.

THE STATE OF READINESS

Macroscopically, the readiness of the inquirer is established by his educational and experiential background, the degree of his familiarity with the specific subject, the amount and quality of relevant peripheral information he possesses, and his intuitive sense of analogy. These form the context of readiness. They do not tell us much about the inquirer's state of mind at a specific moment in relation to a particular investigation.

For our purposes here, readiness may be defined as the "state of mind" which allows a selection to be made from a series of messages. A question is an attempt to shown an "indication of inadequacy" (6) in the inquirer's state of readiness. He hopes by this means to elicit from the receiver (the storage system, etc.) some organizing work to remedy that inadequacy. "It is," D. M. MacKay writes, "as if the questioner uncovered and held out the incomplete part of his organizing system to the receiver for his attention" (4). The state of readiness is not, of course, a fixed position, but a constantly shifting non-linear adaptive mechanism. Acceptance of information as relevant defines readiness before that information was available and causes a change in the inquirer's future state of readiness. He is now prepared and able to determine the relevance to his needs of a different set of messages.

Within the universe of the inquirer, the messages (documents, etc.) stored in the system have no relevance to the inquirer's need until he initiates a question. The indexing and analysis of the input process normally considers relevance to a series of given subjects in a formal and generalized fashion. Such analysis anticipates certain hypothetical queries and conceptual relationships by the users of the system. This was pertinent to our previous discussion on the variables of system organization. That we would like to bring input analysis and answer output closer together is not the problem here. At this point we are concerned only with the "state of mind" necessary to decide that *this* item of information is relevant and *that* one is not.

Within our frame of reference here, to frame a question is to define or specify a subset of undetermined responses.

i.e., the inquirer's doubts. We cannot ask significant questions about something we cannot describe and limit in some minimal fashion. This minimal threshold—the description of our doubts—invites a selection in the specified response space, i.e., some level of answer. Therefore, to receive an answer is to determine a subset of responses which until that time were undetermined or only partly determined (3). Information which operates in a subspace *not* specified in the question is "irrelevant information;" that is, it is irrelevant to the specified question (though possibly not to the inquirer's needs). This observation, however, brings up the problem of browsing, which is too large and complex to discuss here.

At this point it is worthwhile to re-examine the usual symbolism adapted from Shannon's Theory of Information to portray the process of communication. We are not concerned here with a defense of the use of this symbolism, but rather with the analogies and assumptions that lead to its use. It usually runs something like this:

Originator → Transmitter → Channel → Receiver → Brain
(Storage) (Message) (Inquirer)

Occasionally (and reluctantly) we reverse the process; i.e., the arrows run the other way. Such a change, however, is only made half-heartedly, for our base of operations is the "storage", i.e., the collection of documents. In such a symbolism we are concerned primarily with two things: a) the accuracy of the transmitted signal *to* the receiver; and b) "evoking in the receiver [inquirer] a state of readiness in some desired respects similar to that of the originator" (3). In the analysis of this paper, however, we are really not concerned with the sender (generator of information, storage system), but with the receiver (inquirer). For our purposes, the inquirer is the "originator", for it is he who initiates, he who asks the question. He defines and specifies a subset of undetermined responses, and invites the sender (or set of senders) to organize and clarify his doubts and inadequacies. The accuracy of transmission of the messages is not the most important point here. More important is the accurate description and communication of the inquirer's "doubts" (the question). Distortion of the need of the inquirer has more significance in our analysis than distortion of the messages from the collection.

This discussion relates directly to our previous analysis of question levels, Q_1 to Q_4. The state of readiness is a correlate of the level of question. At the various levels of need or questions, our "threshold of doubt" alters, not only substantively as we are able to clarify ambiguities but also in expressed linguistic and syntactical form. It would be worth considering whether there is a stage where the relations between the state of readiness and the level of question reach an optimum point—where an answer will be most useful. At present we can only speculate. We all know the experience of receiving pertinent information too late, or even too early, before we are "ready" for it. We consider it akin to a miracle that information is received at precisely the right moment. A major objective should be to make commonplace this point of maximum usefulness where the three coordinates cross: level of question, state of readiness, and available answer.

Significant as a form of readiness, but seldom mentioned, is the motivation of the researcher. Calvin Mooers touched on it, almost whimsically, in the laconic statement known as Mooers' Law: "An information system will tend not to be used whenever it is more painful and troublesome for a customer to have information than for him not to have it" (5). Although a large topic of study in itself, motivation of the inquirer must be mentioned as a major determinant of his criteria of acceptance, his judgment of pertinence, and his desire for thoroughness. It will determine the level of "pain" and "trouble" he will take to get information.

• Summary of Problems

This paper has attempted to describe rhetorically (and sketchily) the universe of the inquirer: the processes he must perform, consciously or unconsciously, in order to obtain an answer from an information system; the effect a given system may have on him as he formulates his questions; and, conversely, the influence that he can have on both the short-term and long-term design of the system. In a sense we followed the process outlined in this paper. We tried to define our doubts, to state questions, to order and to analyze the field of inquiry by categorization and classification. That such a description may be ambiguous and a distortion of reality is inevitable. It is, however, necessary to isolate the single elements and variables of the process so that they are amenable to future observation, experimentation, and eventual synthesis.

As we stated at the beginning of this paper, more "questions" are posed than "answers" given. Among the many problems discussed, five might be singled out as responsive to experimentation and analysis now.

1. What is the relationship between what we want and can describe (Q_3) and what we anticipate from the system (Q_4)? How do the transitions from inchoate need (Q_1) to the compromised question (Q_4) affect the capability of the latter to serve the needs of the inquirer?

2. Are there methods of obtaining a spectrum of answers to questions superficially similar but originating in different needs? Are there ways of negotiating the question that would increase this capability? Can this art of negotiating the question be taught as a skill? What would such capability mean in terms of cost and system design?

3. What questions are *not* asked of a system because of physical inconvenience, design, or output characteristics? Are such questions answered in other ways? How important to an investigation are these questions?

4. How does an inquirer decide the pertinence or acceptability of answers received from the system? Can a valid and useful relationship be established between the question and the criteria of pertinence exercised by the inquirer?

5. What effect does subject matter—type of research and traditional approaches to literature—have on (a) the

actual use of stored information; (b) the formation of the question; and (c) the type of question? Can we expect certain types of inquiry from particular subject areas or at certain stages of investigative process? We acknowledge differences between, let us say, developmental engineering work and engineering research, chemical research and biological research. But what, in fact, are these differences, and how do they affect the design of information systems?

These areas of ignorance require discussion, experimentation, and analysis, not only for better design, but also to make the information system an effective and continuous element in the research process. The approach to such a Utopia will come only when we recognize that the inquirer is an integral part of the information system and not a stranger knocking at the door for directions.

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