CENTER FOR THE INFORMATION SCIENCES
LEHIGH UNIVERSITY BETHLEHEM, PENNSYLVANIA

STUDIES IN THE MAN-SYSTEM INTERFACE IN LIBRARIES

Report No. 3

Question-Negotiation and Information-Seeking in Libraries

by
Robert S. Taylor
Director, Center for the
Information Sciences

The work reported here was supported by grant from the Air Force Office of Aerospace Research, AF-AFOSR-724-66.

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Report No. 1. Caroline E. Hieber. An Analysis of Questions and Answers in Libraries. June 1966. (AD-635-020) (AF-AFOSR-724-66, Off. Ed. CRP No. S-235)

Report No. 2. Victor Rosenberg. The Application of Psychometric Techniques to Determine the Attitudes of Individuals Toward Information-Seeking. July 1966. (AD-637-713) (AF-AFOSR-724-66, NSF-GE-2569)

Report No. 3. Robert S. Taylor. Question-Negotiation and Information-Seeking in Libraries. July 1967. (AF-AFOSR-724-66)

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Abstract

This report is a study of two types of the process of question-negotiation in libraries and information centers. Through taped interviews with special librarians and information specialists, five levels of information were isolated which are consciously sought and received by the librarian in the negotiation process. These are (1) subject definition; (2) objective and motivation; (3) personal characteristics of the inquirer; (4) relationship of inquiry description to file organization; (5) anticipated or acceptable answers. The second type of negotiation, self-help, is that in which the inquirer alone negotiates with the total information system. Undergraduate students in courses in the information sciences reported on this process resulting from a self-generated information need: the decisions and strategies; the sources used, both human and print; the complexities and failures of their processes; and the ambiguities of their question-asking strategies. Four such reports, including systems charts, are shown in the Appendices. The two types are compared with recommendations for improving the displays at the interface between inquirer and system.

Chapter 1: Introduction

The major problem facing libraries, and similar information systems, is how to proceed from "things as they are now" to "things as they may be." It is an illuminating exercise to extrapolate from present technology to describe the library of the future. However, such exercises have little to say as to how to proceed from "now" to "then" (15).

There are two possible alternatives to this process of change, with a whole range of options (7). First, the revolutionary concept: libraries will wither away and their place in the communications network will be taken by some new institutional form, probably imposed from the outside. The second one, an evolutionary development, is that libraries themselves will gradually make the transition.

The work described here is based on the second alternative. The objective was to examine and analyze certain relationships between library system and library user. It is hoped that this report develops sufficiently fruitful generalizations, so that further investigations can start at a different level, with new assumptions. It is further hoped that, as a result of future investigations in this area, the evolution of libraries from passive warehouses to dynamic communication centers will be less traumatic and more effective.

This report is not concerned with the usual library automation, although I am cognizant of the effect that automation may have on the interface between user and system. In time, the automation of routine processes, i.e. order, catalog, and circulation control, after the bugs are worked out, will allow a different level of interaction. But routine automation is merely an extension of the control and warehousing functions of libraries. The work described here is an early effort to understand better the communications functions of libraries and similar types of information centers, <u>because this is what libraries are all about</u>.

Consequently I have been concerned with two phases of this interface, which revolve around the process of negotiating the question.

This act of negotiation usually takes one or both of these forms: (a) working through a human intermediary, i.e. the reference librarian; and (b) self-help, by which the user himself attempts, often unsuccessfully, to sharpen his question by interacting with the library and its contents.

Reference librarians and information specialists have developed, both consciously and unconsciously, rather sophisticated methods of interrogating users. These methods are difficult to describe, indeed some believe they are indescribable. I have made no such assumption, in the belief that there are gross categories or levels of information which are consciously sought and received by the librarian in the negotiation process. We are dealing here of course with a very subtle problem - how one person tries to find out what another person wants to know, when the latter cannot describe his need precisely. There are a few good but unsystematic papers on the reference functions, but very little has been done of an analytical nature (8,9,17). This process is discussed in Chapter 2.

In the self-help process, the user depends upon his own knowledge, frequently incomplete, of the system. It appears that there are a large number of users of information systems who, for a variety of reasons, will not ask a librarian for assistance. They develop their own search strategy, neither very sure of what it is they want nor fully cognizant of the alternatives open to them. This process is discussed in Chapter 3.

Both of these processes have some things in common: the development of a strategy of search, and frequently a change in the type of answer anticipated or acceptable as the search or negotiation continues. There is an implicit assumption here, which intuitively seems valid. Most experimental work with retrieval systems and most attitudes toward reference questions look upon the inquiry and the relevance of answers as single events. This I believe to be mistaken. An inquiry is merely a micro-event in a shifting non-linear adaptive mechanism (15). Consequently, I prefer to look upon an inquiry not as a command, as in conventional search strategy, but rather as a description of an area of doubt in which the question is open-ended, negotiable, and dynamic (5,24).

Chapter 2 discusses and analyzes the negotiation process as practiced by reference librarians and information specialists. I am indebted to a

number of professionals who subjected themselves to a 60-90 minute taped interview. The interviews were limited to special librarians and information specialists for several reasons.* First, they are usually concerned with substantive questions. Second, their inquiries usually come from highly motivated and critical people who have an idea what is acceptable as an answer. Third, to find material, the librarian must understand and therefore must negotiate the question. In contrast, public and academic librarians, because of the nature of their clientele and institutions, have educational responsibilities which limit their response to inquiry. As one interviewed special librarian pointed out:

> "The levels of frustration in using libraries are awfully high for most people. It's amazing, as hard as we work at making ourselves popular with these people, we still have them come in and stand diffidently at our desk and say, 'Well, I don't want to interrupt, but...' To which I reply, 'If you don't interrupt me I don't have a job.' But it's amazing how people can't get over this. I think it would be a study in itself, that we grow up in school libraries, public libraries, and college libraries, generally where this kind of service is not provided. Consequently you are conditioned to feeling that the library is a place you almost have to drag something out of. The library is almost the last place they want to go, because they've been conditioned."**

I wish to acknowledge the help of Mrs. Margaret N. Sloane, Mr. Lee Magnolia, and Mr. Al Dunlap of TRW Systems, Redondo Beach, Cal.; Mr. Harvey Hammond of RAND Corp., Santa Monica, Cal.; Mr. Norman J. Crum of GE Tempo, Santa Barbara, Cal.; Mr. Alfred Anzalone, Plastics Technical Evaluation Center, Picatinny Arsenal, Dover, N. J.; Mr. John Whelan,

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*In this report, the designations "reference librarian", "librarian", "information specialist", and "subject specialist" are used interchangeably. There are differences. In this report these terms are used merely to identify the person negotiating the question, in contrast to the "inquirer", who poses the question and requires information in some form as an answer.

**Unacknowledged quotations in this report are from the taped interviews with reference librarians and information specialists. It was mutually agreed that such quotations would be anonymous. Minor editing has been done for clarity only.

Federal Aviation Agency, Washington, D. C.; Dr. Bernard Stevens, Bell Laboratories, Murray Hill, N. J.; Dr. F. E. McKenna, Air Reduction Co., Murray Hill, N. J.; and Miss Charlotte K. Boardman, General Precision Inc., Little Falls, N. J. I am particularly indebted to Grieg Aspnes of Cargill, Inc., Minneapolis, Minn., who, through correspondence, conversation, and lengthy phone calls, provided a good deal of the feedback necessary for this report. I also wish to acknowledge helpful discussions with James Olsen of the Lehigh University Library, Mrs. Charles O. Fredregill of the Texas Institute for Rehabilitation and Research, Houston, Texas, and James S. Green of the Center for the Information Sciences, Lehigh University.

The interviews were open-ended and unstructured (18,21). They were designed to elicit three things, described in the subject's own words:

1. What categories of information does a librarian attempt to obtain from an inquirer;

2. What is the role of system file organization in the negotiation process;

3. What kinds of answers will inquirers accept and what influence might this have on the negotiation process.

Chapter 3 pertains to the self-help process, i.e. how the user searches for information. For the data, I wish to acknowledge the assistance of my students in I.S. 202 (The Information Sciences) in 1965 and 1966, who performed searches and reported on their decision and search processes. Four of their reports on search strategy are included in Appendix B.

Chapter 2: Question Negotiation By Librarians

Without doubt, the negotiation of reference questions is one of the most complex acts of human communication (3,23). In this act, one person tries to describe for another person not something he knows, but rather something he does not know. Quantitative data about this process is non-existent and probably cannot be generated at the macro-level of this study. In spite of its complexity, however, it is possible to say certain things about it and to form a gross classification of the process. This is a first necessary step toward a basis for valid observation and the statement of testable hypotheses.

It is worthwhile in this consideration of the negotiation process to attempt to understand what a question is. Although reference librarians and other "question negotiators" count what are called "questions", this is not really what this report is concerned with. Let us attempt to reconstruct in general terms what this negotiation process is, that is, as it pertains to the interaction between an inquirer and an information specialist.

The inquirer has, what D. M. Mackay calls "a certain incompleteness in his picture of the world - an inadequacy in what we might call his 'state of readiness' to interact purposefully with the world around him," (16) in terms of a particular area of interest. He comes to the library or information center as one of several possible alternatives for information to fill out "his picture of the world." These alternatives themselves pose an important problem.

In Figure 1, at decision point A, the inquirer decides whether to discuss his problem with a colleague or to go to whatever literature or information center may be available. Before he disturbs a busy colleague, he is likely to make a minimum search of his own files. This will happen only, however, if he has analyzed his "inadequacy" sufficiently to be able even to look through his own files. This aspect is discussed below in the description of question level.

He also makes a second decision (B in Figure 1): to go to the

library or information center. This is an important choice and reflects a number of factors: previous experience, environment (is this an accepted procedure in his activity?), and ease of access. Studies of information-seeking behavior indicate, for example, that "ease of access" to an information system is more significant than "amount or quality of information" retrievable (22).

At decision point C he makes another choice of paths: (1) to ask an information specialist, or (2) to help himself. Most important in this decision is the inquirer's image of the personnel, their effectiveness, and his previous experience with this or any other library and librarian.

All three of these decisions will have an influence, largely undetermined, on the negotiation process. It is not, however, the intent of this study to do more than list these pre-negotiation choices as forming part of the context and background for the process itself.

Assuming that the inquirer has made these choices and has arrived at the desk of the information specialist, he then specifies in some form what it is he hopes to find out. "Arrived" can mean any of several communication modes: by letter, by telephone, or by direct face-to-face interview. It is at this point that negotiation begins. Before consideration of this process, it is first necessary to discuss various levels of questions. In general we can describe four levels of information need and the configuration of question which represents each level (19,24).

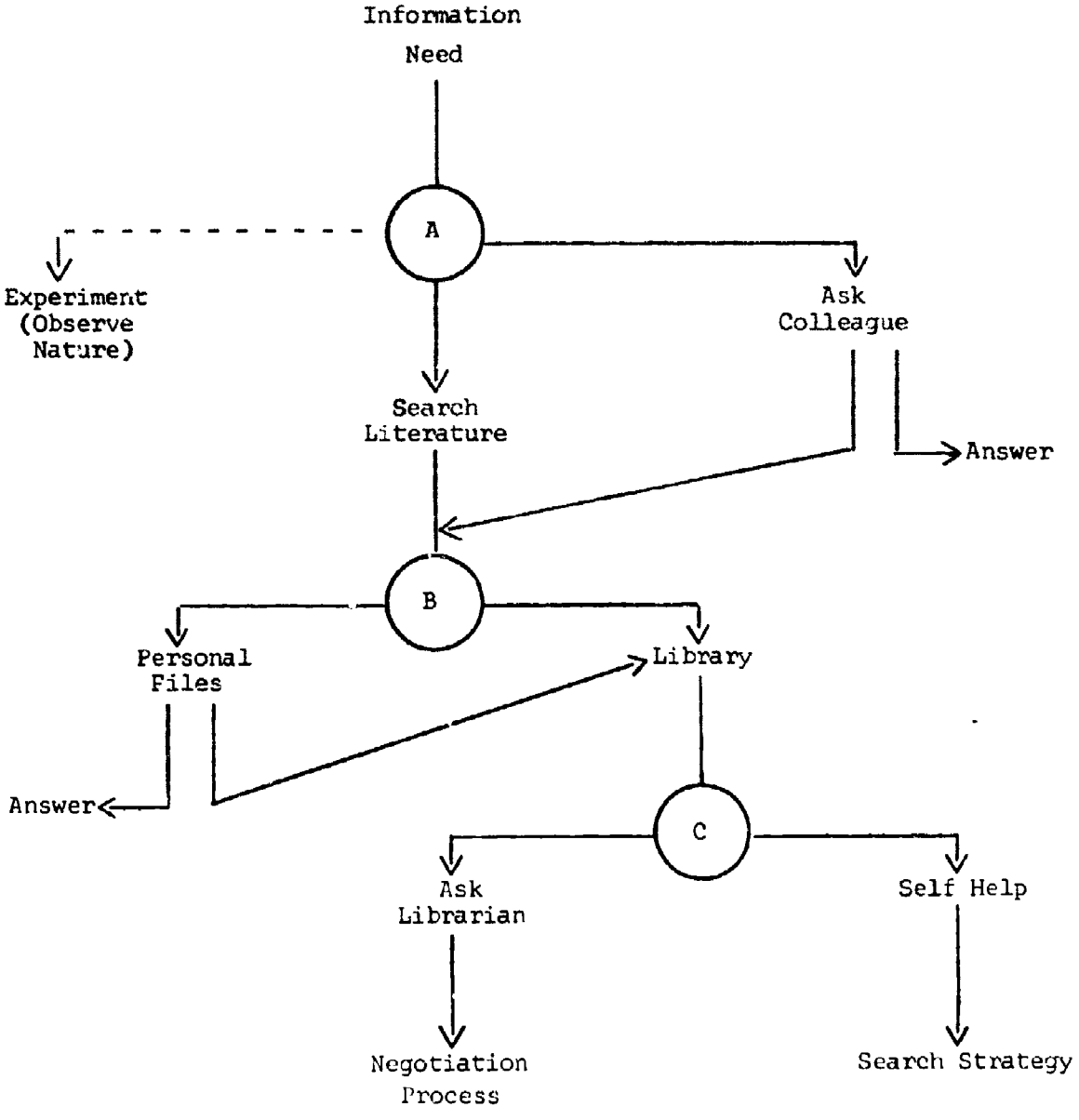

Figure 1: Sketch of Pre-Negotiation and Pre-Search Decisions

A. First of all, there is the conscious and unconscious need for information not existing in the remembered experience of the inquirer. It may be only a vague sort of dissatisfaction. It is probably inexpressible in linguistic terms. This need, (it really is not a question yet) will change in form, quality, concreteness, and criteria as information is added, as it is influenced by analogy, or as its importance grows with the investigation.

B. At the second level there is a conscious mental description of an ill-defined area of indecision. It will probably be an ambiguous and rambling statement. The inquirer may, at this stage, talk to someone else to sharpen his focus. He presumably hopes that two things will happen in this process: (a) an understanding of the ambiguities by his colleague; and (b) the gradual disappearance of these ambiguities in the course of the dialogue.

C. At this level an inquirer can form a qualified and rational statement of his question. Here he is describing his area of doubt in concrete terms and he may or may not be thinking within the context or constraints of the system from which he wants information. By the way, he may view the librarian as part of the system at this level, rather than as a colleague. This distinction is important. As one interviewed librarian said: "For most people, I am the information system."

D. At the fourth level the question is recast in anticipation of what the files can deliver. The searcher must think in terms of the organization of particular files and of the discrete packages available - books, reports, papers, drawings, tables, etc.

These four levels of question formation shade into one another along the question spectrum. They are stated here only as convenient points

along a continuum. They may be outlined as follows:

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 need (the formalized need);

Q_4 - the question as presented to the information system (the compromised need).

Unless the inquirer knows the information specialist well, he is inclined to pose his first question in positive and well-defined terms, even to the point of specifying a particular package (Q_4). If the specialist is accepted as a colleague, the negotiation process can start earlier and be much more fruitful. An important necessary for such acceptance appears to be subject knowledge. As one information specialist put it: "A person with a technical background will handle a technical subject in less than half the time and with more competent and thorough results." This is where the process of negotiation starts. The compromised question (Q_4) is the information specialist's business, the representation of the inquirer's need within the constraints of the system and its files. The skill of the reference librarian is to work with the inquirer back to the formalized need (Q_3), possibly even to the conscious need (Q_2), and then to translate these needs into a useful search strategy.

This is a directed and structured process, although there are of course many different styles and many levels of competence and knowledge on the part of both librarian and inquirer. There are certain obvious traits which will help the librarian: empathy, sense of analogy, subject knowledge, and knowledge of files, collection, and clientele (8).

The negotiation process is a form of communication. It is illuminating to contrast it with normal conversation, in which one person finds out in random fashion about another's interest. Figure 2 shows the stream of communicative acts on a variety of subjects between friends over a period of time. However, embedded in this conversation are elements of a

subject of interest, which one person is communicating randomly to his friend. Communicative acts are shown by a dot; those which are relevant to the subject are circled.

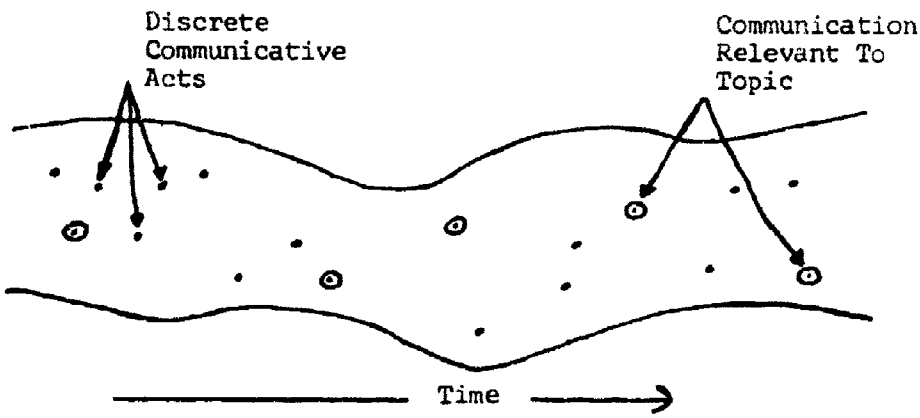

Figure 1. Schematic representation of communications between two friends overtime. (Adapted from Reference 11, page 15)

In contrast, the negotiation process must compress both the boundaries of the interview and the time span. More information must be communicated in less time. This requires both direction and structure on the part of the information specialist. Figure 3 illustrates this compression, where relevant communicative acts are much more frequent.

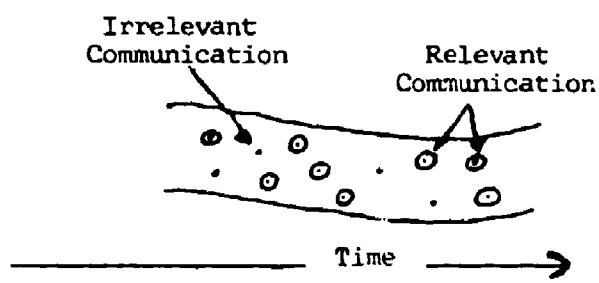

Figure 2. Schematic representation of communication between inquirer and librarian during negotiation process. (Adapted from Reference 11, page 15)

From the interviews with librarians and information specialists there appear to be five filters through which a question passes, and from which the librarian selects significant data to aid him in his search. It is also the structure of these filters, modified for the specific inquiry, that provide the compression of subject and time illustrated in Figure 3. These five general types of information necessary for the search definition are not mutually exclusive categories. The listing is approximately in order of occurrence, although they may occur simultaneously, i.e., relevant data for several filters may be embedded in a single statement by the inquirer.

They may be briefly stated as follows:

1. subject definition;
2. objective and motivation;
3. personal characteristics of inquirer;
4. relationship of inquiry description to file organization;
5. anticipated or acceptable answers.

The problems associated with these "filters" are well-known, even obvious, to active librarians and information specialists. They have not been, as far as I can determine, put together in rational form before.

1. Determination of Subject

Determination of the limits and structure of the subject of the inquiry comprise the content and aim of the first filter. The information culled at this level of negotiation is of course closely intertwined with that of the second filter (the objective or motivation behind the inquiry). However, the two filters appear to have a sufficiently different function and necessary style of negotiation to require separate consideration for each.

At the first pass the primary purpose of negotiated subject definition is to provide some general delineation of the area: from biomedicine to genetics to the genetic code in DNA. Continued dialogue on the ramifications and structure of the subject will define, expand, narrow, and

qualify the inquiry.

> "X said he was interested in 'contact terminals.' Well, that's rather a vague term, and it probably took me a few minutes to find out what he meant by that. He might not even have started with that terminology. He meant 'binding post' type of terminals. I probably asked him a question like: 'Do you mean the type of spring terminals that are used in jacks, plugs and jacks?' He said 'No', and probably then said something about 'binding posts.' And I remarked 'Oh, you mean soldered terminals.' He probably replied 'No, that's where the contact comes into it, I mean the wrapped type.' And so after a few exchanges like that, I would have gotten a picture in my mind as to what he was talking about. This is where my practical experience in radio engineering is helpful, because I can visualize these things."

At some stage, depending on the state of other relevant categories of information, it may be necessary to call a halt to this initial phase, in order to allow the librarian to make a brief search to determine the extent of the subject. He can then come back to the inquirer with 'Is this what you mean?' or 'Is this in the ball park?' From discussion in answer to these questions, the subject is further limited and qualified. This form of dynamic interaction may continue for some time, until the librarian is satisfied he knows what is wanted.

> "Engineer X will come in and say 'Gee, I have these three references on subject A. I've got all the ones I know about. Are there any more?' He may just stop by in passing. This may develop into a major project, just because the man is so busy, he is not aware of the vast amount of information available to him. Once the subject is defined, we define the peripheral areas that may bear upon this. We inform him of our basic search strategies so he feels he is part of the effort. And we inform him how he in turn can interact with us, depending on the time constraints. If it is a long term project he will receive in the normal course of his work, material we may not be aware of. In turn we ask that he input these data to us. And if it becomes necessary for one of our people to go to his office and physically go over and read some of the more important papers on the subject, we will do this. So there is a continuous interaction between the people in the information research group and the scientist and engineer asking for the material."

> "The fact that they write [the question] doesn't help one bit. We think if it's written it's clear. You

> know 'put it in writing.' But you get no feedback with writing. It's the dialogue, the feedback, that is the important thing. For the librarian, the important thing is this awareness of the fact that you will need feedback in order to make sure of what you've got. You have to have this suspicion - a sensing of when it is you know what it is the inquirer wants, and when it is you are sure he has got it clear, and when it is you are not sure."

2. Motivation and Objective of the Inquirer

The second filter or category of information negotiated is probably the most critical: Why does the inquirer want this information? What is his objective? What is his motivation? This requires subtlety in negotiation, but usually has a high payoff in subject definition. It further qualifies the subject, or may even alter the entire inquiry. It also offers an opportunity to ascertain the point of view and influences the size, shape, and form of possible answers. Most of the librarians interviewed felt strongly that this type of question was critical to the success of any negotiation and consequent search. In those instances where this is not the case, the librarian's approach is that the inquirer knows (a) what he wants, (b) more than the librarian, and (c) the search strategies necessary to satisfy his need. None of these assumptions appear to be wholly valid.

> "Unless you are sure what the why is, you can never be sure what it is the person really wants. What's he going to do with the information... We can't help him unless we understand his needs as well as he does."

> "In looking for the signs I use to decide when I know the patron's need well enough to start searching for an answer, with me it seems to be the 'why' of the query. Over and over again, when the first query does not seem clear to me (and this must be a value judgment based on a lot of experience, practiced skepticism, and suspicious awareness of how easy it is to be misled by a patron, how important it is to make sure you know what he needs), I come back with my questions. Most of these are an attempt to find out what the user plans to do with the information. why he wants it, what he is trying to build. I feel it is impossible to help the patron adequately unless I know this. I often learn that in trying

> to tell me why he needs the information, he clarifies in his own mind what he needs and will then reform his query with a better understanding of his own need."

It is an obvious truism to every librarian who works at an information or reference desk, that inquirers seldom ask at first for what they want. When they reach the point of confessing, 'But this is really what I want to know...', the acute librarian knows he is over a major hurdle.

Inquirers frequently cannot define what they want, but they can discuss why they need it. Consequently they are inclined to ask very specific questions, as if they were ashamed to hold up their ignorance for everyone to see. These may include an innocent and unambiguous request for a directory address, which develops into a search on molds; a request for a copy of Aviation Week which turns into a basic and broad company proposal on commercial aviation; an inquiry to verify if there is a place called P____, which turns into a search for information on rat repellants. In these cases, as one interviewee pointed out, "My function is to help him decide what it is he wants."

> "The first step is to be eternally suspicious and the realization that in most cases they simply don't tell you what it is they really need. I think this is a matter of human communication - that we need the dialogue to frame up what we are after. I find this is true even in the simplest questions. There is that eternal suspicion that what they ask is probably not what they really want."

3. Personal Background of the Inquirer

The third level or category of information necessary in the negotiation process has to do with the personal background of the inquirer. What is his status in the organization? Has he been in the library before? What is his background? What relationship does his inquiry have to what he knows? What is his level of critical awareness? Answers to these types of questions have relevance to the total negotiation process. It may well determine the urgency, the strategy of the negotiation, the level of any dialogue, and the critical acceptance of search results. In short, it is the context, the environment for the negotiation process. It

determines what questions should and may be asked.

> "Because we get to know our clientele personally, we know the type of response they need and require. We know whether a person is a thorough individual, or a less thorough one. In the latter case, it may be somewhat frustrating at times when you know you haven't gone far enough, yet they are satisfied."

> "Have I worked with him before? This makes a great deal of difference. If he is an old timer and I've worked with him before, I know pretty well what steps I can take in negotiating the question. If he is a stranger, or relative stranger to the information service, it presents a problem to me. Maybe I've received his application as a new employee and I know something of his background. So I hope to have as much information as possible about the person I am dealing with. Some of the questions I might ask are: What group are you working with? Who is your leader? Where he is situated in the organization is important. His status. Whether he is at ease or not. Sometimes we get people who feel very inadequate in coming to the library. They may come to us as a last resort, not knowing what they are getting into. They may feel that they are exposing themselves to someone looking over their shoulder. That is a position we don't want them to feel in."

There are many problems in this facet of negotiation. An instance cited by one interviewee is when an inquirer, who may be in his own right a highly competent researcher, is used as a high level messenger by, for example, the vice president for research. It is at this point, as the librarian pointed out, that experience and personal knowledge of the organization and people become important. The "messenger" frequently may not know the background and motivation for the inquiry. It is here that the librarian must make some educated guesses and associations based on experience. He must in some way bring the vice president into the dialogue, without undermining the reputation of the "messenger."

4. Relationship of Inquiry Description to File Organization

An information specialist or a reference librarian is an intermediary, an interlocutor, between the inquirer and the system (2). As such, the negotiation process not only provides him with a substantive

description of the inquiry, but also supplies him clues for devising his search strategy. He becomes a translator, interpreting and restructuring the inquiry so it fits the files as they are organized in his library (2). In the symbolism discussed earlier in this chapter, he must construct a γ_4, or a set of γ_4's, so that the total system can be searched efficiently.

> "The inquirer will state briefly his problem over the phone. This is not enough so we go to him. We very likely do not discuss the specific problem but rather the relationship of the problem to the work he is doing. How does it tie in? We work from the general to the specific. He will often use a blackboard. What are the limits of the problem? In many cases we redefine the approach because he isn't familiar with the search strategy. So we redefine the problem to match the search strategy necessary. The inquirer is usually not aware of the sources available to him."

If we view the negotiation process as a "game of chess" as one librarian suggested, the librarian has a tremendous advantage. He is the one who knows the rules of the game; the inquirer doesn't. The "rules of the game" are the organization, structure, associations, and specific peculiarities of the files. The quotation above hints this: "We redefine the problem to match the search strategy." The implications of such a statement, if taken at face value, can have the effect of redefining librarianship.

It should be understood that the "files" refer not only to the catalogs, indexes, abstracts, and other standard files of the library. There is also the "who know's what" file, not on cards but in the librarian's memory. There are special files: previous requests, news notes, recent items read, the unstructured notes (or pieces of paper napkins) in the librarian's desk drawer. There is the sense, or activity, of building the inquiry into the system - the system including the information specialist and all the relevant files.

> "The information research group serves as an information funnel. We have a pretty good idea of who is doing what. We may say to the inquirer: 'Have you talked to _____ over in the Chem Lab, because he is interested in so and so.' And I would say that, nine out of ten times, the reaction is 'Who is _____?' We suggest 'Would you check with _____ first and see if he hasn't a pretty good feeling and handle on this. Then whatever _____ doesn't have or can't answer, get

> back to us. We'll be happy to help you.' And often the man will come back and say, 'My problem is solved, he's got it right in his head,' or 'he was able to help me quite a bit. We've talked it over and I think I need this ... and this.'"

> "Referring people to other people is one of the methods we use. But before referring them, we ask 'Whom have you talked to? Are you working by yourself or with others? Do you know _____? Do you want to talk to _____, or should we?' You see, we don't want to go charging off in all directions, duplicating effort."

As much as possible, the librarians interviewed also tried to elicit from the inquirer any stray bits of information from his specialized knowledge that would give clues in support of a search strategy.

> "One of the standard questions we ask: To your knowledge what will probably be the most fruitful area in which to search? This opens up some leads ... often, he will say, 'Well, I think there was a Proceedings of the IEEE about 1963 and I thought I saw something in there. Maybe that will give you a lead.' In this case we go ahead and proceed."

What the inquirer is saying is "Here is a paper; I'd like ones similar to it."

5. What Kind of Answer Will the Inquirer Accept?

When an inquirer approaches the reference desk, he has some picture in mind as to what he expects his answer to look like, i.e. format, data, size, et. (10). The problem of the inquirer's acceptability of an answer is an important filter in the process of answering inquiries. One of the results of the process of negotiation will be to alter the inquirer's image of what it is he expects. The image is altered as the inquirer changes his question in response to feedback, as he becomes aware of the capabilities of both the library and the librarian, as he changes his search strategy in the negotiation process, and as he is forced in the negotiation process to place limits of time and size on his inquiry.

> "One of the problems is that sometimes you're just never going to find the answer you want. There are two

> difficulties here. One is that the individual searching for it can't find it, although it's there. The second is the inquirer's point of view which he would like to have answered in that way. In addition, some are more thorough, or critical, at least as far as an answer is concerned."

The sense of urgency in the inquiry definitely has an influence on the type of answer expected.

> "The inquirer may say 'I need this in 30 minutes.' By doing so he has pretty well determined what form he will accept and what questions I can ask."

Whether or not the inquirer is asking for information in his own specialty will shape the kind of answer useful to him.

> "If a person is asking for a search in his own field, then you can sit down and talk to him. If he is asking in a field peripheral to his interest, then he has probably been asked to express an opinion on something. He doesn't want a search, but rather something limited, for example a review or a state-of-the-art paper."

Undoubtedly the subject field of the library and its clientele has a bearing on the type of answer expected, in ways we do not even know about yet. For example, in the law, (20) it appears that the questions are very precise, but the answers are less precise. This is due to the nature of precedence in the law, in which a law, a court ruling, or an administrative regulation might be pertinent to a specific case, and are the only answers available. They don't however answer the question. Training in the law appears to make a difference. As one librarian put it: "I can almost tell the law school by the type of question."

One of the nagging problems in the delivery of answers seems to be the degree of evaluation the information staff can and should make. There are of course a variety of factors at work here: the librarian's own capability; the inquirer's attitude; available time. Perhaps most important is the sense of puritanism on the part of both librarians and management who believe, for ethical rather than economic reasons, that every one should do his own work. Such an ethos is at odds with the sense of service in librarianship, with the requirements of management for the best information as soon as possible, and with the growing complexity of information in a "data-rich civilization."

"Now the next level beyond this is one in which we have hardly done anything at all, primarily because we don't have the manpower. But I think it is probably the most important... That is to make an evaluation of these materials. Just to hand someone a batch of raw abstracts is not enough; or even a list of numbers; paper A says the property equals this, paper B says its that, and so on. Well, if they don't agree, shouldn't someone read the papers, and decide what were the experimental techniques, and give these a weight. That is, this is the most significant number, or the most valid number, or this is a significant average. We have just not been able to do it except in a few rare instances. Now the hope had been - when I say "hope" I don't mean only ours, but from the top of the Research and Engineering Department down - that, if we gave the individual chemist or engineer these other materials, he would do this evaluation. The evidence is that he doesn't do it. I would say only 1% actually do it. The others will take the first number at the top of the pile, some will average all the numbers, some will apparently take the number that fits their number best. You know, it's the human problem."

Chapter 3: The Information Seeking Strategies of Users

As discussed in the introduction, this report makes an assumption which seems intuitively valid. In the self-help process, i.e. when an inquirer attempts to find information in his own way, we view the inquiry not as a command, but rather as an adaptive self-organizing system in which the question is open-ended and dynamic. In fact, as will be illustrated, the inquirer's original question may change during the search, as he adapts to the feedback of the search process.

Let us discuss briefly commands and questions, for an understanding of the difference between them is critical for the development of truly interactive systems (14). A command basically denotes the request for a specific item or specific subject combination which the inquirer has already assumed will satisfy his need. Whether his assumption is valid or not has already been discussed in Chapter 2. Let us, for the moment, accept its validity. In response to his command, the inquirer is delivered, or he locates, a specific package. Here the process ends, and he is satisfied (by definition).

Libraries and other information systems have been developed and operated on these premises. However, one may suspect that the rise of reference services - historically, a rather recent development - and the care lavished upon indexing, cataloging, and classification schemes indicates a feeling that traditional "command" systems must have some form of feedback built into them.

There are of course many mechanisms by which classificationists, index designers, and other information system developers have attempted to develop paths and alternatives for the inquirer. For the inquirer, however, these are frequently over-sophisticated, at least in the display forms in which they presently exist. The inquirer is only concerned with getting an answer, not with system niceties. Nor is he interested in learning, and maintaining currency with, a system, in which only a very minor part has relevance to him. An analogy may be made to the myriads of directional signs on an urban freeway. The signs seem to be designed for the benefit of natives and not strangers. Though the

principle remains the same, the results of a wrong decision in the latter case are somewhat more catastrophic.

There really has been little empathy for the unsophisticated (i.e. non-native) user. Within the conventional information system, the signs offered the inquirer pose too many alternatives without specification as to where each may lead or what each will do for the inquirer. It may be that better forms of display and interrogation by the system, in an interactive sense, can provide more adaptive interfaces.

The concept of the interface, in this context, must be extended beyond its usual connotation of a physical surface or panel of control buttons and knobs between man and system. It includes here not only the physical problems, e.g. ease of physical manipulation, but also the subtle and personal interrelationship, however primitive this knowledge may be at present, between user and recorded knowledge.

Within this context, the question, as contrasted to the command, can be better understood. In the symbolism developed in Chapter 2, the command is Q_4, the question compromised by the rigidities of the system, and by the specific need assumed by the inquirer. However the question moves back toward Q_3 and even toward Q_2. It is ambiguous, imprecise, and requires feedback from the system, or from a colleague, in order to provide an acceptable answer.

As a first pass at understanding information-seeking, approximately 20 undergraduate students were asked to report on the process resulting from a self-generated information need. Four of these reports are given in Appendix B. The project had two purposes. First, from a pedagogical standpoint, it was intended to create an awareness in the students of themselves as information-seekers: the decisions they make; the sources they use; the complexities and failures of the systems they encounter; and the ambiguities and strategies of their question-asking processes. Second, it was hoped that some gross generalizations could be made of this process, not withstanding the open-endedness and uncontrolled nature of the project.

The students were first asked to read the section on "Human Search Strategies," reproduced in Appendix A, from the report of the Advanced

Information Systems Company (1,4). This was done to give them some feel for the scope and nature of the problem. They were then asked, following class discussion, to write a description of their search for specific information in any topic of interest to them at that time. This approach was felt to be better than one based on artificially generated searches, because (a) they could draw on their own experience and interests, and (b) they could determine when they had an answer acceptable to themselves. They were allowed to use any sources they wished and to ask advice from anyone. They were instructed to conduct the search in whatever way seemed easiest and most efficient. They were not restricted exclusively to the library, although they were requested to use the library somewhere in their search.

The following instructions were given orally and were briefly discussed:

> A. Do not attempt to describe every motion or every decision in full detail. However, please pick out what, in your judgment, are some of the more important or significant decision points and record those completely.
>
> B. In the beginning analyze your question: What do I know already? What will I accept as an answer? Note that your question, and your criteria of answer acceptability, may change as the search progresses.
>
> C. Analyze possible search strategies and estimate probability of success. Note that new strategies may appear in the search process, or may be altered in a variety of ways.
>
> D. The following activities are significant:
>
> (1) the original question and any re-evaluation of it;
>
> (2) interrogation of a source, both human and printed or graphic;
>
> (3) decisions to try a new strategy or to re-evaluate the strategy;
>
> (4) significant results of an interrogation, including important clues;

(5) memory or store, i.e. partial data thought pertinent to the search, which you hold in "memory," or record in some fashion;

(6) "dead end" of a search path, in which you could (a) go to new strategy, (b) re-evaluate question, or (c) consider the whole question not worth the trouble.

There are several observations and a few generalizations that can be extracted from the search strategies in Appendix B.

1. With the exception of Number 1, all searchers used some human intermediaries, either instructors or reference librarians, to give them clues or guidance.

2. No searcher thought in terms of a library strategy, that is, to view the total collection as a source and then devise one or several approaches to it. All of them however made use of certain library mechanisms of a strategic nature:

a. To use the classification schedule as a means of searching:

"None of the books indicated looks promising. However they all have the same catalog number (510.7834). I'll look in the stacks at that number and see if any of the books are promising." (No. 2)

b. To use the Subject Catalog (the library has a divided catalog).

c. To search the Subject Catalog beyond the original subject heading for phrases, etc. This happened by accident with Number 3.

"Under CURVES there were nine books...So I was about to look at SURFACES when I noticed a card saying CURVES ON SURFACES."

3. It is to be noted that the inquiries posed could not be answered by any single book or paper, with the exception of number 1. They represent however questions of the type that users (in this case, engineers) wish to have answered.

No. 1: What is the relationship for the rate of gaseous molecular bombardment of the walls of the gases container?

No. 2: What is micro-programming?

No. 3: What is a concise definition of "Gaussian Curvature?"

No. 4: How does the Philco F_{10} differential amplifier operate in the model 228 digital memory unit?

4. The searchers generally made good use of table of contents and indexes of single books examined. When they did not, they made erroneous judgments as to the validity of specific sections to their inquiry. As a consequence, in Number 1 for example, they missed the answer.

5. Answers usually do not come in neat little packages in answer to a specific question of the type posed here. Number 3, for example, had to put his answer together from seven different sources, albeit in a single book.

6. When available information sources do not provide enough information for an acceptable answer, it is necessary to alter the question. This is precisely what Number 4 did.

"D - the question will have to be generalized because specific data supply is exhausted.

Q - how is a general transistor differential amplifier analyzed?"

7. For the type of questions posed, there is a great deal of noise in library catalogs, particularly in the Subject section. This may be a function of academic libraries.

The examples shown in Appendix B, together with these observations, seem to support my belief that the inquirer's interaction with a library or information system has certain similarities to the negotiation process. If this belief has validity, it means that systems need considerably more experimental work to approach a better sense of interactiveness.

Chapter 4: Summary and Conclusions

What has been gained by this investigation? Or does it merely reiterate what is already known? Is this, as someone has said about psychology, an elaboration of the obvious? In part, it certainly has been an elaboration of the obvious. But it has been more. It has attempted, by restructuring the obvious, to open up new ways of looking at libraries. The whole purpose has been, by organization and structure, to allow the reference process to be seen from a point closer to actual fact. This was done in the hope that a more intensive study of this process could result, and that elements could be isolated for fruitful analysis and eventual improvement of services.

Negotiation

It has been shown in this report that the negotiation process, in its best form, is structured and can be analyzed. However, the five filters discussed in Chapter 2 are neither absolute nor fixed. They provide a first pass at structuring a complex process, "to get the puck on the ice" as it were. They appear to be valid at this state of investigation. Each filter, however, requires data, analysis, and testing. They could be, for example, further broken down, if it appears fruitful to do so, so that the more important elements could be better understood and utilized by information specialists in the future.

I hope that this approach to the negotiation process suggests ways by which library schools can re-examine courses in reference work. Is it possible, for example, to orient these courses more toward the dynamism of communication, i.e. negotiation, rather than concentrating solely on the static content of reference collections and classification systems? The former has been slighted, if considered at all, in the emphasis on the latter, the static approach. A newer approach should mean, for example, more attention to the social dynamics of definable parts of the population of library users, both actual and potential. This approach is already included in the training of children's librarians. It implies

the total pattern of publishing, formal and informal communication, sociology, dissemination and professional education, if any, at whatever level of society a course is presumed to be relevant, from the "culturally deprived" to the scientifically sophisticated.

A third result of this concern with the negotiation process is an understanding of the difference between a command and a question. This has been discussed in Chapter 2 and 3. A command assumes either (or both) of two things on the part of the inquirer. First, he knows exactly what he wants and can describe its form (book, paper, etc.) and its label (author and title). The second assumption is that the inquirer knows the functional organization of the system, the "rules of the game." It has been the argument of this paper that only the first assumption may be accepted as valid. The second assumption, with some exceptions, is not valid.

Self-Help

It is obvious that librarians and information specialists are unable, physically, to handle the present demands on their services, let alone potential user demand. It is equally obvious that, as a communication channel, libraries are frustrating and complex systems to use. The previous section implied that a different type of education for librarians might make them more efficient in serving their various publics. That is, they could handle more inquiries. Such a course would by no means be sufficient to nullify the self-help process, even if we wanted to. Do we then wish to duplicate reference negotiation? Duplication of such a complex process is obviously impossible now. Also, in spite of the glittering potential of artificial intelligence, problem solving, and theorem-proving systems, the nature of print and other media may in fact require different approaches than those of human-human negotiation. There do appear to be several elements of the negotiation process worth investigating to see if mechanical systems might be feasible and useful.

Certainly substantive definition is one of these processes. Present subject naming systems however appear to be more concerned with the

description of physical objects (books, papers, etc.), than assistance to the user in defining his subject. This is an important and critical differentiation, for present systems are object oriented (static) rather than inquiry-oriented (dynamic). This is related directly to the concept of feedback - presentation to the user of various levels of display requiring a response from him. The inquirer's response in turn guides, alters, or limits future displays, searches, and answers by the system. However most important in the process of subject definition is the display to the inquirer of alternatives, with specification of what these alternatives mean, where they lead to.

A second element or negotiation filter relevant to self-help is the inquirer's description of what he anticipates as an answer. Is it quantitative? descriptive? review? What is the level of sophistication? The very brief dialogue reported in Information Search Strategy Study No. 3 (Appendix B) illustrates this process.

> "She began to look in a book of mathematical tables, and I explained to her that she would not find "Gaussian Curvature" there. I told her it was a theory, not a measurement. Whereupon she gave me a mathematical dictionary which looked as if it would help."

The important part of this process is that the user must be presented with choices, which match his type of anticipated answer with the forms available in the system.*

A third relevant filter is the process of translating from the inquirer's terminology to system terminology. The idea here of course is to allow the inquirer as much latitude as possible in describing his need (λ_3 or even λ_2), and then funnelling these into system terms (λ_4).

The remaining two elements of the negotiation process probably cannot at present be built into the self-help process. However it may be possible at a primitive level to interrogate the user about the objective of his inquiry, what the information is to be used for. Using the ELIZA

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*It is worth noting that the form divisions in the Dewey Classification anticipated this kind of approach.

program developed by Project MAC (26) or a related system presently being devised by James Green of Lehigh University, it is possible to extract from such questions, as "What do you intend to do with this information," additional concepts, phrases, and terms which would aid in specifying the subject. As such it may have a therapeutic effect on the inquirer, forcing him to define, limit, and analyze his inquiry, even though the system itself is not sophisticated enough to do much with the information in response to such questions.

The background or status of the inquirer does not appear to have much relevance to the self-help process, except as it may serve to determine a level of sophistication in the displays presented to him or in the answer delivered.

Possible Systems and Devices

All present systems have forms and elements intended to aid the inquirer: see also and see references; broader term, related term and narrower term; form division in classification; generic relationships in classification. As more research goes into these sophisticated and often intricate mechanisms, the more the inquirer must turn to the information specialist. As it was implied earlier, these are librarian's tools and appear to have little relevance, in their present form, for the inquirer. The system that is best able to display itself in a useful and functional way for the inquirer will be the most effective. Like information itself, the system that provides ease of access, specifically physical convenience, will be more effective than those concerned only with the quality of the scheme of subject organization. Video, film, microform, and computer media offer a tremendous array of possibilities hardly touched for interactive systems at the operating, i.e. public level. Even at the elementary level of description of collection and its physical arrangement, very little has been done to direct the user to areas of concern to him.

General instruction in the use of library and information systems is presently normally accomplished by tours, formal instruction, and handbooks, none of which are available when the user actually has an inquiry.

One of the more interesting systems presently under development is the Videsonic system at Mt. San Antonio College (8A). Controlled experiment with these devices indicates that students who utilized the system used the library more effectively and sought services from the staff less frequently than those not exposed.

The Recordak Lodestar Microfilm Reader-Printer with an Image Control Keyboard offers several possibilities for a programmed learning and interrogating system relevant to the library. Each of approximately 2,500 frames on a reel are available by dialing or otherwise signifying an address on the keyboard. Michael B. Leibowitz of Lehigh University has done a preliminary design study (12) for such a microfilm system in the field of metallurgy. The general structure of the system is illustrated with sample frames in Appendix C. In the system the user moves from index frames to network frames, then to bibliography, tables of contents, or data, as his needs indicate. The important part of this process is that the user is led through the system not sequentially, but by his reaction to the displays, i.e. by dialing a frame that explicates further his area of interest. He can also obtain hard copy as he moves along. The system as illustrated in Appendix C can best be envisaged by tracing the entry "Metals-Fatigue" from the first sheet, i.e. Frame 56, through the remainder of the diagrams. There are some grave limitations in such microfilm systems. Updating for example becomes difficult, without redesigning an entire reel. However, the display of subject maps may allow a user a much better understanding of the relationship of his inquiry to terms within the system and to the interrelationships among terms. The presentation of tables of contents in this form may allow a user to scan quickly a summary of the contents of a specialized reference collection.

The difficulty of reel film for updating might be overcome by the use of microfiche as in the Houston-Fearless CARD (Compact Automatic Retrieval Display) system (10A). Such a system could also be computer manipulated, affording faster scanning access and a more dynamic interrogative process.

The study now underway at the Graduate Library School of the University of Chicago on the format, information, and public use of data on

catalog cards (25) may indicate more effective display of bibliographic information. The augmented catalog, now being experimented on by Project INTREX (19A), will include such important forms of display as reviews and tables of contents. Although both of these developments will influence the displaying of information, they appear to be related more to command rather than to question. The work by Engelbart and others at the Stanford Research Institute (6) on the augmentation of human intellect by computers may generate interesting systems sometime in the future, but appears to have little pertinence at this time to the problems under consideration here.

Conclusion

If nothing else it is hoped that this first pass at the analysis of negotiation, both by human intermediaries and by self-help, may induce libraries and librarians to become critically aware of their role in this process. The advent of the MARC project, commercial processing of library materials, and the gradual disappearance of local cataloging operations will have a profound influence on operating libraries. It will become increasingly important for librarians to become interpreters and guides, developing both negotiation skills and displays for users of all levels.

The contrast between the "wholesaler" and "retailer" of information may serve as an analogy here. However much they like to think otherwise, most libraries are "wholesalers" of knowledge, and the library is a warehouse (however grand the Gothic windows or beautiful the new carpeting) from which gobs of knowledge are indiscriminately doled out to whomever happens to be captive of the system at that moment. There are exceptions - and they are noble ones. Certainly most of the librarians who gave their time for this study are helping to make their libraries "retailers." This is the difference between the supermarket or discount house and the local dealer who takes pride in serving his customers, i.e. public. He is not pushing merchandise. He is matching a customer and his merchandise.

If libraries, at any level of service, are going to grow and evolve (and indeed exist) as integral parts of our urban technico-scientific

culture, then they must know themselves. They must know themselves both as single institutions and as parts of a very large, very dynamic, and very complex information and communications networks, which operate on both a formal and an informal level. It may be, as someone has said of formal education, that the storage media which libraries handle are noise in the system. The real education and communication may take place outside or on the periphery of libraries and formal education. Indeed it may be that the reference interview, the negotiation of questions is the only process in libraries that is not noise. For it is through negotiation that an inquirer presumably resolves his problem, begins to understand what he means, and begins to adjust his question to both system and substantive noise in the store of recorded knowledge called the library.

References

(1) Advanced Information Systems Co. Report on the Organization of Large Files With Self-Organizing Capability. Los Angeles, Cal., 1961 (?)

(2) Artandi, Susan. "The Searchers - Links Between Inquirers and Indexes." Spec. Libraries, 57, 571-574 (October 1966).

(3) Belnap, N. D., Jr. An Analysis of Questions: Preliminary Report. Document TM-1287. System Development Corp., Santa Monica, Cal., June 1963.

(4) Carlson, G. Search Strategy by Reference Librarians. (Part 3 of Final Report on the Organization of Large Files.) Sherman Oaks, Cal., Advanced Information Systems Division, Hughes Dynamics Inc., March 1964. (See also 1)

(5) Doyle, L. B. "Is Relevance an Adequate Criterion in Retrieval System Evaluation." In American Documentation Institute, 26th Annual Meeting, October 1963, Automation and Scientific Communication, Part II, 199-200.

(6) Engelbart, Douglas C. Augmenting Human Intellect: Experiments, Concepts, and Possibilities. Stanford Research Institute, Menlo Park, Cal., March 1965. (AD-640-989)

(7) Ennis, Philip H. "Technological Change and the Professions: Neither Luddite nor Technocrat." Library Quarterly, 32, 189-198 (July 1962).

(8) Francillon, M. "Information Retrieval: A View from the Reference Desk." J. Doc. 15, 187-198 (December 1959).

(8A) Genung, Harriet. "Can Machines Teach the Use of the Library?" CRL, 28: 25-30 (January 1967).

(9) Goffin, Margaret K., editor. "Current Trends in Reference Services." Library Trends, 12 (January 1964, whole issue).

(10) Hieber, Caroline E. "An Analysis of Questions and Answers in Libraries." Report No. 1, Studies in the Man-System Interface in Libraries, Center for the Information Sciences, Lehigh University, Bethlehem, Pa., June 1966.

(10A) Hoadley, Howard W. A Rapid, Compact, Automatic Retrieval Display System. Publication 3-103-66. Houston Fearless Corp., Los Angeles, Cal., 1966.

(11) Kahn, R. L. and C. F. Cannell. The Dynamics of Interviewing. Wiley, New York, 1958.

(12) Leibowitz, Michael B. A Proposed System for Displaying Accessing Techniques to Library Users in the Field of Metallurgy. M.S. Thesis, Lehigh University, 1967.

(13) Licklider, J.C.R. Libraries of the Future. The M.I.T. Press, Cambridge, Mass., 1965.

(14) Mackay, D. M. "Informational Analysis of Questions and Commands." In Information Theory, C. Cherry, editor, Butterworths, London, England, 1961, pp. 469-476.

(15) Mackay, D. M. "Operational Aspects of Some Fundamental Concepts of Human Communication." Synthèse, 9 (Issue 3, nos. 3-5), 182-198 (1954).

(16) Mackay, D. M. "What Makes a Question." The Listener, 63 (May 5, 1960) 789-90.

(17) Mount, Ellis. "Communication Barriers and the Reference Question." Spec. Libraries, 57, 575-578 (October 1966).

(18) Payne, Stanley L. The Art of Asking Questions. Princeton University Press, Princeton, N. J., 1951.

(19) Perry, James W. Defining the Query Spectrum - The Basis for Designing and Evaluating Retrieval Methods. n.p., 1961 (Mimeo)

(19A) Planning Conference on Information Transfer Experiments (INTREX), Woods Hole, Mass., Aug. 2-Sept. 3, 1965. Report, edited by Carl F. J. Overhage and R. Joyce Harman. M.I.T. Press, Cambridge, Mass., 1965.

(20) Radcliffe (Lord) "How a Lawyer Thinks." Laucet, 270, 1-5 (7 January 1956).

(21) Richardson, Stephen A., et al. Interviewing, Its Forms and Functions. Basic Books, New York, 1965.

(22) Rosenberg, Victor. "The Application of Psychometric Techniques to Determine the Attitudes of Individuals Toward Information Seeking." Report No. 2, Studies in the Man-System Interface in Libraries, Center for the Information Sciences, Lehigh University, Bethlehem, Pa., July 1966.

(23) Simmons, R. F. "Answering English Questions by Computer: A Survey." ACM Communications, 8 (January 1966) 53-70.

(24) Taylor, R. S. "The Process of Asking Questions." Amer. Doc. 13 (October 1962) 391-96.

(25) University of Chicago. Graduate Library School. Requirements Study for Future Catalogs, Progress Report No. 1, October 1966.

(26) Weizenbaum, J. "ELIZA, A Computer Program for the Study of Natural Language Communication." ACM Communications, 9, 36-45 (January 1966).

APPENDICES

Appendix A

"Human Search Strategy - Protocol of a Search" (from Advanced Information Systems Company, a Subsidiary of the Electrada Corporation, Report on the Organization of Large Files with Self-Organizing Capability, [Los Angeles, Cal., 1961?] pp. 63-71).

T = Person posing the question.

D = Person making the library search.
(Ltr., 3/30/64, from Dr. Gary Carlson, Brigham Young University, Provo, Utah)

T: I want the temperature and the material with the highest melting point.

D: The temperature?

T: The temperature and the material with the highest temperature melting point.

D: I don't understand the question.

T: What is the temperature...

D: What is the melting point -- the metal with the highest melting point.

T: I want to know the material.

D: The handbook might have the answer to that but I will try the catalog first. I will look under melting point to see if there is a book on melting point. That, likely, is the only thing to look under to start with. I am now trying to think of anywhere else to look. I can think of none.

NOTE: Goes to the card catalog.

D: I looked under "met" instead of melt. My error. I came to a card with melting point. I am now backing up to the first card with melting, not melting point but melting. I am reading the title of the first card under melting. It seems inappropriate because melting point is not mentioned. I am now turning to cards of melting points. I read the title of the first one. It seems too particularly concerned with semi-_____solids. I will not check it further at this time.

T: When you say that, do you feel you are going to retain it?

Appendix A

D: I think I have really dismissed it. Here, I found it. Melting points -- a pamphlet of the U. S. Bureau of Standards Temperature Interconversion Tables and, note this, Melting Points of the Chemical Elements. I will fill out a slip for that. While writing the title to retrieve the pamphlet I feel confident that I will find the answer. I just noticed that the pamphlet only has four pages. It probably is too restrictive to have the answer. I will look at some other cards.

NOTE: D has apparently simplified the question because the card that he was just looking up was for the chemical elements rather than for material.

D: Notice I even stopped right at the title of that pamphlet. Oh dear, there are only two cards on melting points. I guess I will have to check the pamphlet but now I feel the odds are against me in finding the answer in the pamphlet. I notice the date is 1947 but that does not bother me because melting points certainly don't change with the time. Now I will have to find the pamphlet file. I am looking now. A row of file cabinets which should have pamphlets in them...

T: Some pamphlets they keep in the periodical stuff and they may have some in the file there.

D: I will ask the librarian. I will try to just ask for the pamphlet. I am now trying to think while he, the librarian, is searching for the pamphlet, where else I could find this. I am not clear now whether it is an element or component I am looking for. The pamphlet will probably have only elements. I think the question is more general than components. I can't understand not being able to find a book on the subject. This annoys me. Surely someone must have written a book on it. Maybe the periodical index -- likely the engineering index could help me. Either that or a handbook probably should be my next try. The librarian made the same mistake -- metal for melting. The librarian re-checked the card catalog entry and, under "Pam" and typed in red was temperature. This is apparently the subject matter in their pamphlet file. I still don't think this pamphlet is going to give it to me. With only four pages, this probably only covers the elements but I will look at it anyway.

NOTE: Receives the pamphlet.

D: Well there is a conversion table which does not interest me. Here is the melting points of the metals. I was right. These are arranged alphabetically by element. I see the column melting point. I will run down here while I am at it to get the element with the highest melting point. Number 7 -- of course carbon has a melting point of 3700°C plus or minus 100. That looks like the highest. It is interesting the great variety in melting points for the elements. I would never have thought of that before. Now I feel I should check the question again to see if an element satisfies the question. If so, I am through.

Appendix A

T: What is the question you were holding?

D: The question was: what is the element -- no -- metal -- what is the material and what is its melting point, or the element of the material with the highest melting point -- an element is too specific. I must find it for a material now. Let's try a handbook first even though T said he would try to find one that would not be in a handbook so it might not be there but I still think that is my next best bet. The handbook should be around the corner, I imagine.

NOTE: We go around corner.

D: I am not sure of handbooks. They sometimes file handbooks in a reserve section. I will check the open reserve section first anyway. I see the engineering index. Maybe I ought to try that first anyway. I think I will keep looking for the handbook. I think that has a better chance of having the answer. These all seem to be abstracts of some sort. I may have to go to the desk to get the handbook but I will check a little bit further.

T: D has been walking among the shelves looking at the books.

D: I will try the card catalog again under handbook. Probably the chemistry or physics handbook. Right now let's say it would be the best. T is making faces and distracting me and biasing my opinion. Probably the chemical handbook will be my best one so I will look under chemistry handbook.

T: I will bias you. I think you will find nothing in the card catalog. Why not go to the librarian?

D: I will go to the reference desk and ask for the handbook then. Just a point of clarification. T, did you mean in clarifying that the handbook is probably ---

T: I just meant going directly to the librarian down here and it would be faster than going back through the card catalog to find the handbook.

D: Regardless of whether the answer is there or not?

T: Correct.

NOTE: Goes back to librarian. D asked for chemistry handbook.

D: Well, it has been a long time since I have looked in this thing. I will look at Table of Contents. No, that is too broad. I will look for an index. Well, there is an index. I will look under melting, melting and boiling points of the elements. I don't want elements, I want gunk. Right under elements has melting and boiling temperatures for various substances. Now I will hold that for a minute. I

Appendix A

am now skimming melting point index, boiling points, organic compounds, that is too restrictive, alloy, that too is restrictive, ice, industrial organic compounds, inorganic, no, these all seem too specific. I will finish skimming the list under melting point and then go back and check the entry of temperatures for various substances. Good, I have finished the list. I will go back to the second entry, that is, temperatures for various substances. I opened it to a table called specific heat. I hope I don't have to convert. If I do I will look somewhere else. Here is the table - Melting and Boiling Temperatures. I am reading the heading of the table. This is Temperature of Fusion. I don't understand. I am looking to see if I can find a familiar one to see if the temperature of fusion would be reasonable with melting point. I find olive oil 2 = 6°C. That sounds reasonable. Paraffin at 55°C does not seem reasonable so temperature and fusion must not be the same as melting point. Yet the next table down has boiling point for various substances yet the main heading of the table says melting and boiling temperatures so I guess temperature of fusion must be melting point. But this is no good. The highest one on the table is glass at 1100°C whereas the other element gave carbon at 3700 I think. Now I will have to go back to the index and find under specific sub-headings -- let's see, organic components. Now I am trying to figure what kinds of materials would most likely have the highest melting point. Metals, organic compounds, probably organic compounds. I will check that first. But I may have to check several entries to make sure I am fairly close. Here we have a table, Melting Point Index of Organic Compounds -- what do they mean index? I don't understand. I will have to read the fine print at the top of the table. Ha, ha. I am in luck. The table lists a melting point of organic compounds in ascending order of temperature in degrees centigrade so the table is ordered how I want. Now, if I can figure it out because it looks like it just has numbers and letters in chemical notation of elements.

T: I will interrupt search a minute. I think what you did is important and one we will have trouble with. You glanced at the table and analyzed the table for meaning, or whatever you want to call that, and realized that in looking at the table you were going to have to convert. When we do this, we are liable to come clear up with the -- put it this way, the answer may indeed be correct but not meaningful. In other words, you could have come back out of this table with temperature and when I say material, you say 22.6. I don't know what to do with this at this point. Just get it in the record for later. Do you have anything...

D: I realize immediately I need to have some kind of table look-up from this table to find the material.

T: Correctly then is that you looked and knew you would have to have table look-up. You have done some kind of test.

D: The symbols obviously were only numbers and single letters. This could not possibly directly infer a material to me without further

Appendix A

referencing. I assume the reference immediately follows or is an integral part of this same table. Now I am reading all of the fine print at the heading of the table to see where the table look-up is. Not much help. It says the compounds are identified by the numbers as given in table --- physical contents of organic compounds. I hope that is in this book. If not, baloney. So all I have to do is look at the end of the table because it is in ascending order and should cause the compound -- notice the table says organic compounds where I have been using the word material. This is nutty. Ha, 470 to 500 D which I thought was a temperature -- but I will have to look back at the heading of the table. Yes. This says the melting points are given in bold face and these are in centigrades, so 500°C. This is no good. At 500°C doesn't seem right for the melting point of an organic compound. I will check the highest and see if it seems reasonable. Now I have got to find this other table -- what is called Physical Content of Organic Compounds. I guess I will look in the index under physical. I am beginning to think T knew the answer was not in the handbook so this may be a dead end but I will continue checking this path I am on now. The index has the table listed I think. I found the table, now I have to figure it out to see where the list by number is. No, wait. This table says values of the general physical contents. That doesn't seem the same as the table I want. I am checking back to the earlier table. No, it says table of physical contents or organic compounds. I will re-check the index. Here it is. I did not look down the index listing far enough. Ah, here we are, and they are numbered in ascending numbers so now I go back to the first table and look for 4865. As I am looking it occurs to me someone has done a nice sorting job here. I have found the element number 4865. I have never heard of it. Some crazy unpronounceable name. It says the melting point in degrees centigrade is 470 - 500D. Now I don't know what the D stands for. It may be a unit increment. I will look at the beginning of the table to see if it has an explanation. I think the entry in the first table had a D also. I will check. Yes it does. I am looking now at the explanation in the table under melting point and boiling point. Decomposition on heating is indicated by the abbreviation D so D is not an increment in units. Too bad. Now I am back to the element. Only 500 degrees centigrade. That is terrible. Carbon has a much higher one. So now back to the index for other metals. Maybe T is tricking me and it might not be in this book at all but I feel I must check other entries under melting point. Now the decision again -- which to check first -- alloys -- that infers metals to me. Metals boil, melt, quite hot. In fact, it seems like steel holders hold a carbon that sparks in a search light so maybe alloys is a good bet. At least alloys might be hotter than carbon so I am checking now. I have the table on alloys. These are arranged alphabetically but I guess the main element under each element, various alloys, so I guess I will have to skim down the melting point column. Gee, these don't look very high. This seems like a do-able task though I have not checked how long the table is. I guess I will check how long the table is. No, it is not too long. All I am doing is looking for one higher than 3700° now. Disgusting. Metals must be relatively soft,

Appendix A

like butter. Here is a supplementary table. I will skim it, too. Nope, no luck. Back to the index under melting point. Now again. Melting point, ice - no, out of the question. Industrial organic compounds. Gosh, do I have to check all of these? No, there must be other ways. Lets look over the list again. Organic -- ceramic. Hey, of course, ceramics in nose cones. Of course, that it is. Maybe I should look under missiles. Nose cone. I feel I have got it now even without T's grin. Let's see. What is the date of this book? I will check this and, if it is fairly recent, it will give a recent ceramic for nose cone. Copyright 1959. That is good enough. We have it nailed down now. I feel confident; in fact, over-joyed. Melting point for all ceramics, let's hope, includes nose cone. If not, where -- I have it nailed down and can go back to the catalog and look under nose cones. In fact, there is a recent article in Scientific American about re-entry problems. Let's see, it mentioned in there nose cones. It seems like 7,000 degrees -- was it in farenheit or centigrade. I don't know, but it must be. That raises a problem. Is there something hotter? What about, let's see now - diamonds - they have extreme temperature and pressure but that is carbon and we will find that. No, it is probably nose cones. I will now check ceramic. Funny I didn't get to nose cones before now. I just thought I was smelling my way in --- here is the table. Melting points of some ceramics, dirty guys. Something is wrong. The highest is 4160°C. Let's see, what was carbon? 3700. This is hotter, higher, or something. Let's look on the other page to see if there is some other data. No. All right. It looks like hafnium carbon has 4160°C melting point. Notice hafnium carbon has carbon in it so I was on the right track but didn't have the use of the metal as a clue. This says nothing about nose cones though. Maybe I should check nose cones or ballistic missiles. Maybe it is not too important. I will just skim this index for nose cones. No entry. Well, I will check with T.

T: You have produced an answer which you say here is a material and here is its melting point but the way in which you did the search provides no information as to whether or not it is the highest.

D: There was an inference on my part that the most severe heating problems have arisen in the re-entry problem. Ceramics seem to be erroneously used here.

I: In fact, if you continued search you would get out of handbook into recent research work.

D: Though I may find an element with a higher melting point, I feel almost certain it would be in the nose cone area so now it is a question of pinning it down to the very specific.

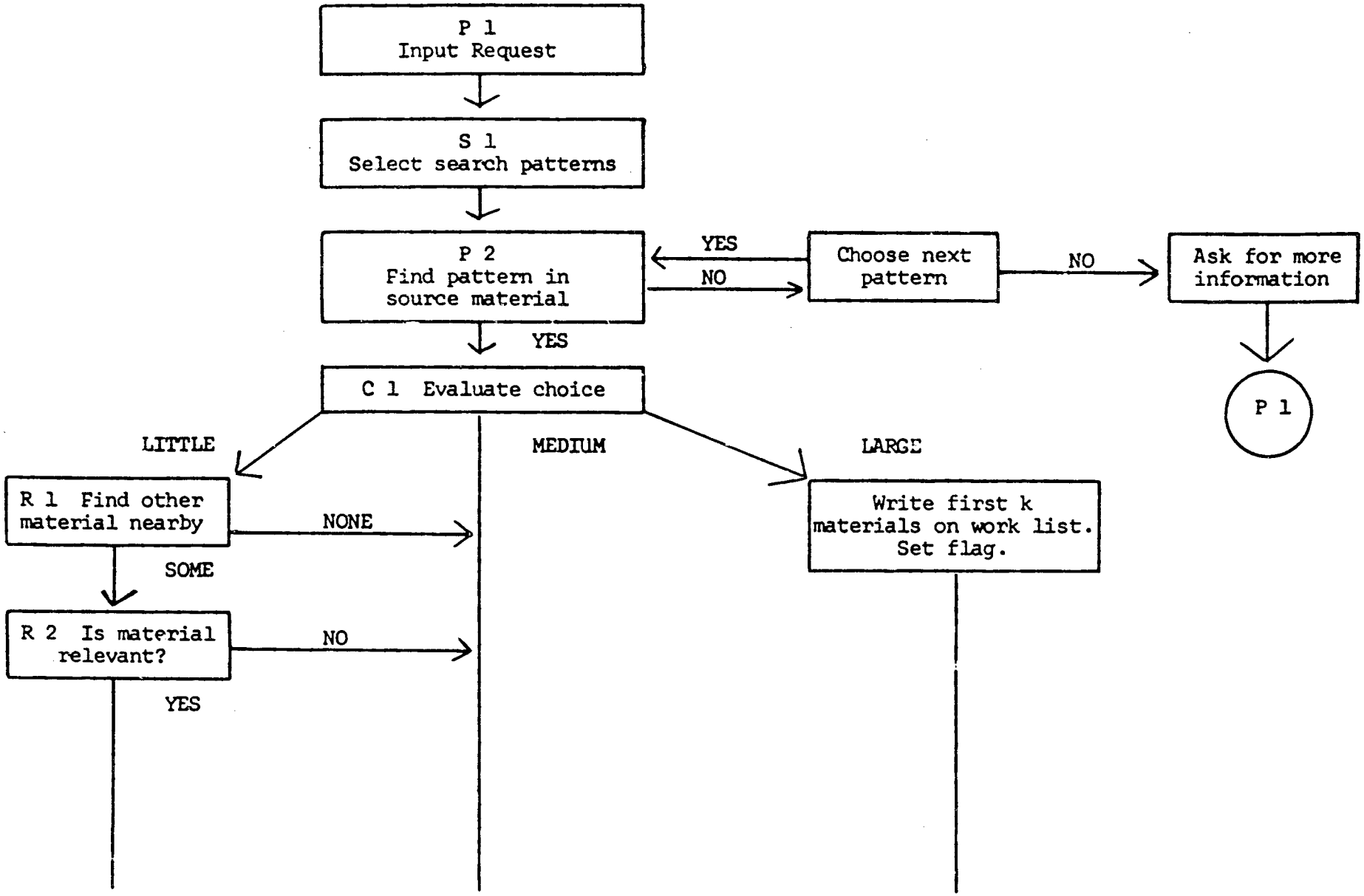
T: The question was not a handbook question because I purposely made it material to not lead into the field of ceramics immediately but to make that a find and, in addition, I am quite sure that you would not be able to produce the result of the search even getting in there,

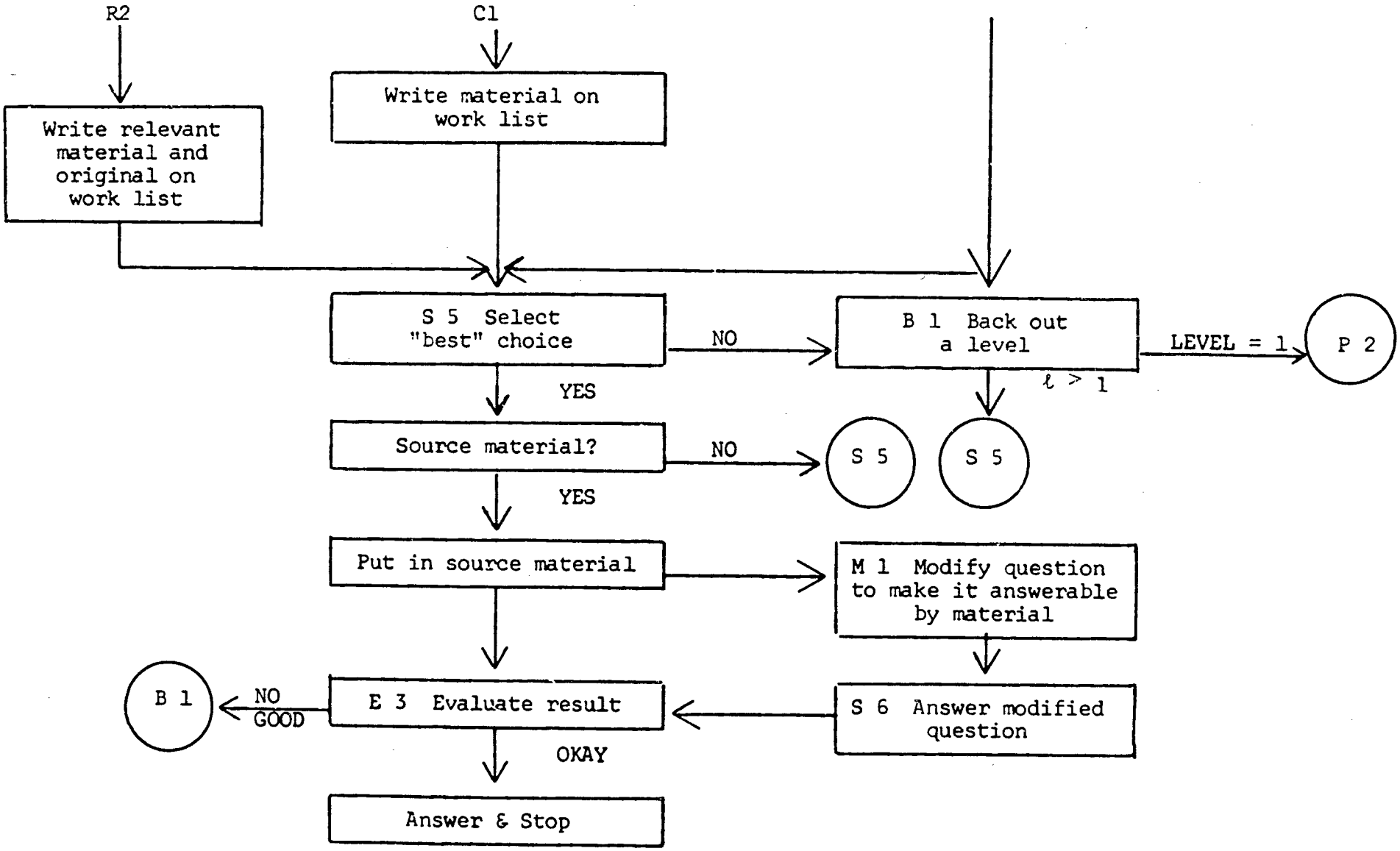
Appendix A

even going into the library, because this library does not have classified material.

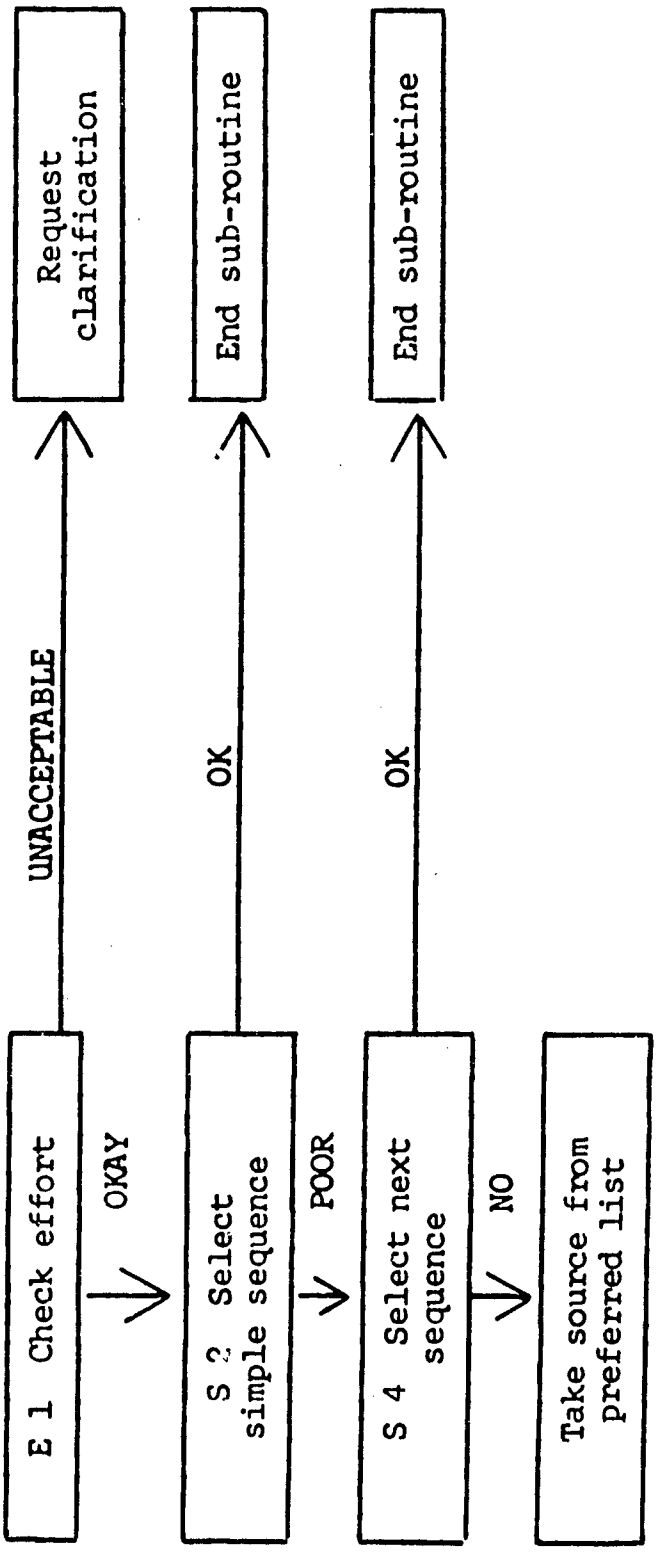
"Librarian"

Flow Chart

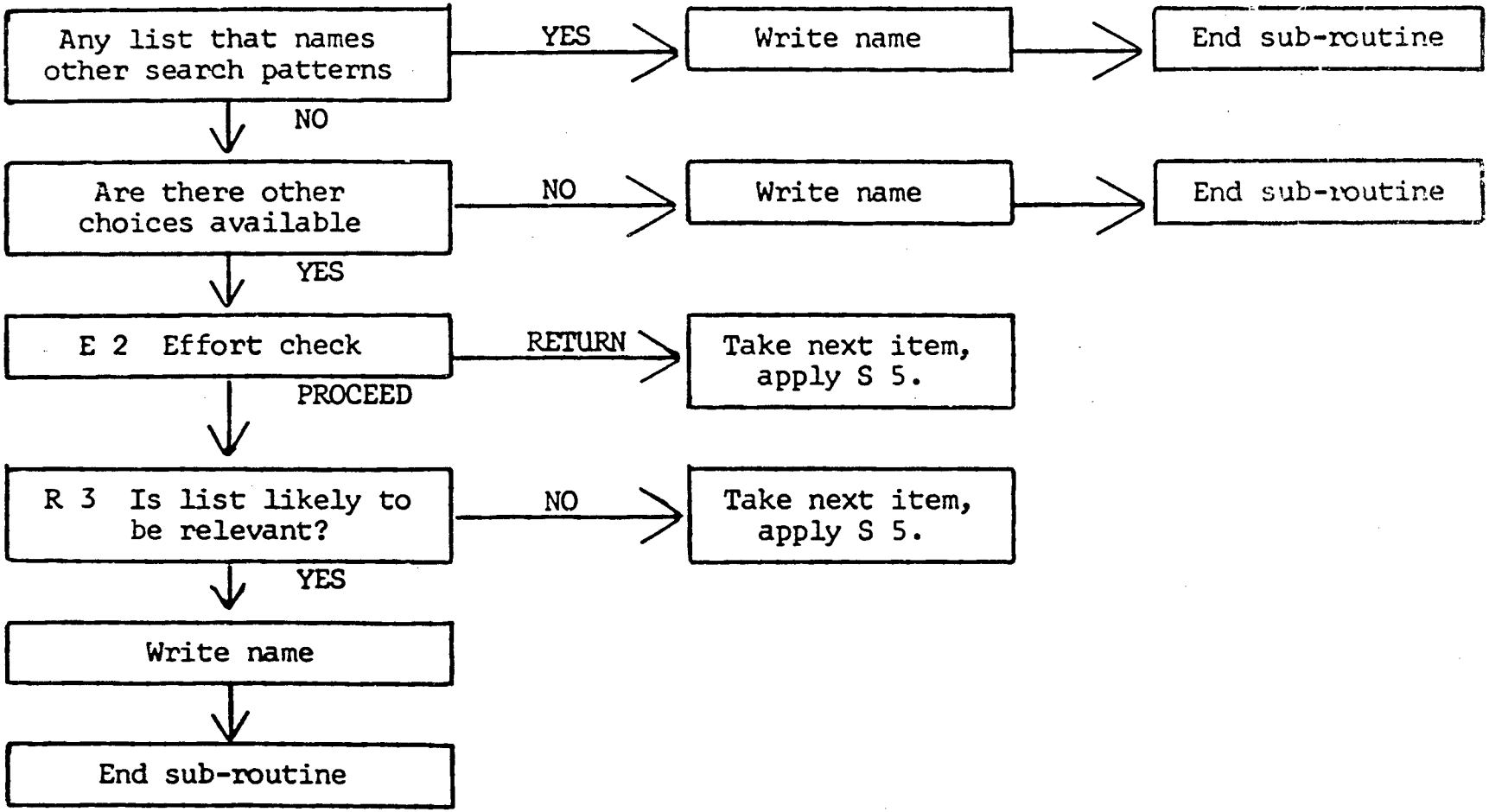



R2
C1
Write relevant material and original on work list
Write material on work list
S 5 Select "best" choice
NO
B 1 Back out a level
LEVEL = 1
P 2
YES
ℓ > 1
Source material?
NO
S 5
S 5
YES
Put in source material
M 1 Modify question to make it answerable by material
B 1
NO GOOD
E 3 Evaluate result
S 6 Answer modified question
OKAY
Answer & Stop

S 1 Select Search Patterns



S 5 Select Best Choice



Appendix B: Information Seeking Strategies

The four descriptions of information seeking strategies in this Appendix were reported by undergraduate students in I.S. 202 (The Information Sciences) in the Spring Semesters of 1965 and 1966. They were selected from about 20 such reports as better-than-average descriptions or as posing some particular problems.

Appendix B: Information Search Strategy Study No. 1 (May 1965)

Question: Find a relationship for the rate of gaseous molecular bombardment of the walls of the gases container.

Posed to: A sophomore mechanical engineer.

[Note: The student making the study followed the pattern illustrated in the model (Appendix A). He posed the question to another person (a sophomore mechanical engineer) and recorded the decisions made by the latter in searching.]

A- Denotes comments by observer.

Quotes: "---" denotes statements by the searcher.

"I'll try CHEMISTRY in the card catalog first, since I think I remember something about that from my Chemistry class. No, on second thought, I think I'll look under GASES instead.

A- Looks under GASES

A- Skips first card - "It's in German."

"I'm considering this one."

"These two are in French, no good."

A- Finds Chapmans-Kinetic Gas Theory.

"I'll try this because the card says it deals with mathematical relationships."

A- Gets the book from the stacks (533.C466m).

"I'll look at the table of contents first, then if necessary, the index."

"This chapter (Maxwell's Distribution) has something to do with it, I think, since I remember the title from Chemistry."

A- Scans chapter - then asks what the question was again.

"This doesn't seem to be it."

A- Goes back to table of contents.

"Here's a chapter called 'Collision Frequency.'"

A- Is that what you want?

"I'm hoping for some extended relationship for container walls rather than just collisions between molecules."

Appendix B: Information Search Strategy Study No. 1 (May 1965)

A- Scans a few pages. Asks if a relationship is needed only for gases and container walls.

"Here's a formula for the number of collisions between molecules but this isn't what you want. I'll continue in this chapter though."

A- Finds nothing.

"I'll try the table of contents again."

"I'm skipping chapters if the titles don't look relevant to your question. If it looks at all relevant, then I'll read the notes under the main heading to decide whether to read the chapter or not."

A- Stops at 'Dense Gases.' Finds sub-title 'Probability of Collision.'

"I'm not too hopeful of finding a solution here but I'll try it."

A- Scans chapter - Scratches it.

A- Finishes reading table of contents.

"I'll start over again, in case I missed something."

A- Notes that as he went further into book, work became more difficult and complicated.

"I think the answer is pretty simple so if it's here, it should be in the front of the book."

A- Tries first chapter [Theory of Gases].

"I'm not too hopeful, but no place else to check in the book."

A- Scratch this.

A- Goes back to table of contents, tries 'Properties of Gases.'

"I'm doing this because the sub-titles indicate the word velocity and I think the answer is related to velocities."

A- Scans chapter but gives up.

"I think I'll try another book."

A- Aren't you going to look in the index?

"No, the table of contents decided me against it."

A- Rather than going back to card file, he checks books on shelves near the one just looked at.

Appendix B: Information Search Strategy Study No. 1 (May 1965)

"I don't feel like going all the way back to the card file."

A- Picks 'Kinetic Theory of Gases.'

A- Again looks in table of contents.

A- Picks 'Collisions and Maxwells Law' chapter.

"I'm just picking a chapter."

A- First sentence in chapter says that Section 8, deals with the paths of single molecules.

"This looks good, lets try Section 8."

A- Finds mention of 'collisions with walls' but no direct formula for such.

"I'll look in that last chapter again."

A- Reads this chapter, hits end and continues into next one 'Freepaths in a Gas' because he sees the words 'Number of collisions.'

"This looks like more about intermolecular collisions so I'm doubtful of finding the answer."

A- Scans it, then retreats to Section 8.

"I'm trying here again because that chapter didn't lead anywhere."

"Maybe, I could derive a formula from the stuff they give. I don't think, I know enough however."

A- Tries anyway, obtains from $P = 1/3 \ m/v \ c^2$

$n/t = PV/WC^2t$

A- Think that's right?

"Are you serious?"

A- Is n/t what the question asks for?

"No, come to think of it, n/t is meaningless."

"I give up."

Note by Observer: The book "Kinetic Theory of Gases" contains the correct relationship in the chapter entitled 'Pressure in a Gas.' This was decided by the searcher to be a non-relevant chapter, apparently.

Appendix B: Information Search Strategy Study No. 2 (March 1966)

Search Process

[Note: The student here recorded his own search strategies and decisions].

I want to know what micro-programming is.

Where can I find information about micro-programming?

I can ask Mr. H_____: He's writing a master's thesis on micro-programming systems.

I can look it up in the library, but it's a new field and they probably don't have any books on it.

I can look in my E.E. 201 text; it deals with computer systems and is a recent book.

I'm at home so I'll check the book first.

I'll look in the index under "micro-programming."

Here it is, reference page 210.

Only one page contains a definition of "micro-programming."

It also references page 211, section on "Read Only Memory," Read this Section.

That's all the information I have at home. Does it satisfy my question.

Yes, however, I would like to know what more detailed information about micro-programming might be available.

I'll ask Mr. H_____ if he can give me any references and any additional information on micro-programming.

The secretary at the E.E. Department tells me Mr. H_____ will not be in until Wednesday; that's too late.

I'll try the Computing Lab and see if Mr. R____ (my Math instructor in computer programming) can help me.

Mr. R____ is in, and Mr. L_____ (my E.E. 201 instructor) is with him.

They don't have much to say; apparently they aren't too familiar with the subject.

Mr. R____ suggests I use the Index to Computing Reviews in Packard Lab 251.

Appendix B: Information Search Strategy Study No. 2 (March 1966)

Search Process

I have the Reviews for 1960-63. Apparently the Index uses a new system with which I'm not familiar.

They use a Keyword Index. I'll look under Micro-programming. There are four entries.

Index	Keyword
1. A Micro-instruction System (LOGLDSGN) =	6232 1738
2. Micro-programmed Control Units (PRCES)	6343 4166
3. Micro-programming (LOGLDSGN) =	6232 1737
4. Micro-programmed Computer with PHOT	6341 3625

I don't know what the keywords mean, I'll ask Mr. R____.

The first two numbers following are the year, '62 etc.

The next two numbers are the volume number and the issue number of the Computing Review referenced. The remaining four digits are the review number.

I look up the respective reviews. Two (numbers 1 and 3) are references to preprints of papers presented at a meeting of the Association for Computing Machinery. They are not available so I'll not look any farther.

Numbers 2 and 4 are abstracts of papers printed in Technical Journals. For my purposes the abstracts will suffice.

That seems to exhaust the computer library sources.

Now I'll check the University Library.

I'll check the card catalog first.

I'll look under MICRO-PROGRAMMING first. There is nothing here.

I'll try looking under COMPUTERS. The card catalog refers me to ELECTRONIC DIGITAL COMPUTERS.

I'll look under ELECTRONIC DIGITAL COMPUTERS. None of the books indicated look promising. However, they all have the same catalog number (510.7834). I'll look in the stacks at that number and see if any of the

Appendix B: Information Search Strategy Study No. 2 (March 1966)

Search Process

books are promising.

None of the books are sufficiently up to date to help.

However, here are some bound publications of the I.B.M. Journal of Research and Development.

I remember I've been told the I.B.M. system 360 uses micro-programming.

I'll check the journals.

Each bound group seems to have an index. I'll use the index.

Micro-programming is new so I'll start with vol. 5, 1961.

Nothing here.

Try vol. 6, 1962.

Here's an article on Micro-programming. I'll read the article. This article seems quite inclusive and sufficient.

However, I'll check the remaining volumes just in case.

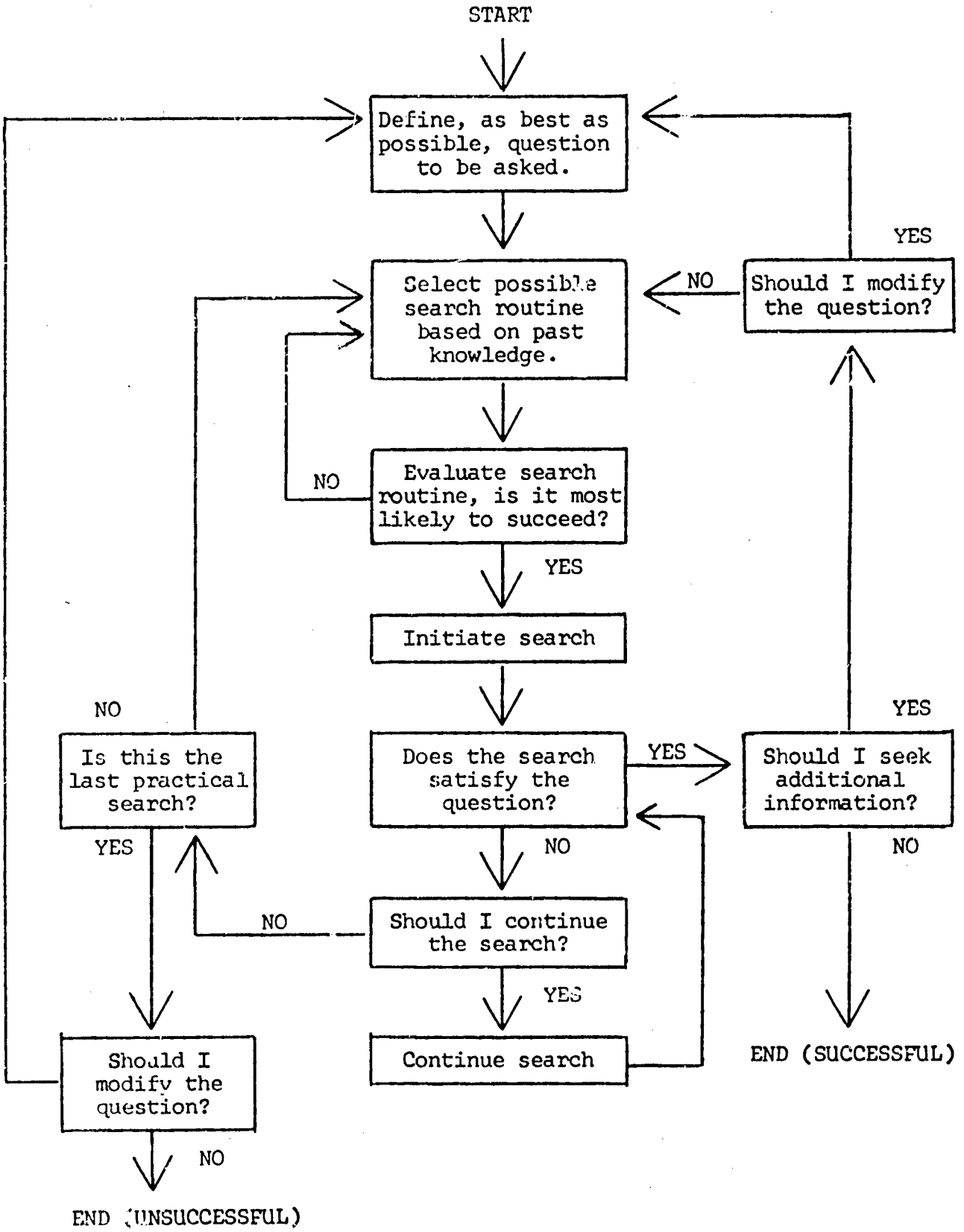
Check vol. 7, 1963. Nothing here.

Check vol. 8, 1964. Nothing here either.

I have enough information; I'll end the search here.

Appendix B: Information Search Strategy Study No. 2

Block Diagram of Search Procedures



Appendix B: Information Search Strategy Study No. 3 (March 1966)

Search Process

[Note: Student here records his search and decision processes in his own words].

Question: What is a concise definition of "Gaussian Curvature?"

Upon entering the library I noticed that the Reference Librarian did not seem to be in. After choosing a seat I once more checked her desk and found that she was still absent. So I went over to the Card Catalog to begin my search.

I dreaded to look for books listed under Subjects rather than under Authors and Titles because, due to the nature of my question, I did not feel there would be any books concerned merely with this question and listed by some pertinent title.

The first subject I begin to look for is GAUSSIAN CURVATURE. While thumbing through the cards I see there is nothing on this subject, but there are two books listed under GAUSS. One of these books is German, so I didn't bother with it, but the other seemed relevant to my subject so I copied its number.

I then looked under GEOMETRY, and under this subject I found ten sub-headings: analytic, algebraic, plane, descriptive, differential, history, non-Euclidean, plane (a second time), projective, and solid. Of these sub-headings I choose three which seemed most relevant to me: DESCRIPTIVE, HISTORY and NON-EUCLIDEAN.

There were forty-two books under GEOMETRY, DESCRIPTIVE; of these I immediately overlooked sixteen, seven of which were in French and nine in German. Of the remaining twenty-six, only eight seemed as if they might be of any use.

There were ten books under GEOMETRY, HISTORY. Of these ten, four were in French and one was in German so I discarded them. Of the remaining five only two seemed as if they might be appropriate.

Appendix B: Information Search Strategy Study No. 3 (March 1966)

Search Process

There were thirty-three books under GEOMETRY, NON-EUCLIDEAN. One was in French and eleven were in German. Of the remaining twenty-one only seven seemed relevant.

Next I looked under CURVATURE and found only two books neither of which seemed to be of much use, so I decided to look under CURVED SURFACES. There was nothing there except a card referring me to SURFACES. I wrote this down and then proceeded to look under CURVES while I was in that part of the catalog.

Under CURVES there were nine books; three of which were in French, four in German and the other two were irrelevant. So I was about to look at SURFACES when I noticed a card saying CURVES ON SURFACES so I decided to look at this. There were ten books listed here; one was in French, two in German, one in Italian (I think) and two in Russian. Of the others, two seemed as if they would be of some help.

I then looked under SURFACES and found twenty books listed there. One was in Dutch, four in French, six in German, one in Latin, and the other eight seemed useless.

I could think of no more subjects under which to look. After a little bit of thinking I decided to look in the Author index under Gauss. I came to Gauss, Carl Friedrich and was referred to Gauss, Karl Friedrich under which I found eighteen books with him as author. Of these, thirteen were in German and one was in Latin. Of the remainder all but one were concerned with astronomy, but the one seemed as if it might be relevant.

I recorded the numbers of all the books I thought would be relevant. I determined the relevance of a book by its title and any other comments on the card concerned with the contents of the book. I then gathered all my numbers and proceeded to find all these books.

All but two of these books were in the same section of the library. One of the two was on the same floor in a different section, and the other

Appendix B: Information Search Strategy Study No. 3 (March 1966)

Search Process

was on a different floor.

There were six books that I couldn't find on the shelves. If I couldn't find the book where I felt it should be, I looked around the surrounding area to see if it were misfiled. None of the six were. So I went back to the index to recheck my numbers. All of the numbers were correct. Just to take a break I went to the Loan Desk to check on these six books. I was told that none of them were listed as "out", and that I could put a search on them if I wished. I decided against this and went back to the books I had.

I then proceeded to look through the books. First I would look in the index under "Gaussian Curvature" or "Gauss". Next I would check "Geodesy" or "Geodesic Curve". If I still found nothing, I would then look under "Curves", Curves on Surfaces" or "Surfaces". I recorded the number of the pages where this information was and then looked it up.

If the book had no index, I looked under the table of contents for any heading or sub-heading which might be of some use.

After going through about half the books on descriptive geometry, I decided not to waste my time on the other books because descriptive geometry was not as closely related to my problem as I thought it would be.

I checked through all the other books and still found no solution to my question. Two of the books gave very brief, somewhat ambiguous descriptions of "Gaussian Curvature", and the others merely mentioned it if at all.

I was stumped because I could think of nowhere else to look. I was about to leave when I noticed that the Reference Librarian was in. So I decided to try her as a last resort. I asked where I might find information on "Gaussian Curvature". I explained that I had been looking through the Card Catalog and could think of no more subjects under which to look. She said that she knew nothing of this subject and so could not think of

Appendix B: Information Search Strategy Study No. 3 (March 1966)

Search Process

where else to look in the Catalog.

She began to look in a book of mathematical tables, and I explained to her that she would not find "Gaussian Curvature" there. I told her it was a theory, not a measurement. Whereupon she gave me a mathematical dictionary which looked as if it would help.

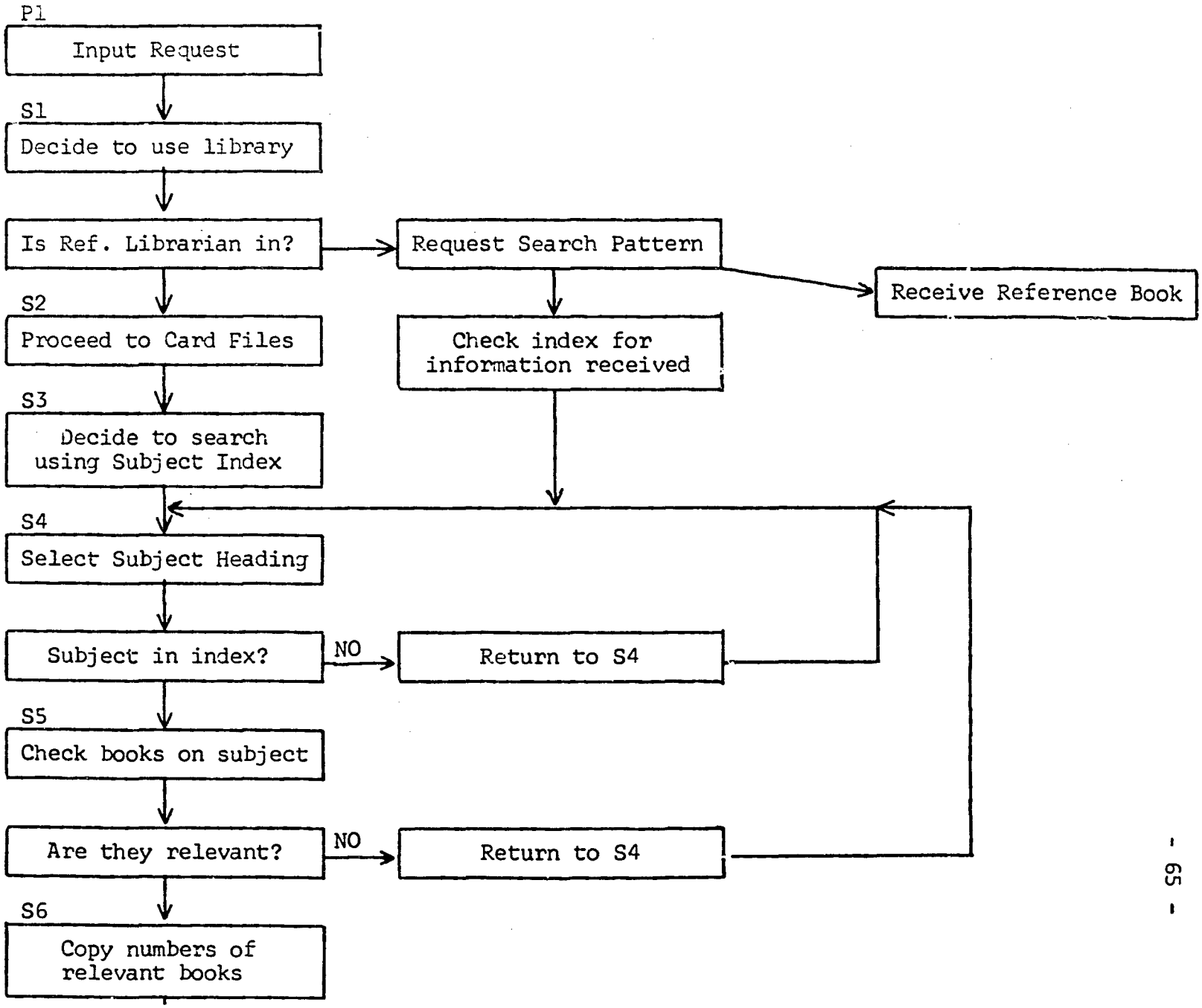
I found nothing under "Gauss", but I continued on to "Gauss's Equations" and the "Theorem of Gauss" both of which helped some but were still too general.

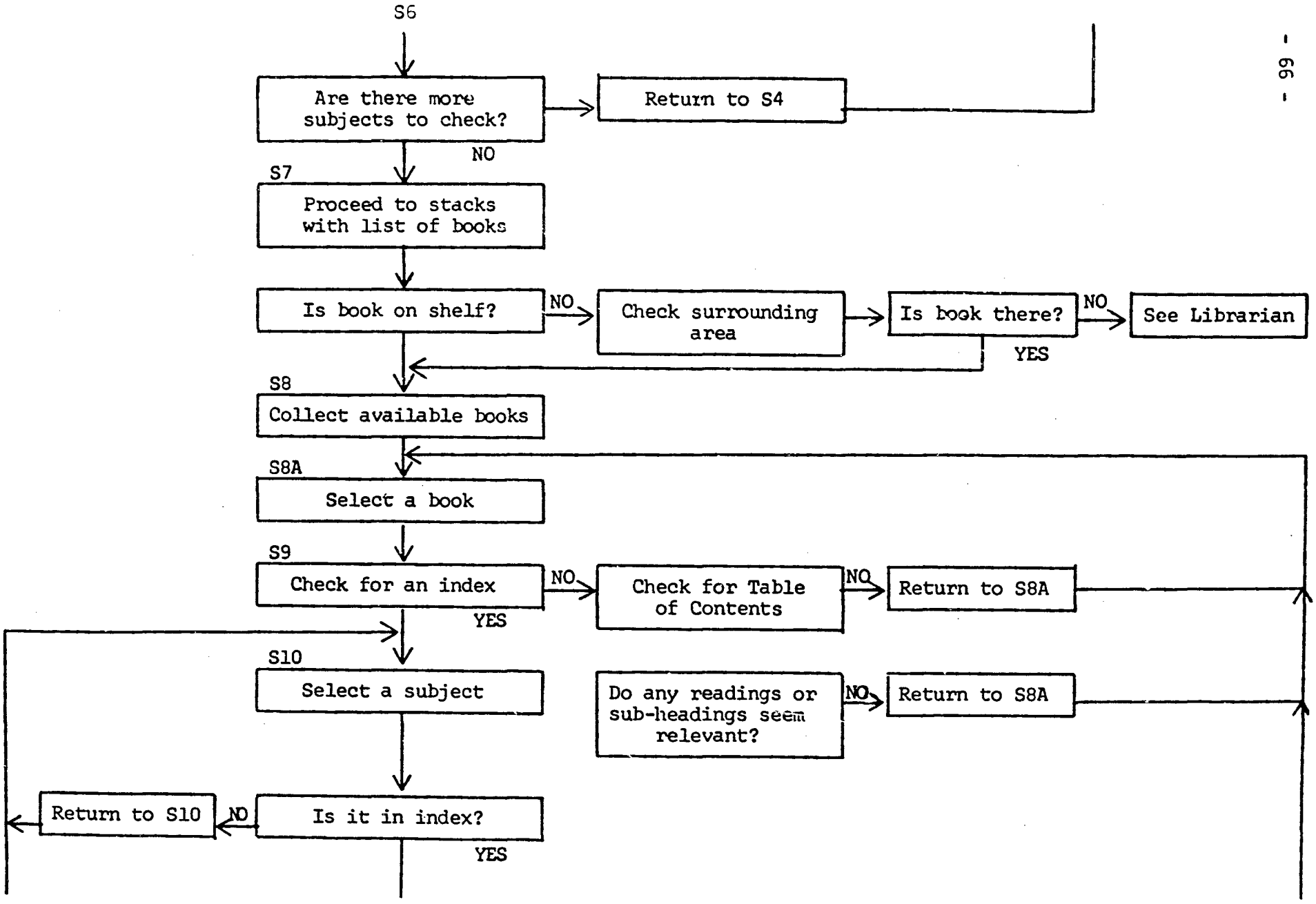
I was referred to "Codazzi Equations" which was of no use and further referred me to "Christoffel Symbols" which did not help either.

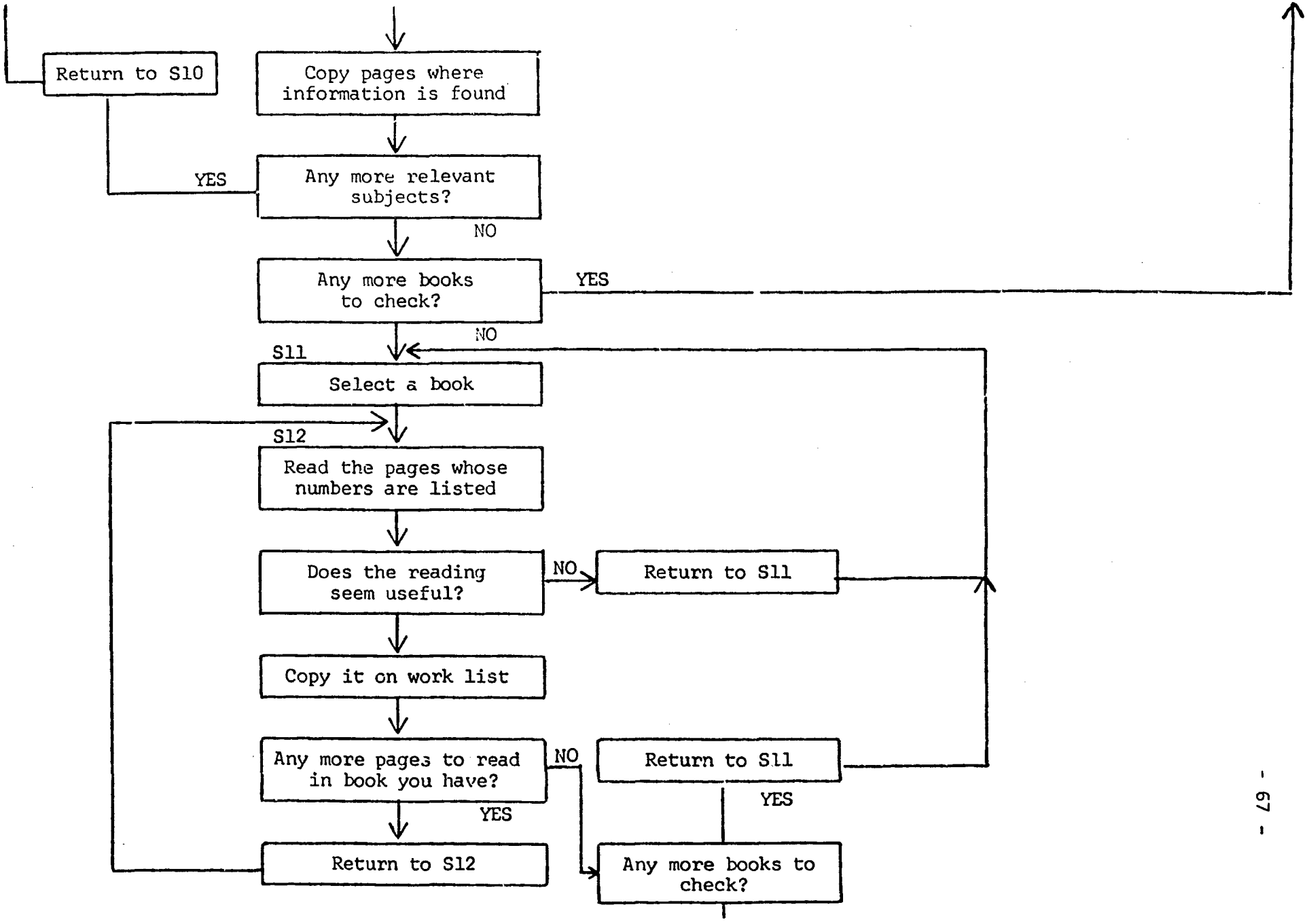
So I decided to look under "Surfaces" and was referred to "Curvature" where I found "Gaussian Curvature" which still did not supply me with a suitable definition. I was further referred to "Total Curvature" which helped a little.

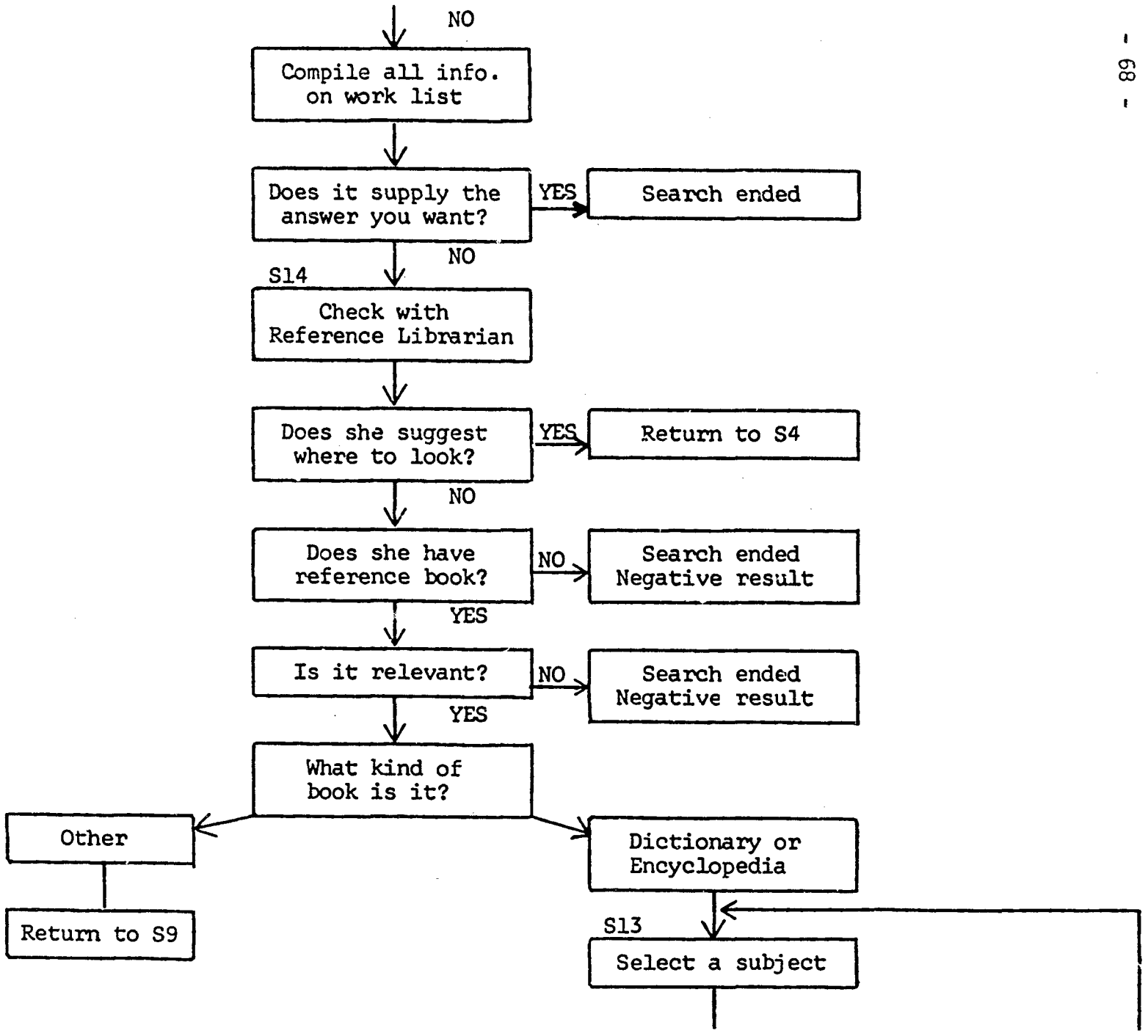
By following up references and looking up definitions for words in other definitions, I found that I could finally come up with a suitable answer by combining the information from: 1) "Gaussian Curvature" - under "Curvature", 2) "Total Curvature" - under "Curvature", 3) "Principal Curvature" - under "Curvature", 4) "Normal Curvature" - under "Curvature", 5) "Principal Directions" - under "Directions", 6) "Fundamental Coefficients" - under "Surface", and 7) "Radius of Total Curvature" - under "Radius".

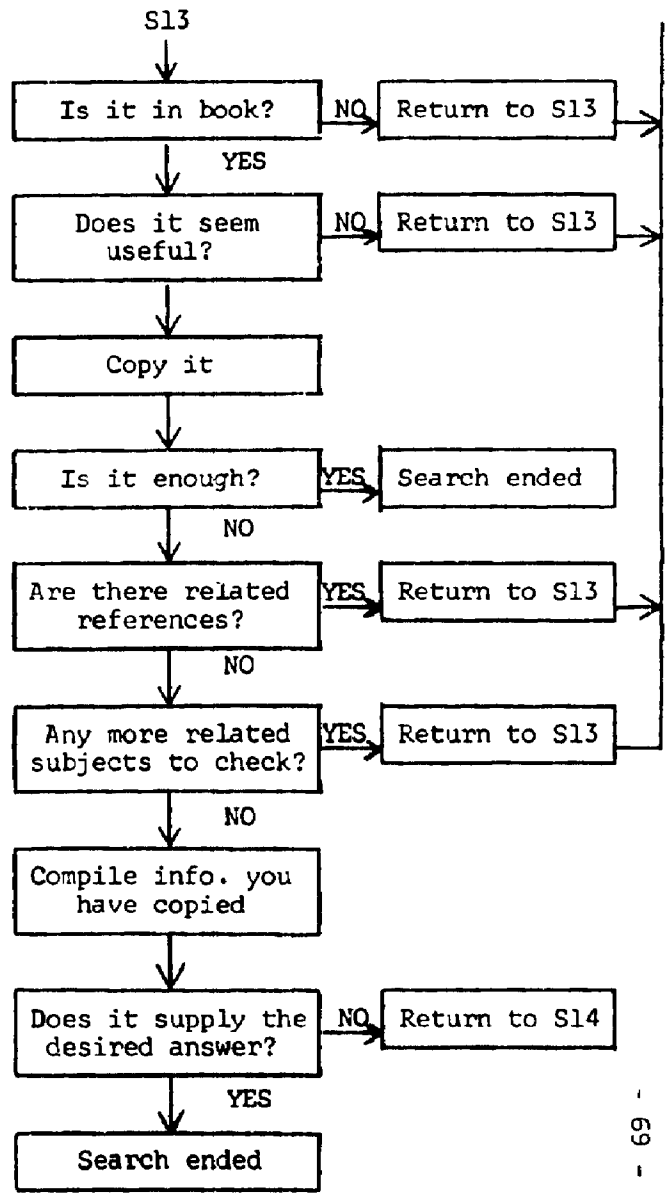
Appendix B: Information Search Strategy Study No. 3 (March 1966) Search Flow Chart




S6
Are there more subjects to check?
Return to S4
NO
S7
Proceed to stacks with list of books
Is book on shelf?
NO
Check surrounding area
Is book there?
NO
See Librarian
YES
S8
Collect available books
S8A
Select a book
S9
Check for an index
NO
Check for Table of Contents
NO
Return to S8A
YES
S10
Select a subject
Do any readings or sub-headings seem relevant?
NO
Return to S8A
Return to S10
NO
Is it in index?
YES


Return to S10
Copy pages where information is found
YES
Any more relevant subjects?
NO
Any more books to check?
YES
NO
S11
Select a book
S12
Read the pages whose numbers are listed
Does the reading seem useful?
NO
Return to S11
Copy it on work list
Any more pages to read in book you have?
NO
Return to S11
YES
YES
Return to S12
Any more books to check?


NO
Compile all info. on work list
Does it supply the answer you want?
YES
Search ended
NO
S14
Check with Reference Librarian
Does she suggest where to look?
YES
Return to S4
NO
Does she have reference book?
NO
Search ended Negative result
YES
Is it relevant?
NO
Search ended Negative result
YES
What kind of book is it?
Other
Return to S9
Dictionary or Encyclopedia
S13
Select a subject


S13
Is it in book?
NO
Return to S13
YES
Does it seem useful?
NO
Return to S13
Copy it
Is it enough?
YES
Search ended
NO
Are there related references?
YES
Return to S13
NO
Any more related subjects to check?
YES
Return to S13
NO
Compile info. you have copied
Does it supply the desired answer?
NO
Return to S14
YES
Search ended

Appendix B: Information Search Strategy Study No. 4 (March 1966)

In an effort to reduce a somewhat wasteful and wordy description of search procedure, I have broken the search into various parts. These parts are labelled according to their function as follows:

Q	question
I	interrogation of a source
D	decision
R	significant result of an interrogation
!!!!!	"dead end" of a search path

The indentation of the various branches shows their relationship to the other elements much, like an outline, shows ideas and sub-divisions of ideas. The analogous parts of the following outline are elements in the search path (a tree-like structure), one element stemming from the other. For example, The "I" labelled "Biasing And D-C Amplifiers..." is a direct result from the interrogation of the General Electric Transistor Manual.

Significant deviations from the planned search procedure, re-evaluations of the question and strategy, are labelled in red.

The following outline should be considered as a time function. Time proceeds from the top of the chart, the original question, until the search is finished.

Q-How does the Philco F10 differential amplifier operate in the model 228 digital memory unit?

I-F10 logic diagram

R-no operation description

D-look elsewhere!!!!!

I-F10 schematic diagram

R-diagram not accurate

sub-question-- Q-what is correct schematic?

I-F10 schematic

R-schematic diagram inconsistant

R-parts list agrees with assumed correction

D-correct schematic***question satisfied

I-correct F10 schematic

R-not enough information to analyze circuit

D-store information

D-look elsewhere!!!!!

I-general preliminary description of the memory unit

I-circuit description section of preliminary description

R-no information for this circuit

D-look elsewhere

D-look elsewhere!!!!!

re-evaluation-- D-the question will have to be generalized because specific data supply is exhausted

Q-how is a general transistor differential amplifier analyzed?

I-General Electric Transistor Manual

I-Biasing and D-C Amplifiers (ch. 4)

I-D-C amplifiers

I-Single Stage Differential Amplifiers

R-too specific to be applicable

D-look elsewhere in this section

I-Two Stage Differential Amplifiers

R-even more specific

D-look elsewhere

re-evaluation of-- strategy D-look elsewhere!!!!!

I-Prof. L____ (E.E. Dept.)

I-Fairchild Design Bulletin ADC-10

R-too specific

D-ask for other sources

I-Fairchild Design Bulletin ADC-15

R-contains no analysis

D-ask for other sources

I-Texas Instrument Corp. Transistor Circuit Design

I-Part 2; D-C and Low Frequency Design

I-Sec. 8.4; Differential Stage

R-too specific

D-look elsewhere in this part

I-Sec. 8.5; Input Stage Design

R-too specific

D-look elsewhere in this part

R-no more pertinent information

D-look elsewhere in the book

I-index

R-no further information

D-look elsewhere!!!!!

I-Prof. H_____ (E.E. Dept.)

I-Angelo: Electronic Circuits

I-Index

I-p. 429; difference amplifier

R-need more background to interpret information

D-check associated material in Angelo

I-p. 426-430; Bisection Theorem

R-very general description of analysis of differential type circuits

R-desire more specific material concerned with transistor circuits

D-store as reference to help in interpretation of any more specific information found

D-look for more information in this source

I-Index

R-no more information

re-evaluation of-- D-look elsewhere!!!!!

I-General Electric Transistor Manual References

I-references rom ch. 4

I-Hellerman, in AIEE Proceedings of Fall General Meeting 1957

I-card catalogue, author section

I-AIEE Proceedings of Fall General Meeting 1957

R-not available

D-take next reference

I-Snyder, "A High Performance Silicon Transistor..."

D-not applicable by title

I-Okada, R. H. "Stable Wide-Band D-C Amplifiers" Communications And Electronics, March 1960

I-card catalogue

I-author section

I-A.I.E.E. Transactions

R-referred to serials catalogue

I-serials catalogue

I-A.I.E.E. Transactions March 1960

R-referred to stacks 621.306 A512T

I-Transactions of A.I.E.E.

I-Communications and Electronics

I-1960 volume

I-author index

I-p. 26-33

R-differential amplifiers mentioned on p. 28

I-p. 28-33

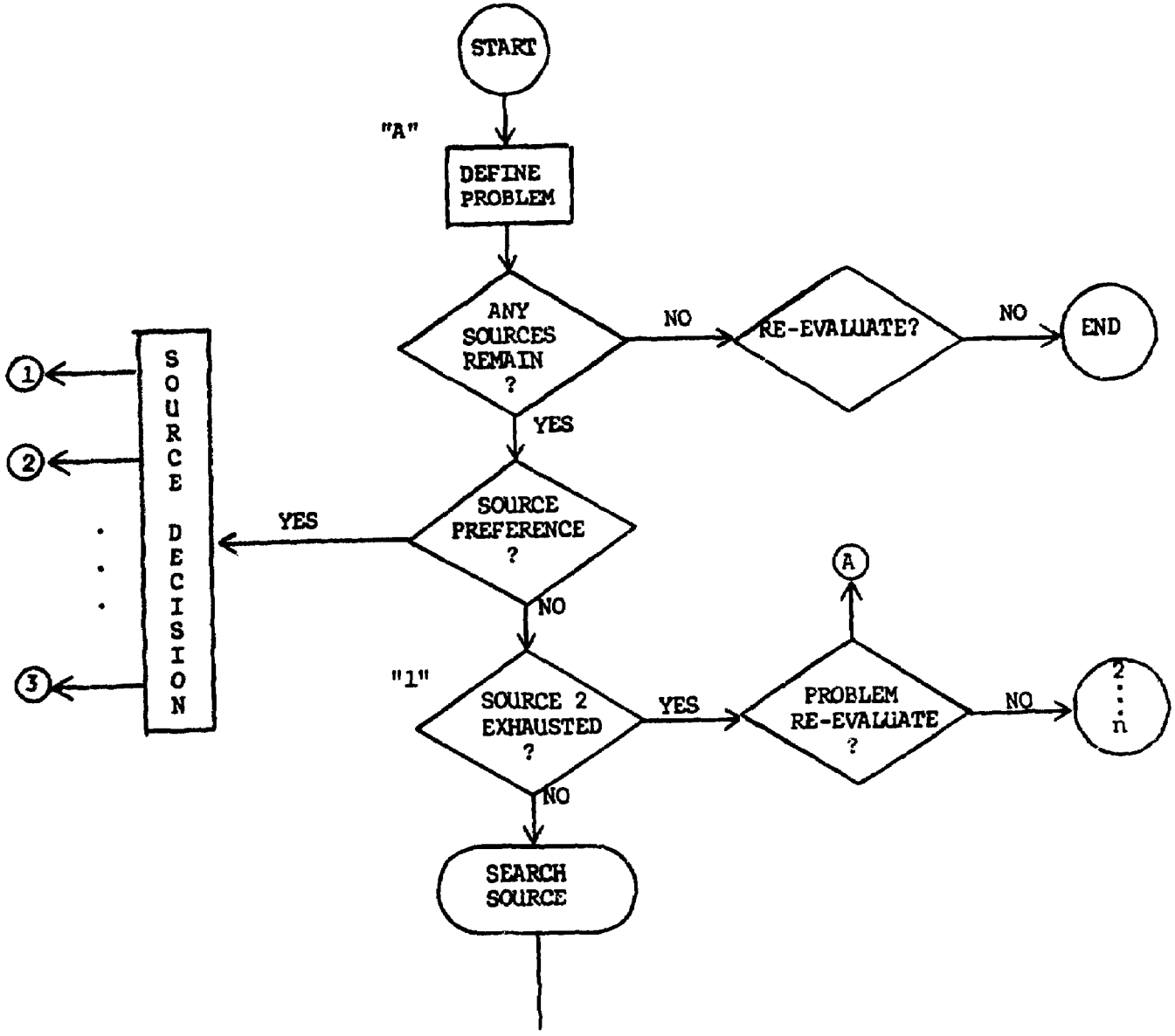
R-a general description and methods of analyzing differential amps. given

D-Angelo will give assistance in comprehending the analysis

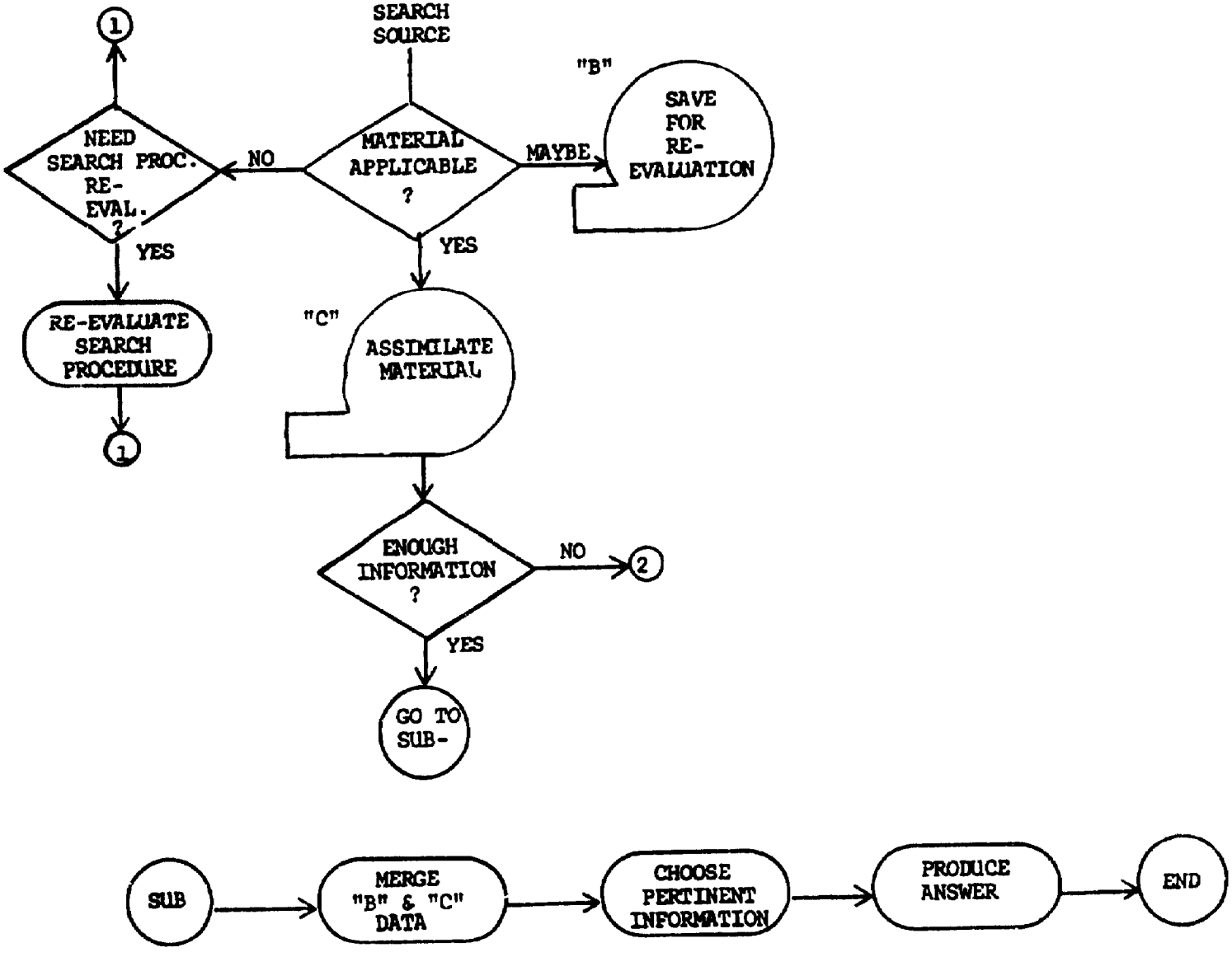
D-revised question has been answered!!!!!

R-original question can now be answered after schematic has been retrieved

SEARCH STRATEGY



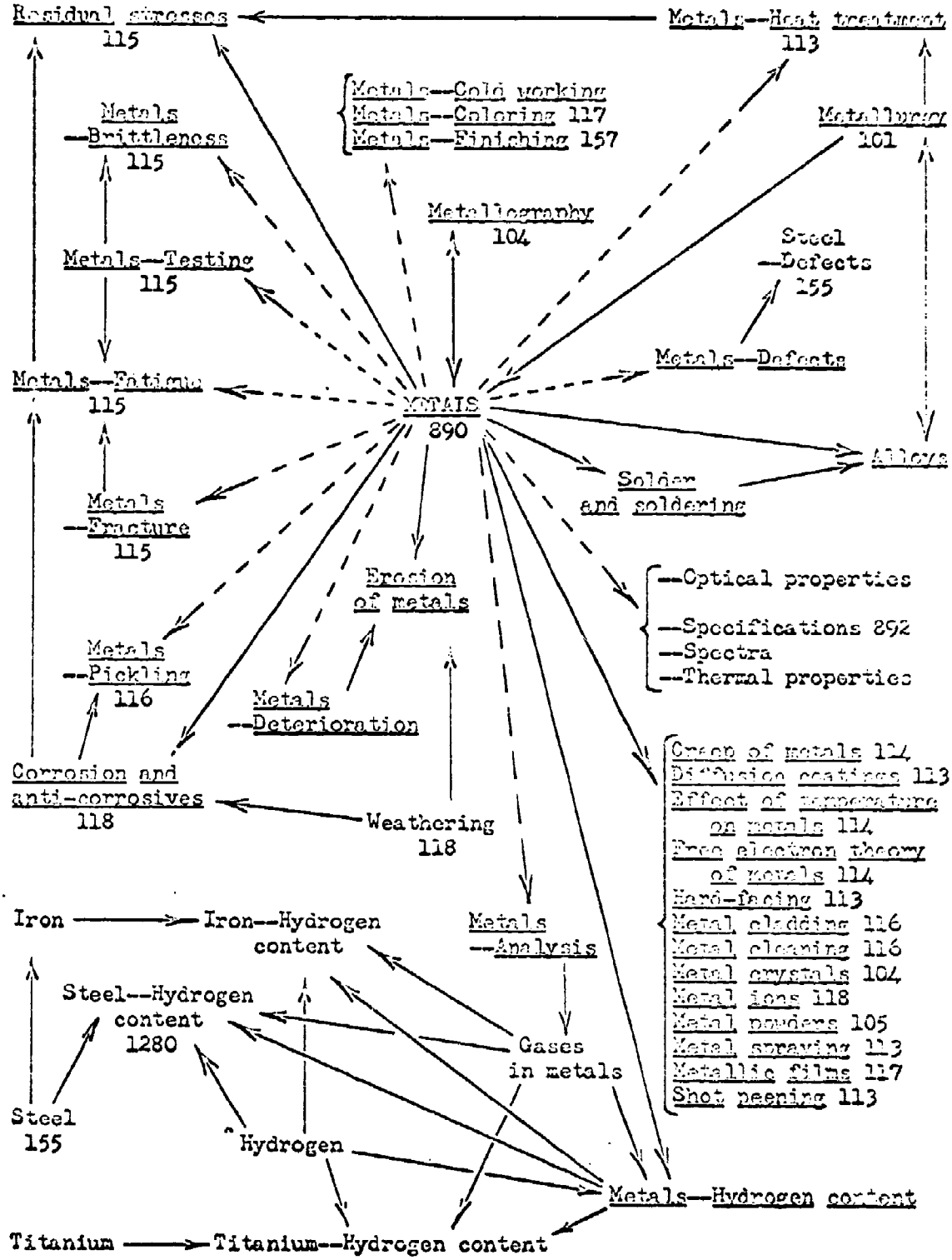
Where 2...n transfers to identical procedure following the pattern of statements 1---C, but, which search the other sources.


SEARCH SOURCE
MATERIAL APPLICABLE ?
NO
MAYBE
"B"
SAVE FOR RE-EVALUATION
YES
NEED SEARCH PROC. RE-EVAL. ?
YES
RE-EVALUATE SEARCH PROCEDURE
"C"
ASSIMILATE MATERIAL
ENOUGH INFORMATION ?
NO
YES
GO TO SUB-
SUB
MERGE "B" & "C" DATA
CHOOSE PERTINENT INFORMATION
PRODUCE ANSWER
END

Appendix C

Sample Frames for Programmed Display Searching System in Metallurgy designed for Recordak Lodestar Microfilm Reader-Printer with Image Control Keyboard.

From M. B. Leibowitz. A Proposed System for Displaying Accessing Techniques to Library Users in the Field of Metallurgy. M.S. Thesis, Lehigh University, Bethlehem, Pa., 1967.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Metallography 104
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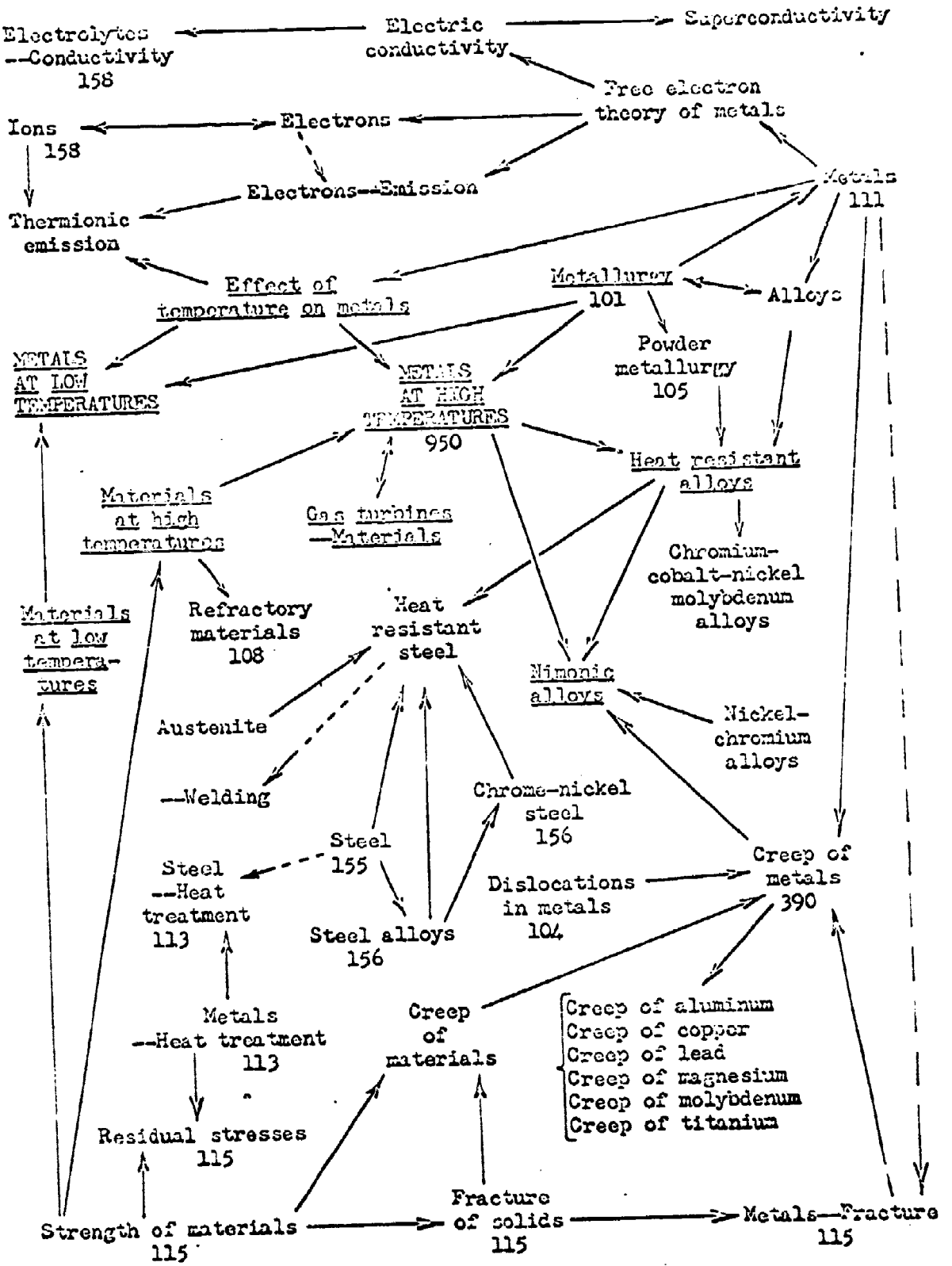
Titanium--Hydrogen content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Nimonic alloys
Nickel-chromium alloys
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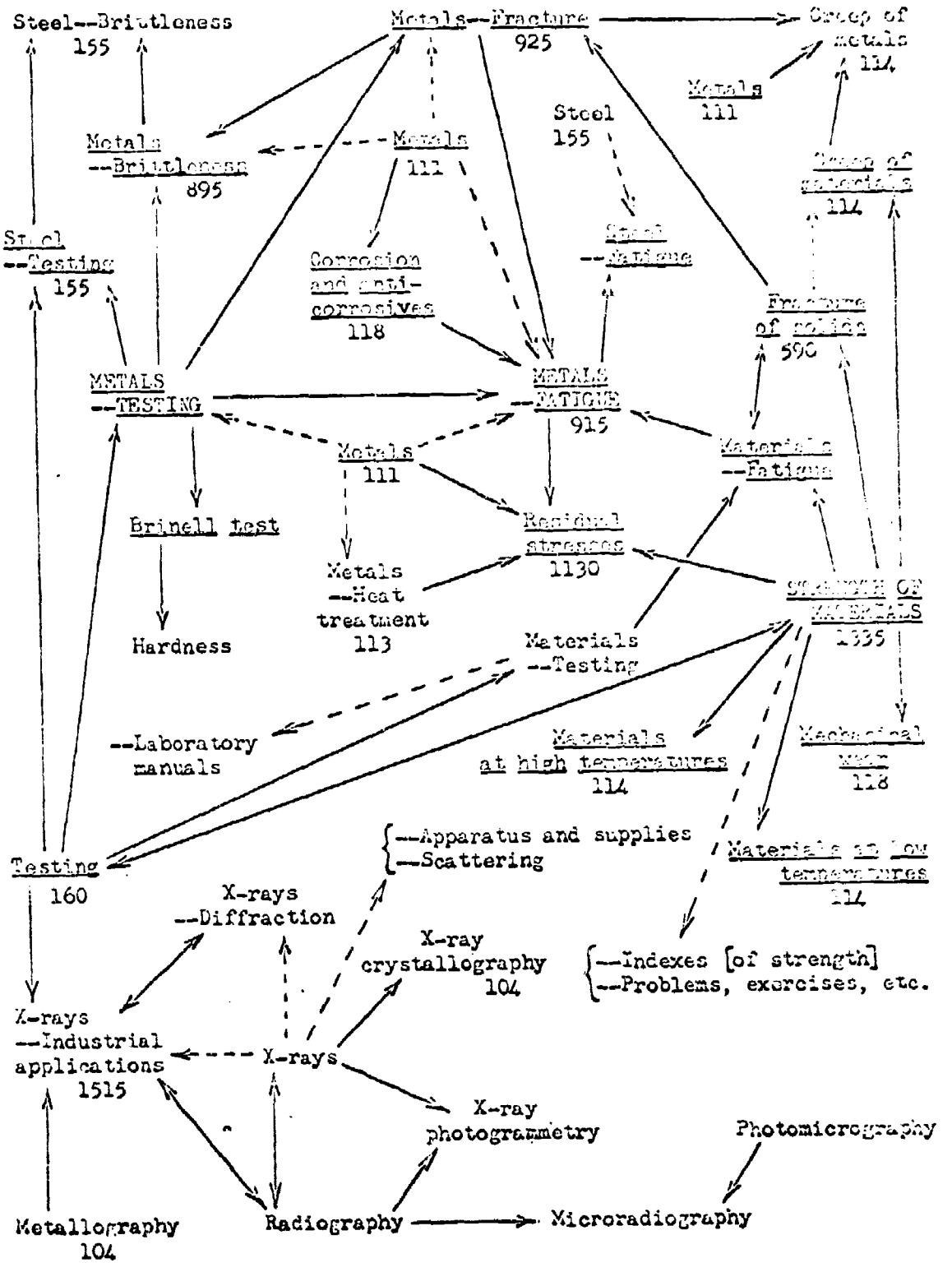
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--Problems, exercises, etc.
X-rays --Industrial applications 1515
X-rays
X-ray photogrammetry
Photomicrography
Metallography 104
Radiography
Microradiography

METALS--FATIGUE

General

Forrest, P. G. Fatigue of Metals. Reading, Mass.: Addison-Wesley (Addison-Wesley Series in Metallurgy and Materials), 1962. 425p. illus.
Many detailed charts, diagrams, tables, plates. Includes 30 pages of references. FRAME 1730

Kennedy, A. J. Processes of Creep and Fatigue. New York: Wiley, 1963. 430p. illus.
An advanced treatment for physicists, metallurgists, and engineers. Includes fundamentals and bridges gap between engineering and metallurgical aspects. Many references.

Forrest, P. G. Fatigue of Metals. Reading, Mass.: Addison-Wesley, 1962.

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TABLE 50. THE EFFECT OF SURFACE TREATMENTS ON THE CORROSION FATIGUE STRENGTH OF STEELS

All fatigue tests in rotating bending

Material	Tensile strength tons/in²	Surface treatment	Approximate thickness of protective layer in.	Frequency of stress cycles/min	Corrosive medium	Endurance limit for fatigue strength	Fatigue strength tons/in²		Corrosion fatigue strength tons/in²		Source	Ref.
							Untreated	Treated	Untreated	Treated		
0·5% C cold drawn steel: as drawn	41·6	Enamel	—	2200	3% salt spray	2×10^7	24·5	22·6	3·5	10·5	Sopwith and Gough	392
as drawn normalized	43·1		—				16·4	17·2	4·0	11·2		
as drawn		Galvanizing	0·0019					24·7		23·2		
normalized								14·8		16·6		
as drawn		Sherardizing	0·0005					22·6		24·5		
normalized								14·8		15·2		
as drawn		Electrolytic zinc plating	0·00055					24·4		21·4		
normalized								16·1		14·7		
as drawn		Electrolytic cadmium plating	0·00032					22·6		18·9		
normalized								15·2		13·3		
as drawn		Electrolytic cadmium plating + enamel	0·0305					23·2		17·7		
normalized								15·8		13·5		
as drawn		Electrolytic cadmium plating + oil	0·0005					21·8		15·0		
normalized								15·8		13·4		
as drawn		Phosphate treatment + enamel						22·8		10·2		
normalized								17·8		12·9		
as drawn		Aluminium spray	0·003					24·8		19·5		

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Robert S. Taylor

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13. ABSTRACT

This report is a study of two types of the process of question-negotiation in libraries and information centers. Through taped interviews with special librarians and information specialists, five levels of information were isolated which are consciously sought and received by the librarian in the negotiation process. These are (1) subject definition; (2) objective and motivation; (3) personal characteristics of the inquirer; (4) relationship of inquiry description to file organization; (5) anticipated or acceptable answers. The second type of negotiation, self-help, is that in which the inquirer alone negotiates with the total information system. Undergraduate students in courses in the information sciences reported on this process resulting from a self-generated information need: the decisions and strategies; the sources used, both human and print; the complexities and failures of their processes; and the ambiguities of their question-asking strategies. Four such reports, including systems charts, are shown in the Appendices. The two types are compared with recommendations for improving the displays at the interface between inquirer and system.

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14 KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Questions						
Negotiation						
Libraries						
Reference Service						
Information Seeking						
Display						
Search Strategy						