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SEARCH PROCEDURES IN THE LIBRARY—ANALYSED FROM THE COGNITIVE POINT OF VIEW

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The paper reports experimental results concerning user interaction with document organization, user–librarian negotiation and the librarian's search processes in public libraries. The focus of the investigations is on the cognitive aspects of information retrieval.

After defining the formal framework of the information retrieval (IR) process a theoretical section discusses the cognitive viewpoint on which the research is based, followed by an outline of applicable findings and theories within the fields of cognitive science and cognitive psychology. The experimental design involving tape-recording and analysis of verbal protocols is briefly described and considered. The main part of the paper concentrates on the results of investigations and considers certain implications. It is shown how the user's knowledge structures cope with the structures of the system. User needs seem often to be presented as a label which may create ambiguity problems. Functions of open and closed questions are investigated and certain behaviouristic factors discussed. Matching the knowledge structure of the user and the librarian is considered a kind of learning process.

Librarians prefer search activity before consideration of the presented problem. Without a user present the librarian's IR process is determined by three search attitudes involving motives and expectations as to search routines and possibilities. Conceptual knowledge, previous search and working domain play important roles. The attitudes have consequences for the objectives concerning use of routines and for the use of search concepts.

1. INTRODUCTION

IN RECENT YEARS several studies have been carried out with the purpose of describing and understanding the information transfer process involved in the reference situation. A major part of these research efforts has been related to user–IR system interactions, and attempts to improve the efficiency of information retrieval systems and indexing methods. Other investigations have focused on the user–librarian negotiation or the information retrieval process itself. This paper reports the main results of investigations conducted by a research team from the Royal School of Librarianship, Copenhagen, during the years 1976–80.[1]

The investigations have focused on the COGNITIVE aspects of information transfer. The aim of the project was to gain detailed information about the following transfer processes in reference work in public libraries:

— the user's interaction with the document organization
— the negotiation process between user and librarian
— the librarian's search procedure (search patterns and thought processes)

Library and information education could no doubt be improved by a more

methodological approach to reference work or information retrieval. We are concerned with education of generalist librarians who have no prior background in particular subject fields, and who may—in certain fields, such as technology —have extremely weak subject knowledge. Through long practice the librarian probably will develop quite efficient working methods, and a problem in education is to understand, select and evaluate useful methods—especially for the generalist situation.

Thus, it is a part of our aim to try to reinforce methods and teaching aids which may improve the quality of the information transfer processes conducted by librarians/information specialists. Most librarians constantly handle subject-related questions and concepts outside the sphere of their own formal training and knowlege. Users also normally cover a very broad range of learning and educational levels. In addition, the documents as well as the representation of documents mirror knowledge structures, which for the most part are originally derived from scholarly domains. Thus, the librarian faces a very complicated task of transforming user questions and concepts into user needs and then re-structuring these needs to fit the organization of documents or the organization of information in documents.

1.1. *Related studies*

Although the experiments referred to only involve the public library area and general users, we believe that some of the results are useful and relevant to other parts of the information and documentation (I & D) sector too.

Most user studies generally apply observation or interview techniques. Lancaster gives an overview of such studies conducted so far, including catalogue use studies which are of direct interest.[2] Studies of librarian behaviour are also primarily observational. Bunge has studied public librarians exposed to more factual reference questions. The aim of this study was to relate reference work performance and formal education.[3] More recent formulations of reference problems are given by Bunge in relation to information networks[4] and by Kochen in relation to cross-reference structures in bibliographic tools and in other connections.[5] The test of a descriptive model, reported by Jahoda, is very interesting, not only with regard to investigating the reference process itself but also regarding the didactic implementation of such study results.[6]

Also based on observation is a recent investigation made by Barnes of the relationships between public librarians and users in adult service departments, which describes and analyses interpersonal patterns in the negotiation process.[7] In her study of user–librarian communication concerning fiction, Annelise Mark Pejtersen has applied observation and recording techniques.[8] Belkin and Oddy used interview techniques and monitoring in investigating the problems of formulation and understanding of information needs, and the match of these with the IR system.[9]

The above-mentioned methods do not satisfy our purpose because they are unable to provide sufficient detailed data on mental processes. Hence, we have based our experiments on the 'thinking aloud technique' combined with observation. Using this technique, certain elements of the thinking processes related to the formulation of user needs, interactions and information search activities may be recorded on tape. Obviously, the user–librarian conversations may be directly recorded. Analysis of the librarian's search processes is based on written queries directed to the participating librarians. Investigation of user-

system and user–librarian interactions proceeds with the users' own problem situation as the starting point. The recordings produce verbal protocols that are subject to both qualitative and quantitative analyses. Especially during recent years this experimental method has been used in cognitive psychology to study the mental processes which take place during problem solving.[10]

To provide a conceptual framework this paper begins with a brief discussion of information retrieval processes and some definitions. This is followed by an outline of the theoretical approaches and considerations related to the investigations, and a brief description of the experimental design and analysis. Finally, research results are reported and implications suggested.

2. THE INFORMATION RETRIEVAL PROCESS

The concept of 'information retrieval' is considered to have the same meaning as 'information search'. The starting point is the information need situation, which leads to a subject enquiry, and the search result is the specific titles or information included in documents, databases etc. The formal framework of the information retrieval process (Fig. 1) contains a sequence of main steps identifying the mental stages:

1. Information need of user (deriving from a problem situation)
2. The formulated information need of user
3. User–librarian negotiation
4. Developing the search profile—topic analysis
5. Choice of tools
6. Looking up. Systematic or alphabetic
7. Judgement based on index (terms)
8. Judgement based on descriptions, abstracts, titles
9. Evaluation of the documents themselves

FIG. 1. *Formal steps in the retrieval process*

The figure shown differs from, for example, the synthesized diagram displayed by Keen[11] in that it omits locating activity and adds the need situation, being similar to Bunge's scheme.[4] Locating is considered a part of stages 6 to 9. Although the stages may be formally distinct, real search situations involve mingling, subtleties and feedback loops appearing during stages 2 to 9.

To define the information need of the user I loosely borrow a formulation by D. M. MacKay: '. . . 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'.[12]

In an often quoted model Taylor has suggested and described the development of the request from step 1 to 2:[13]

(a): The actual, but unexpressed need
(b): The conscious need
(c): The formalized need
(d): The compromised need (the question as presented to librarian or system)

Stages (a) to (c) are considered internal representations in the mind of the user. It is important to identify the relation between stage (c) and (d) which determines the following stages of retrieval.

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In negotiation the problem is how the librarian comprehends and interprets the question. Besides complicated memory processes, this interaction situation is influenced by questioning methods and interpersonal rules and habits treated in fields of sociolinguistics and psychology. In studies of similar professional situations—such as dialogue between doctor and patient—one may find valuable findings.[14] Hutcheson has made a useful distinction between three kinds of information, transferred during a negotiation:[15] (i) 'co-operative' information organizing the dialogue; (ii) behavioural information; (iii) information on the factual meaning of the dialogue (information on the actual subject request).

It is obvious that steps 4 to 9 depend on thought processes linked to mental processing of entries in tools or documents. Hence, recall, recognition and perception of concepts are considered as important factors in the sequence of decisions which occur during the search. Also different kinds of knowledge influence these steps—knowledge regarding actual topic and/or regarding library and information work.

What kind of information do librarians try to remember, and what thought processes, search routines and procedures do they develop and rely on? It is of interest to clarify these issues, as well as WHY these procedures are activated. Search routines involve stages 4 to 9 in Fig. 1, and are defined as limited activity units serving the purpose of obtaining an overview of a part of the problem: verifying a document in a tool or getting a reference to a class in the classification system etc. I have avoided the term 'search strategy' which implies prior considerations on the entire search process. Instead 'search procedure' is preferred, because of its descriptive connotations. Search procedures are defined as consisting of combinations of search routines.

The information search is regarded as a problem-solving task. Thus, besides behavioural phenomena involved in negotiation, the central problems concerning the processing of information in the IR process are mainly of a linguistic and psychological nature.

3. THEORETICAL APPROACHES AND CONSIDERATIONS

This section discusses briefly the cognitive viewpoint, followed by a short outline of applicable findings and theories, mainly originating from cognitive science and cognitive psychology. Finally these approaches lead to a cognitive model for information retrieval.

3.1. The cognitive viewpoint

This view has been described by De Mey in an epistemological framework and the central point is: '. . . any processing of information, whether perceptual or symbolic, is mediated by a system of categories or concepts, which—for the information-processing device—are a model of its world'[16], whether the device is a human being or a machine. This model of the world is determined by the individual and social/collective experiences, education, training etc. The knowledge structures—the system of categories and concepts—may be visualized as a battery of maps hanging from a classroom ceiling. The different maps may cover the same material, ordered according to various overriding concepts. In the course of discussion, other maps may be pulled down as needed to follow conceptual developments. Indeed, a complete change of maps may occur in a sequence of mental operations or during conversation. A consequence of this view is a variety

of individual differences in knowledge structures—a variety which recent research in learning has also suggested.[17] Thus, the task of IR is to bring cognitive structures of authors, system designers and indexers into accord with those of the information worker and the user, in order to cope with the actual need.[18] Collective cognitive mechanisms often described in paradigm theories[19] also influence the structure of classification and indexing systems, and thus have implications for the relations of topics and concepts treated in the body of literature and information needs.

3.2. *Cognitive science*

Cognitive science is an emerging discipline, defined as an intersection of linguistics, artificial intelligence and psychology.[20] Possible links concerning recent approaches to the problems of representation of knowledge, relevant in IR, are explored by Belkin.[21]

We have been sensitive to linguistic theories and experiments connected to syntax and semantic problems. Useful sources were the works of, for example, Spang-Hanssen on natural language,[22] and Sparck Jones on representation of meaning,[23] which, however, focus on the understanding of texts in automated IR systems. Since our concern is human intermediaries and users from a search point of view, a psycho-linguistic approach is found profitable. In this field, which treats cognitive processes in connection with language proficiency, both the computer science area of artificial intelligence (AI) and the corresponding approach in psychology named 'information processing', prove helpful.[24]

De Mey has established a valuable evolutionary view on such domains in relation to information science, i.e. perception, in terms of pattern recognition, language understanding, representation of knowledge and philosophy of science. He stresses that the adoption of the cognitive view is a recent stage in a series of four stages through which thinking on information processing has developed. The parallel to IR evolution seems applicable:

— a *monadic* stage during which information-units are handled separately and independently of each other, as if they were single self-contained entities;
— a *structural* stage which views information as a more complex entity consisting of several information-units arranged in some specific way;
— a *contextual* stage, where in addition to the structural analysis of the information-bearing units, contextual information is required to disambiguate the meaning of the message;
— a *cognitive* or epistemic stage, in which information is seen as supplementary to a conceptual system, that represents the information-processing system's knowledge of its world.[25]

The cognitive stage implies a context which is produced by the conceptual information system (e.g. man) itself. The system's knowledge of its world provides the basis for decisions on which ambiguities should be eliminated. Thus, the cognitive view is useful to IR since it also deals with ambiguity problems.

Very recently Smith has produced a thorough review of artificial intelligence (AI) applications in IR systems.[26] But despite the many cases where AI experimental results have fallen short of expectations, extensive studies of basic psychological problems have been carried out.

3.3. *Cognitive psychology*

Current trends in cognitive psychology may contribute to a better understanding of the information processing involved in negotiation and search. The central theoretical ideas about the functions of the human brain are outlined by Norman and Lindsay[27] and Johnson-Laird and Wasow.[28] Besides presenting information processing models as a whole, both collections cover the psycholinguistic aspects, problem solving, decision making and experimental techniques, including thinking aloud and protocol analysis. The central model consists of a sensory organ, followed by a filter which sorts out that part of the extensive amount of information or data received by the senses which is allowed to pass to the processing in short-term (STM) and long-term memory (LTM).

The filtering action is thought to be controlled by information stored in LTM and recalled at the time of the processing event. The mentioned cognitive view explains why certain stimuli may activate a particular 'map' or part of the knowledge structures in LTM, on which the individual operates in the actual thought process. Several concepts are connected to this understanding of memory:

> 'schemata'—'knowledge structures'—'frames'
> 'scripts'—'state of knowledge'—'image'

In this paper the designation 'knowledge structures' is preferred.

The theories also distinguish between two different groups of knowledge structures: *episodic* and *semantic* memory. It is of interest to know how episodic memory—private knowledge of the individual—influences the librarian's search; and how semantic memory—formal knowledge also shared by others resulting from education, including library training and skills—is employed.

In a study of the development of cognitive processes, Luria isolates two different kinds of human approaches to the classification of objects:[29]

(i): *categorial* classification, i.e. a person sorts out an abstract concept and chooses the objects which can be included under this concept.

(ii): *situational* classification, i.e. a person tries to involve the objects in different concrete situations from practical life, hereby classing objects which belong together.

This classificatory approach seems to be in harmony with Vygotsky's dichotomizing of concepts into scientific and common concepts[30] and similar to the frame and script concepts of Minsky[31] and Schank.[20] When using the concept of knowledge structures, the distinction between categorial and situational classification is implied.

3.4. *A cognitive model for IR*

Based on a cognitive viewpoint, Belkin has presented a model of the communication system within information transfer.[32] This model is related to what might be called traditional information science, in which little attention has been paid to the role of the human intermediary between user and system. Due to our concern with this role in the present context, a more elaborated model is established (Fig. 2), emphasizing the information processes shown in Fig. 1. The model indicates some basic theoretical assumptions.

Each individual's image of the world consists of a conglomeration of different knowledge structures. The model contains three main individual images which have to be harmonized to a certain extent, if an actual IR situation shall succeed:
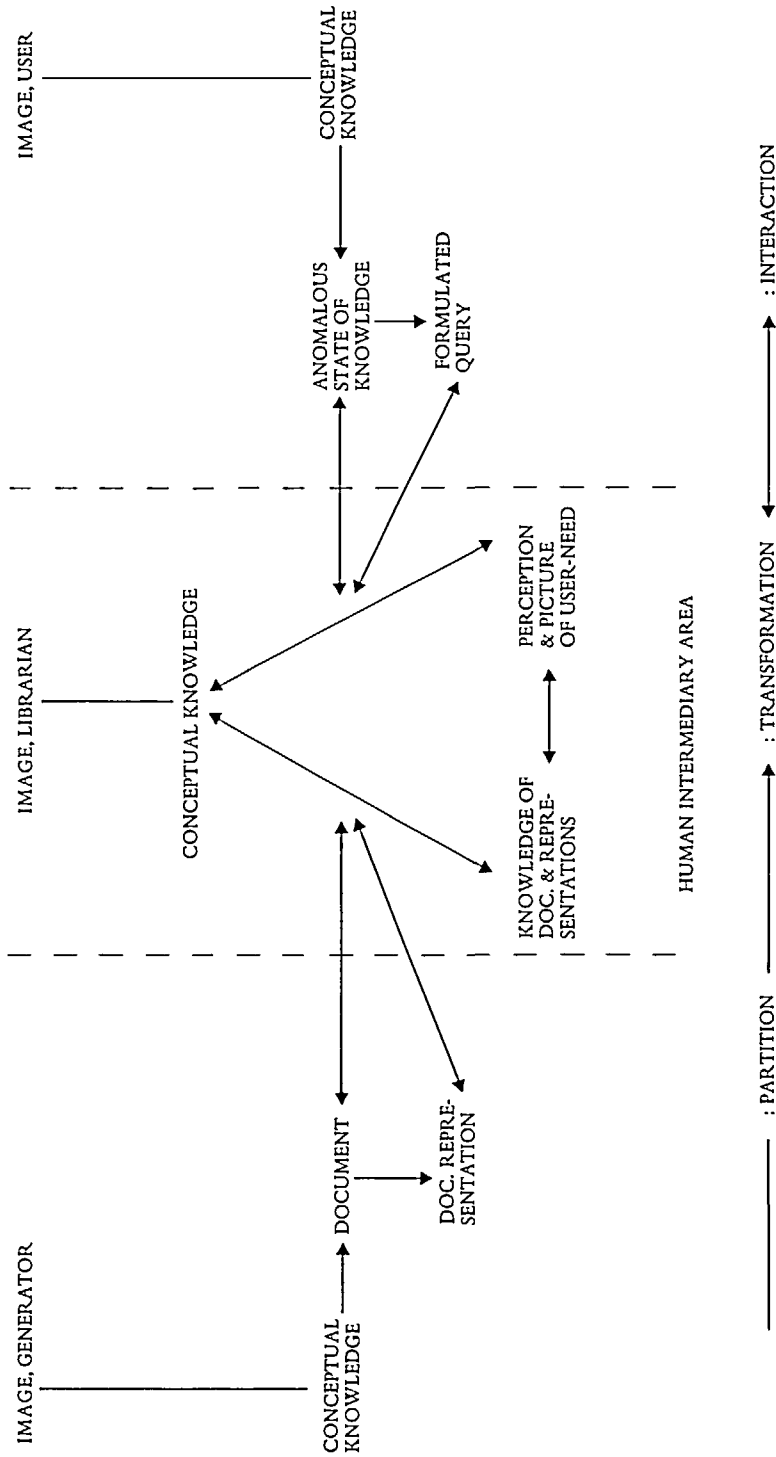
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FIG. 2. *The library communication system from a cognitive point of view* (PI/SK–1979)

the images of the user, the human intermediary and the generator. The images of the selector, system designer and indexer—also responsible for the image of the IR system—are implied in the notation 'Document representation'.

The right side of the model illustrates the user need formulation process. When the user's Conceptual Knowledge Structures in a particular area of interest are considered incomplete from a user point of view (what is termed 'anomalous' by Belkin), they are transformed into an 'Anomalous State of Knowledge'—equal to the information need situation of Fig. 1. In the transformation from anomalous state of knowledge to a Query presented to the human intermediary one has to have Taylor's step-model of the information need formulation in mind.[13]

Considering the librarian's situation as a professional problem-solving situation, the model operates with three different kinds of knowledge structures of the intermediary:

- structures concerning library and information work (documents, surrogates, search routines etc.)
- structures which concern Conceptual Knowledge
- actual perception of the user's verbalized information need and problem situation forming a Picture

The librarian's Conceptual Knowledge Structures—more or less well established regarding the topic—are activated in the interactive situation. On the basis of the Query formulation—and of other psychological and interpersonal relations—the intermediary creates a Picture of the need and perhaps the need situation. This initial picture can be elaborated through negotiation in which the librarian's Conceptual Knowledge, his Knowledge of Documents and search and the user's (Anomalous) State of Knowledge are involved.

The Knowledge of Documents, document representations and search is connected dynamically with the intermediary's Conceptual Knowledge and activated in the situation as the professional means to match the Picture of the need with the system of Documents and Document representations—equal to steps 3–8 in Fig. 1.

In Fig. 2, we have on the left the Generator of texts/documents who—in the terms of Belkin—'wants to communicate his or her values, intentions, purpose and knowledge of potential users (and) transforms this Conceptual state into a state of knowledge identified as information'[32]—in the figure included in the notation 'Documents'.

The model emphasizes the possible implications and complications to be considered in designing 'intelligent' IR systems, replacing the human intermediary: the dynamic interaction between conceptual knowledge, actual perception of needs, professional knowledge and development and use of search procedures.

Hence, as it is stated by Smith, and as trends in AI literature show, information scientists and workers are challenged by new roles: investigating *human* information processing in construction of knowledge-based systems and as 'intelligent' online assistants and instructors.[26]

4. EXPERIMENTAL DESIGN AND ANALYSIS METHODS

The thinking aloud technique using a tape recorder and protocol analysis has a number of advantages over systematic introspection. Thinking aloud minimizes the danger of confusing past and present states of knowledge. This means that it need not be confined to tasks of short duration. Highly complex tasks can be

analysed too. Byrne has provided a survey of the development and use of thinking aloud and protocol analysis.[33] In laboratory experiments on processing of printed subject index entries during searching, the technique is applied by Keen.[34]

4.1 *Considerations*

Some problems must, however, be considered. First, obtrusiveness in this kind of investigation is inescapable. We have tried to establish a situation which the subjects experienced as natural by carrying out the experiments in their own libraries. Furthermore, we have discussed the experimental situation and the purpose with the subjects. No essential changes in the work routines of the subjects have been noted during the investigations. Secondly, by requiring the subjects to verbalize their thoughts one may change their thought processes. Undoubtedly these processes become more concious and the search prolonged in time. In the present study several subjects remarked that the verbalization did not seem significantly different from the normal working routine in which they small-talk with users or themselves during search. Thirdly the interpretation of the verbal protocols is itself problematic. To prevent misinterpretation, thinking aloud has been supplemented by *observation* of the subjects behaviour and actions, and by *self-confrontation*. This means that the subjects and the observer make repetitive runs of the recorded tape immediately after recording, adding comments.

To cope with the above-mentioned problems and to adjust the experimental design, several *training series* were carried out before the experimental recordings took place. In this way the subjects became accustomed to verbalizing their thoughts during a search. Furthermore, the training reduced gaps and pauses in the recordings. However, pauses still exist in the experimental recordings —especially when subjects are looking for documents on shelves or when scanning a tool. Such phenomena may be due to capacity limitations in the filter or attention component, mentioned earlier in section 3.3 in connection with long-term memory.

The technique could no doubt be improved, reducing the extent of the gaps, by more intensive training of the subjects—as recent cognitive experiments have demonstrated.[35]

4.2 *Experimental design*

The subjects consisted of thirteen librarians, seven of whom were lending librarians, three were reference librarians and three served in both capacities. All thirteen possessed several years of library experience, and the libraries chosen covered both larger cities and rural areas. The five users who participated were chosen from persons with a limited library experience: four were technicians and one a college student.

Much attention was paid to the instruction of the subjects before tests. Two different kinds of experiments were carried out:

> (i): On the basis of written test-questions representing information needs of users not present, the information search procedures of the librarians were investigated. The librarians were instructed to treat the query as an inter-library or interdepartmental request and to perform the normal routines, including decisions to stop searching. The subject should report to the recorder which tools or documents were used.
>
> (ii): To study the user's separate search and the negotiation process between

user and librarian, investigations were based on the participating user's *own* need situations and formulations. In these cases both subjects were wearing tape recorders and two observers were attached. The user was told to find a problem within a field of interest, about which he was unable to provide adequate answers himself. He was asked to think aloud during his own search. If he found no relevant material, he was to verbalize his information needs to the librarian.

The written test-questions applied were:

Q 1. 'Which marking scale is used in the assessment of (technical) draughts-men?' (12 recordings).

Q 2. 'Does Danish aquavit freeze in a freezer? The freezing point of Danish aquavit?' (11 recordings).

Both questions are factual, since this type proved most successful in the training series. Questions selected from technology and adjacent fields might be expected to fall outside the strong subject knowledge of the subjects. However, this does not imply that answers would solely be found in material classified as belonging to the technology groups. Both questions provided an opportunity to relate the topic to a particular class and to broaden the search to other possibilities in additional classes; e.g. in Q 1., main group 7 (UDC) will contain technical drawings, but two classes in main group 3 will deal with government pub-lications and education.

Seven recordings were made which covered the user-search, followed by negotiation and information search. Each recording was based on the needs of the participating user. Two examples are given below. The content of the queries is obtained from the thinking aloud process of each user during his own search:

(A) 'Literature concerning identities of Boolean algebra in a form suitable for application to design and repair of circuits in computers.'

(B) 'Non-tendentious literature about the German-Soviet non-aggression pact of 1939 in the form of sources, correspondence and the text of the the pact; with special regard to clarifying from which side the initiative originated.'

Each record is transcribed into a verbal protocol which includes observational remarks on involved material and behaviour of the subject. Additional com-ments derived from the self-confrontation are incorporated (see Fig. 3).

4.3. *Analysis methods*

Before analysing the protocols in depth it is necessary to identify search routines and to analyse subject relations, search and solving possibilities (topic areas) for each query. This analysis is based on a heuristic model developed in connection with the project.[1,36] Having acquired an overview the real analysis is carried out at two levels.

The *macro-analysis* consists of a functional and structural division of each protocol into activity elements. For each test question, one is from this able to determine exactly which search and solving possibilities are used and by means of which search routines. Comparisons of the protocols reveal patterns in use of possibilities and considerations across subjects.

In order to examine reasons for such patterns or the application of search concepts, we pass to the *micro-analysis*. This requires an examination of the

Subj: 05/1/UL/761020-rev. 1-obs.: SK
QI: WHICH MARKING SCALE IS
USED IN THE ASSESSMENT OF
(TECHNICAL) DRAUGHTSMEN?

OBSERVATION REMARKS ( ):	
(1): begins at the reference desk	$|^1$(1) "Which marking scale is used in the assessment of technical draughtsmen"$|^2$
(2): $|^5$walks to doc. in reference room$|$ (there are 2 *EK*: a: one for reference purpose b: one for lending Subj. employ first a $|^6$reach *EK* and pick up the index card$|$	/4/yes/3/then I in the first place rather have to find out which . training the draughtsmen get$|^3$err which high school they consult I don't know that immediately$|^4$. and uhmm that I think I will look up in the *Erhvervskartotek*$|^{5*6}$/12(2)/$|^7$in .. Erhvervskartoteket's. index . . one can
(2a): look up tech. draugh. in index	look up (2a)$|^8$. technical draughtsmen
(3): look through the *EK* without finding the card	$|^9$/26 (3)/$|^{10}$ but that article is not in its place$|^{11+12}$... (4)$|^{13}$ I'll try the other Erhvervs-kartotek$|^{14}$/24 (5)/$|^{15}$ yes that was really embarrassing that . there is a mess in the Erhvervskartotek$|^{16}$... there it was (6)
(4): look up in *EK* b	..$|^{17}$ "technical draughtsmen"$|^{18}$/11 (7)/---
(5): look through *EK* b	Key:
(6): pick up the card concerning tech. draughtsmen	$|^1$ .... $|^2$: a statement . .: 2 sec. pause /4/: 4 sec. pause EK: Erhvervskartoteket—an archive with information on
(7): Subj. scans the text	cards on different professions.

FIG. 3. *Part of verbal protocol concerning QI translated from Danish; observational remarks are to the left and refer to ( ) in the text to the right*

protocols selectively, i.e. with regard to points of decision-making, with the recordings as an important supplement. Here we seek to identify in detail the relationships between activities, information perceived by subjects through the search process, and the processing of this information. For that purpose the protocols are divided into statements, defined as the smallest limited utterances or actions which make sense—see Fig. 3. The statements have been coded according to a scheme developed in relation to the principles of the cognitive model. (Fig. 2.)

To be able to investigate communication and behaviour important to the IR process, the micro-analysis is supplied with an *interpersonal* analysis. This is based partly on studies on the reference interview by Gothberg,[37] partly on investigations and theories concerning interpersonal communication and behaviour as treated by Hutcheson.[15]

5. USER-INTERACTION WITH DOCUMENT ORGANIZATION

In general the result of the user's separate search—the browsing—is dependent on the following conditions:

— the understanding of the connection between catalogue, index to the

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subject catalogue, and the organization structure of documents on
shelves;
— the knowledge or recognition of this structure or parts of it;
— whether there is, or may be created, accordance between the user's
knowledge structures and concepts, and the generator's knowledge
structures and subject entries implemented in documents and tools (see
Fig. 2).

Danish catalogue use investigations show that only 5% of users in public
libraries are able to combine catalogue subject index and the shelf arrangement.[38]
This stresses the intermediary's important role and the importance of user
instruction.

5.1. *General structure*
The organization of documents in Danish libraries is mostly based on the DK-5
system, a modified and simplified derivation of the Dewey system. The protocol
analysis shows that non-experienced library users generally find the system con-
fusing or strange.
They try implicitly to *establish* an *alphabetical order* between the signs which
describe main classes on shelves. Not finding this order they abandon hope of
establishing any general order. Instead a random search is made to find a sign with
the concept by which they have labelled their need, e.g. 'ADP'. Other
possibilities are excluded. In other cases, if the need is not formulated in a superior
generic term (i.e. categorial concept) but classified by the user in a situational
manner—e.g. 'application of Boolean identities in circuit design'—it seems easier
for the user to *adapt the need* to a present sign or topic, e.g. 'Mathematics'
—because he wants the identities in a suitable mathematical form. The signs
seem to be interpreted as advertisement boards for the contents of the shelves,
and therefore probably just as misguiding as guiding. In the example mentioned
the adaptation gave no results. 'Electronics' would have been more profitable
to adapt to, since it is related to the application aspects.

5.2. *The substructure*
When the user tries to match his conceptual knowledge structures (including
anomalous state of knowledge) to more limited units of the system, he is facing
other kinds of problems. The users identify the topic of the documents only by
looking at the titles—not using the class notation which obviously is not
associated with any significant structure (step 8, Fig. 1). Furthermore, the fact
that different aspects of a certain topic are not placed physically together on the
shelves creates confusion. Thus, users face problems concerning the appearance of
knowledge structures, built into the system, which are different from their own.
Fig. 4 may illustrate a typical situation.
The user is seeking information about 'navigation instruments for aeroplanes'.
He ends up in DK-class 62.3: Electronics. From the protocol one can see that he
misses the general class on aeroplanes—62.9—because he first meets class 62.629
concerning military aircraft, subsequently class 62.72: Motor vehicles. An extract
of the protocol follows—the user is scanning the shelves from 62.629 and further
on:

'...ohh there is something about aeroplanes here.. there is a whole shelf with
aeroplanes...it is evidently only what. the aeroplane looks like and how it

flies... Hawker Hurricane that is a special aeroplane...........and then we come down to the shelf underneath and it is motor vehicles ... in any case it can't be there it has to be here under aeroplanes (looking at 62.629) ...... so on this shelf I don't think I can expect to find anything.'

(....means 4 sec. pause. Words in ( ) are observation comments.)

The user does not continue further in the system. Having been in one class concerning aeroplanes he does not imagine that there exists another in 62.9 and stops his search.

One may conclude from this that no logical or helpful order is immediately evident to a user faced with this system of document organization. The designers of the system are innocent at least in part, since no universal order can accommodate the vast array of individual users' conceptual images. Attempts to cope with this problem by means of signs will turn out differently, depending on which user groups and user needs one tries to accommodate. However, national DC-systems could perhaps be improved from a general user point of view by incorporating knowledge structures related to the content of public education. It is here that the cognitive structures common to large user groups are formed.

	62	MECHANICAL ENGINEERING–HEATING–ELECTRONICAL ENGINEERING
	62.1	Heating. Lighting. Pneumatic technology. Low temperature tech.
	62.2	Mechanical engineering
user begins —	62.3	Electrical engineering. Electronics
	62.4	Fans. Blowers. Pumps
	62.5	Tools and manufacturing equipment
	62.6	Military engineering
	62.628	Naval vessels. Nautical engineering
—	62.629	Military aircraft
	62.7	Transportation engineering
user stops —	62.72	Land transportation
	62.8	Nautical engineering
!!! —	62.9	AEROSPACE ENGINEERING
	62.95	Aircraft

FIG. 4. *Example of knowledge structure of the Danish DC-system—and an interrupted search*

6. THE NEGOTIATION

It has to be noted that since, for technical reasons, only four protocols out of seven were subjected to analysis, the following negotiation findings have more the character of indications, which later research studies may investigate further.

6.1. *The label effect*

According to Taylor's steps the third and final internal step in the user's mind is the 'formalized need'. This mental step is revealed in all protocols concerning the users own search. The fourth step—the request—is the primary formulation to the librarian; see also Fig. 1. Taylor describes this step as the 'compromised' question or need which is 'the information specialist's business, the repre-

sentation of the enquirer's need within the constraints of the system and its files. The skill of the reference librarian is to work with the enquirer back to the formalized need (step 3), possibly even to the conscious need (step 2) and *then* to translate these needs into a useful search strategy."[13]

The protocol analysis shows that the users in the important first formulation of their need to the librarian *compromise* the subject description of the real need in terms of a *label*. The label consists of one or several concepts out of the context which forms the real, formalized need. Even when the users in the phase of thinking aloud during their own search have specified statements clearly in mind, this label effect appears.

In a typical case—e.g. 'Boolean algebra'; the real need is mentioned in section 4.2—the user has searched through Philosophy, ADP-theory and Mathematics. He turns to the librarian because no suitable information appears with the following request formulation:

> (At the desk)
> 'Yes, I am looking for eerr. Boolean algebra. and . or logic algebra and uhmm I have now been in (??).. Philosophy.'
> (??): Insertion by librarian:
> 'Will you please repeat that?'

This labelling effect often misrepresents the subject area needs to the intermediary, and thus the label may well fall outside the context of the user's real need. Hence, the librarian has to be aware of this possibility of misguidance (ambiguity). The limited concepts which constitute the label often describe subject categories related to *several* different topic areas or aspects.

This stresses the importance of the quality of the following negotiation—as quoted from Taylor above. The role of the intermediary is to find the right context by making the user expand and specify the statements through a conscious and deliberately structured dialogue.

6.2. *General characteristics in the dialogue*

The interpersonal analysis displays the following framework:

— From the start of communication the librarian's position is regarded as very strong by both parts, caused by his role representing the institution and the fact that the user is regarded as a sort of 'guest'.
— If the librarian in his opinion is knowledgeable concerning the topic and the need situation formulated by the user, he tends to lead the dialogue. The user assumes a more passive position and the situation may be regarded as asymmetrical.
— When the librarian admits lack in his conceptual knowledge and has difficulties in establishing a knowledge of the topic/need situation, the position between the partners is much more symmetrical—i.e. the user is recognized to be the topic 'expert' delivering information and the librarian to be the search 'expert'.

In this latter situation the user retains his position as floor-holder and it is the librarian who makes insertions, trying to obtain information. This situation of equality may also be established consciously by means of treating the user as a search partner throughout the dialogue. The combination of *belief* in his immediate grasp of the user's problem and the librarian's strong position creates

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situations in which the user finds it difficult to correct the librarian's picture of the need.

However, asymmetrical negotiations are not necessarily negative. The real need may be of a less complex nature. This means that the label and need may be almost in accord and the chances of identifying the real context from the start optimal.

This problem depends on the knowledge structures and question methods of the intermediary in the actual situation, and the consistency of the user formulations in the dialogue. Also, the analyses show that from a certain point every negotiation normally tends to a more asymmetrical shape—i.e. when the librarian feels he has obtained the right picture of the need.

When trying to correct a picture the user shows communicative regulatory behaviour such as use of filled pauses (ehh—aahh—umm—eerr) and insertions. Simultaneous speech may appear. Indirect questions to the librarian often characterize a weak position of a user, e.g.

'Perhaps it might be..?'

It may be noted that filled pauses as well as pauses also may be used by the floor-holder to indicate that she/he wants to maintain this position—in the meantime probably reorganizing data and knowledge.

An almost immediate searching for documents seems to be a general mechanism—observed by Barnes in her study of librarian–user interaction[7] and by Bunge, who describes how the primary attempts in the reference procedure are to try to locate titles.[5] In the analysed negotiations this kind of search pattern appears too, but is not explainable in an unambiguous way, e.g. check questions are in fact posed before action takes place—or the reason for rushing to the documents is an attempt to clarify a part of the query.

6.3. *Function of questions*

The qualitative analysis of the question types and their use is mainly confined to the negotiations of 'Boolean algebra'[A] and 'The non-aggression pact'[B] which display different characteristics. The first encounter is nearly symmetrical; the latter is in general asymmetrical, the (lending) librarian possessing broad knowledge of the present topic.

Barnes[7] and Lynch[39] have reported a (surprisingly) rare use of *open questions* in reference situations. From a theoretical point of view open questions of the 'where..?', 'why..?', 'how..?' kind should provide open answers loaded with useful information.

The analyses reveal a similar picture. Open questions are not found when the intermediary believes he possesses a fairly strong conceptual knowledge in the topic field. An explanation may be that the librarian has no acute need for an amount of additional information, feeling his own knowledge sufficient as a framework for the user need. In addition, perhaps previous negative experiences with open questions may influence question patterns.

Nor do open questions appear in more symmetrical encounters. When rarely used—e.g. in the 'Boolean algebra' situation in which the librarian's knowledge of the topic is weak—the librarian seems momentarily unable to control and assimilate the amount of data in the answers. A cognitive structure to which the data may be related is missing. Open questions seem avoided and closed questions preferred instead; for example, the librarian could have asked: 'In *what* connection

did you read about this phenomenon?' but asks: 'Did you read about this in a book on *philosophy*?' (from negotiation A). The question indicates which kind of answer he wants at the present state of negotiation, i.e. related in concrete manner to a broader topic.

Two kinds of *closed questions* are observed: normal closed questions—leading closed questions. *Normal closed* questions lead first of all to a 'yes' or 'no' answer. If the user wants to contextualize he must pass or break the formal frames of the question. Question sample:

> Ex. 1.: Librarian, pointing at the shelves:
> 'Have you looked over here in ADP?'
> User:
> 'Yes, I glanced at it' (from neg. A)

Leading closed questions contain expectations to the user's answer, e.g.

> Ex. 2.: Librarian:
> 'Consequently, more mathematical than philosophical?'
> User:
> 'Muhh-yeaaa' (from neg. A)
> Ex. 3.: Librarian:
> 'Yaa, so you want it in more detail?'
> User:
> 'Yes' (from neg. B)

As seems the case concerning open questions, the closed questions are closely related to the librarian's conceptual knowledge structures in the actual situation. (See Fig. 2.)

If the librarian trusts her state of knowledge both kinds of closed questions are generally used to *confirm* and *delimit* the initial picture of the need and the search possibilities. In such situations both types of questions may underline the user's 'guest' position, one which increases the difficulty of redirecting the search if the intermediary is off on the wrong track. Studies of physician–patient interviews reveal that many medical conclusions reached by the physician are based on leading questions that do not allow the patient to clarify his answers. By his questioning mode the physician tends to look for several complementary interpretations of the initial diagnosis.[40]

However, in a symmetrical negotiation closed questions tend to serve to *extend* the librarian's limited picture of the need. They appear not to consolidate the 'guest' role, nor is it difficult for the user to break the formal frames. The *normal* closed questions tend to be signals in the feedback operations which may *open* up for contextualization (= new information), e.g.

> Ex. 4.: Librarian, with a book on Boole:
> 'Is this.. is it Boole...this?'
> User:
> 'Yes, that... it's his LAWS. but his
> . his dogma-DOCTRINES are not here..
> his they are called IDENTITIES'
> (LAWS a.o. is new information)

The *leading* closed questions are most frequently used to *confirm* pieces of infor-

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mation which the librarian has grasped and then tries to combine to a whole —see examples 2 and 3.

Another phenomenon observed is the practice of posing more than one question to the user at the same time, e.g. an open question followed by a leading closed one. Exposed to single open questions the user shows uncertainty as to which level he ought to answer on, due to lack of clues. With question combinations he becomes uncertain as to which question to answer. Some misunderstanding and ambiguity problems arise. Nevertheless, this manner of questioning has a complementary effect, which explicitly exemplifies the mode of answer by means of the closed question. By this the librarian tries to warn the user against delivering too much context or to tell him to keep to a certain categorization level.

6.4. Match of knowledge structures

Examination of the protocols shows that the match between the involved knowledge structures—see Fig. 2—happens in terms of an acute learning process. With the questions as instruments and the different need-formulations as basic source, the librarian builds up a picture in his mind. Analysis of need-formulations uncovers that these do *not* normally correspond to the librarian's conceptual knowledge structures in terms of the whole context. However, single concepts and topic relations are perceived and built together. In the construction of a picture—which matches with the real need—the librarian continuously combines relevant concepts recalled from memory with *new* information linked to recognized user concepts. Concurrently translations from the picture to the knowledge of tools and documents take place which lead to activities—e.g. looking up, showing documents etc.

This results in judgements and feedback (steps 4 to 8, Fig. 1). The perceived concepts are placed at several levels of categorization, involving both situational and categorical classification, depending on the shape of the conceptual structures of the receiver of information. Concepts not recognized or linked appropriately seem not perceived and stored; unless repeated they seem to disappear.

This accumulation leads to a kind of jump in the cognition of the intermediary, caused by a certain perceived concept which in the situation reacts as a clue. After some confirming questions the picture is transferred to the knowledge of documents and document representations (Fig. 2) often in terms of a previous established relation in the semantic memory between a category and the classification system. The user is now able to match his conceptual structures with relevant structures in documents—judging them and obtaining information according to his need (step 9, Fig. 1). This latter process has not been subject to analysis.

6.5. Implications

In general, the librarian relies on the first user formulation—the label—for some time in the negotiation. In this situation both user and intermediary try to relate the label concepts to different more general topics—most often in terms of categorical classification. This creates some ambiguity problems regarding comprehension of the real need and retrieval of relevant information.

The problem in some asymmetrical sequences seems to be that far too little new information is exchanged because of the mode of questioning applied. The chance of retrieval from the right context is diminished. Thus, one may suggest that in cases in which the intermediary *possesses* a certain amount of topic knowledge, a

deliberate use of some *open questions* would be appropriate. New items within the user's answers ought to match some parts of the conceptual structures of the librarian. Furthermore, a conscious effort to keep the negotiation on equal footing would improve the user's chances to provide useful insertions, when confronted with closed questions.

However, when the intermediary's knowledge of a topic is minor, admitting this fact seems psychologically fruitful—thereby offering a rather symmetrical position to the user. Yet, there is a possibility of *overload* of exchanged information that may result in a loss of relevant concepts. In such cases a simple but important routine may be to fix user concepts on paper—even though the meaning of the terms is unknown at the moment.

Based on the protocol analysis one may suggest the advantage of deliberately posing (open) questions with regard to the need situation (towards step 1, Fig. 1) e.g.:

— 'What shall the information (once retrieved) be used for?'
— 'What is your field?'
— 'Does your field have something to do with..?'
— 'Does it (the label) have something to do with..?'

Frequently the answers take the form of situational classification of concepts, including highly relevant relations to some kind of process or working situation—often containing recognizable common concepts linked to more special/scientific terms.

7. LIBRARIAN–SYSTEM INTERACTION

As mentioned earlier twenty-three recordings of the librarian's separate information searches have been made based on two written questions—with no user present. When processing the large amount of data in the protocols one has to be aware of rather well-known factors related to working conditions affecting search behaviour; e.g.

— each librarian possesses an impression of the *time-limit* allowed for handling an enquiry. This is individual, varies from query to query and differs from lending department to reference unit. It causes pressure to accumulate during the IR process.
— from the *division of labour* between lending and reference departments it follows, for example, that librarians working in one or the other unit generally estimate by which unit an enquiry is to be dealt.
— generally reference staff tend to be rather tool and source-oriented whilst lending librarians seem more oriented towards monographs.
— accessibility and ease of use of aids and tools also have implications.

7.1 *The search process*

In dividing the protocols into activity elements for macro-analysis, such factors must be kept in mind; this in turn results in an overview of the search process. This information search procedure consists of a sequence of search routines related to considerations of activities. At the same time these are affected by and influence the mental processes concerning the information need, the search and solving possibilities. The mental processes concern motives and expectations in relation to use of search possibilities and routines, and contain conceptual formulations of

topic problems in relation to the need. The routines are mostly developed on the basis of experience and training. They are to a certain extent affected by least effort factors, implying that the daily mental work is minimized concurrently with a reliance on previous experience in terms of generalized search routines.
They can be characterized as follows:

— from the start of a search, both lending and reference librarians *prefer to act* before consideration of the problem in question;
— activity is directed towards concrete titles on shelves, class(es) in classification scheme(s), or subject headings in indexes.

Analysis reveals that *no* real topic analysis takes place, as we initially supposed to occur before the first search action—see Fig. 1. This seems to be in accordance with the previously mentioned reference studies.

However, the macro-analysis indicates that some considerations do occur in the beginning of the IR processes, but these are confined to brief formulations of either conceptual knowledge structures, knowledge of tools and documents, or in some cases private experience as to, for example, bottles of aquavit in deep freezers.

7.2. Search modes in IR

Although it is possible to observe the application and combination of specific search routines and certain search possibilities across all protocols by means of macro-analysis (mainly steps 5–8, Fig. 1), it is not possible to structure the search procedures into a formalized scheme. However, investigating all points of decision-making throughout the retrieval processes and examining the considerations behind, the micro-analysis unveils three different and specific search modes on which the information search procedure depends (Fig. 5).
The treatment of a retrieval problem depends at first hand on the motives underlying the librarian's way of attacking the search and the expectations concerning the tools and documents. Two decisive *motives* are uncovered:

(i) Open search motive, to *gain* information useful to the librarian in the further IR process;
(ii) Fixed search motive, to locate *the* document or tool which includes *the* answer.

Motive relates to *expectations* concerning both

(a) whether a document may provide an answer at all; or
(b) in what form the answer may exist.

Consequently the search procedure is dependent on what one may call the degree of openness towards documents and the information thay may provide.

These two elements are strongly influenced by *knowledge* of the actual need— the topic—documents, document representations and former search, and the librarian's *working domain* (lending or reference unit etc.). The analysis reveals that fixed motive most frequently is adopted by lending librarians and open motive most often is preferred by the reference and combined reference-lending librarians.

The interaction between these four elements determines which of the three search modes the librarian employs in the actual situation: open search mode, semi-fixed search mode and fixed search mode.
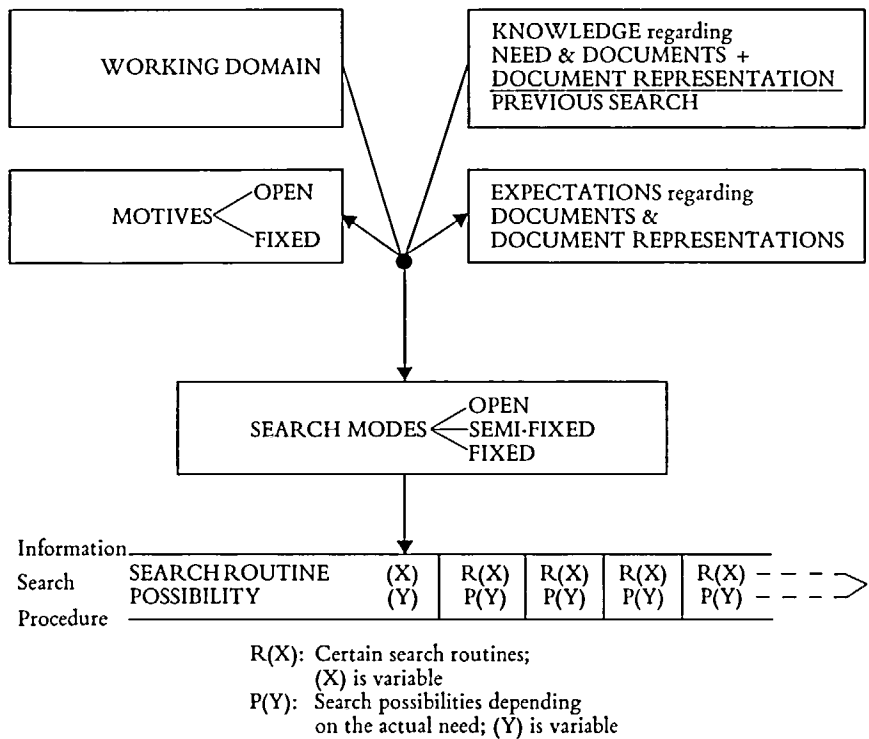
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FIG. 5. *Conceptual model of the physical and mental elements which constitute the individual information search procedure*

The modes are understood as mental attitudes and not as a result of conscious choice. Consequently, the four elements constitute the retrieval process as actually performed. However, the framework of the elements is flexible enough that a certain arbitrary element is possible in the use of search routines and possibilities; i.e. effects such as near miss, or 'now when I am here I could just as well..' etc. may result. The investigation does not make it possible to rank the elements according to importance, except into the two main groupings—as shown in Fig. 5.

7.3. *The open search*
This mode is characterized by a heuristic IR process in which the librarian from the start is concerned to *extend* his conceptual knowledge structures (see Fig. 2). This extension may again serve as a foundation for further search by formulating lack of knowledge about (a part of) the topic. The librarian is *open* to new information from the environment.

The search routines—which form part of the knowledge of documents and tools—are applied in order to obtain information throughout the search process up to a certain point. When sufficient information items are perceived and processed the application of search routines *changes* to the means for solving the original information problem. Fig. 3 shows a typical example of this search mode; the recording is from the question concerning 'marking scales for technical

draughtsmen' (QI). From the other test question on 'if Danish aquavit freezes in a deep freezer and the freezing point' (QII) the following example is displayed:

> 'I could think of physical...chemical. or errr no no maybe I should find out how much alcohol there is in . in aquavit and by means of that be able to use a . physical-chemical table to see when different aqueous solutions freeze.'

Almost all the reference librarians who participated in the investigation employ the open search, probably due to their experience with complex information needs. It is characteristic that those librarians who practise an open style of retrieval also grasp relevant information items later in the search process. Few of those who employ fixed or semi-fixed search modes perceive such data even though the same document sections are scanned. This difference is related to expectations and attention.

7.4. Fixed and semi-fixed search

The *fixed* search is carried out as an algorithmic IR process. The librarian searches at first for a *direct* solution to the query—e.g. in terms of a marking scale (QI) or a freezing point table (Q II)—either mentioned by its concept or described. This means to find *the* document (title) that includes *the* answer immediately. To solve the information task search routines are applied in relation to the different search possibilities—but always *within* the framework of the fixed motive. This motive continues throughout the search process and the formulation of the query is accepted and maintained as initially stated.

The librarian does not in general formulate specific search problems, with the exception of a formal analysis of different search possibilities. The rather fixed expectations about the mode of answer frequently result in relevant data being overlooked. The librarian relies to a great extent on his/her knowledge structures related to documents and representations (Fig. 2), for example from the beginning of a protocol (QI):

> 'One could check in the Erhvervskartotek to see if it contains marking scales.' (Erhvervskartotek is an archive with information on different professions).

And an example from beginning of protocol QII:

> 'Yes . one could of course immediately look it up in a book on deep freezing.. and the freezing point of aquavit..err. it must be some kind of . errr what is it called . a book . on chemistry.'

Lending librarians often employ this mode, presumably because users frequently expect results from lending departments in the form of single documents which are immediately obtainable.

The *semi-fixed* search follows a pattern identical to the fixed one. The librarian, however, may reach a certain degree of openness caused by the search process itself, which *momentarily* leads to a kind of open search during the IR process. In such moments reformulations of parts of the query may appear due to either expected but missing answers or other problems encountered during the search.

Thus, the conceptual knowledge structures (Fig. 2) contribute much more to solving the information task than in fixed search. However, the librarian often returns to this latter mode, continuing to trace the direct solution. Both cate-

gories of librarians are found using the semi-fixed attitude in their search pro-
cesses. A shortened protocol sample from QII is displayed below:

> 'That's just to find the freezing point of aquavit. uhm.. and . then I'll go to
> the reference room and look up in some kind of . uhmm book on chemistry it
> has to be (Walks to the reference unit and picks up a table)'

> .
> .
> .

> 'Handbook in Physics and Chemistry.. it must be there . let's look....ohh
> but...no . I can't do that because I can't find it under 'aquavit' I can only
> find.. 'alcohol'..(scanning the book)

> .
> .
> .

> no . but first I must have a..definition of aquavit..this handbook is not that
> good anyway.'

( ) = observation remarks; ... = 3 sec. pause

7.5. Search routines and possibilities

It is important to note that—although we have stated that the librarians when
initiating an enquiry prefer action before consideration of the problem—these
actions, which consist of search routines involving search possibilities, may have
different objectives because of the attitude employed. Thus, externally observed, the
same repeated search routine—e.g. looking up in a tool—may in fact be used in
different ways; for example to gain information or find the answer (steps 5–6,
Fig. 1). Compare, for example, the different use of Erhvervskartotek in Fig. 3 and
in the protocol sample concerning fixed search.

In addition a micro analysis of the connections between actual, different search
possibilities applied in the search processes in both test questions shows that three-
quarters of the connections are explainable, whereas the rest depends on non-
verbalized relations. About 50% of the connections are derived from a wish for
further information—partly depending on previous data from materials or
constituted by a relevant reference—partly caused by a conscious formulation of
lack in the conceptual knowledge. The other 50% of connections are constituted
by 'near miss' phenomena—organization structures of materials in the library
—wrong classification of documents related to the topic, and effects like 'now
that I am here I could look in it as well.'

From this it can be concluded that search procedures that consist of more than a
couple of applied search possibilites are composed of both conscious assimilation
and processing of information from materials (learning processes), which are
incorporated in the further search process, and more or less random associations
and impulses from the environment.

All these preceding steps regarding the use of routines and search possibilities
occurring in the IR process may serve to emphasize and explain some of the 'idea
tactics' suggested by Bates.[41]

7.6. Search concepts

By examination of the search concepts applied in each activity—including check-
ing the documents involved—it is possible to obtain a more detailed understand-

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ing of the search processes. This analysis concerns concepts applied to a document or tool by the searcher (here librarian) when looking up (step 6, Fig. 1). Search concepts are consequently not identical to entry terms, which are regarded as concepts occurring within documents/indexes as entries or headings.

Fig. 6 displays the origins of the applied search concepts. In all experimental recordings concerning a librarian's separate search, 264 individual search activities took place. 189 contain a known search concept (72%). The concepts are displayed in three groups:

— recalled from memory
— originating from the query
— originating from materials

The concepts are distributed into use at the first search activity and in connection with all activities taking place in all search processes.

Applied SEARCH CONCEPT	First search activity		All search activity	
	%	no.	%	no.
Recalled from MEMORY	17	4	26	49
Originated from QUERY	83	19	54	102
Originated from MATERIALS a.o.	—	—	20	38
Total	100	23	100	189

FIG. 6. *Distribution of applied search concepts by origins—across all protocols for both test-questions*

Despite limited statistical material, it is obvious that the librarian *during* the *first activity* immediately uses *concepts* and terms that are formulated in the *query*. Only 20% are recalled from memory. One should expect this result considering that immediate action is preferred before consideration of the information problem. The tendency to use concepts from the enquiry decreases during the progress of the search. Yet, every second search act is carried out by means of the relatively few terms originally mentioned in the question formulations—five terms in all for both queries.

Those librarians especially, who base their information search on *fixed* search mode, have a tendency to employ exactly the same concepts—primarily from the query—again and again throughout the main part of the IR process: 65% of the applied concepts (Fig. 7). Hence, they seem to rely mainly on the search experience and knowledge of documents and tools which forms a part of the semantic memory, in combination with their picture of the need (see Fig. 2).

Semi-fixed and *open* search mode display a more complex pattern. In such IR processes librarians seem to draw upon their own conceptual knowledge, and more frequently produce related concepts to be used—in Fig. 7, 30% and 35%. Furthermore, new related concepts are often obtained from the environment to be

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Applied SEARCH CONCEPT	OPEN SEARCH %	no.	SEMI-FIXED SEARCH %	no.	FIXED SEARCH %	no.
Recalled from MEMORY	35	18	29,5	10	20	21
Originated from QUERY	40	21	41	14	65	67
Originated from MATERIALS a.o.	25	13	29,5	10	15	15
Total	100	52	100	34	100	103
No. of subjects	7		5		11	

FIG. 7. *Distribution of search mode of applied search concepts and their origins —across all search actions in all protocols*

employed later on—25% and 30%. Again, this is in accordance with expectations with respect to the two search attitudes. The perception involves the librarian's conceptual knowledge structures *and* the knowledge of documents and tools —developing new aspects in relation to the picture of the need. As in fixed search, however, query concepts are still applied but to a lesser extent: 40% of the search concepts. In general, both semantic and episodic memory play important roles and seem to be involved depending on the search mode.

Private experiences from the episodic memory within the librarian's conceptual knowledge participate in the IR process. But in most of the cases examined, they are employed with a certain degree of reservation or almost indirectly.

An interesting point is the frequency of 'new' search concepts—either recalled or perceived through retrieval—for each librarian, distributed on the search modes:

2·43 search concepts in Open search
1·8   ,,   ,,   ,, Semi-fixed search
1·63 ,,   ,,   ,, Fixed search

Hence, it must be concluded that the search modes—the attitude toward the IR process—have important implications for the search procedure itself, the objectives concerning application of search routines, as well as which kinds of search concepts are to be used and which knowledge structures are involved.

8. CONCLUDING REMARKS

It has not been possible to make the obvious comparison between the results of librarians' separate search procedures and the results of the negotiation process, because of the paucity of comparable material. However, there are indications of a correlation between *open search* and *symmetrical* negotiation. The symmetrical position is characterized by a situation in which the user—on equal footing with documents and tools—acts as a resource of information, which supplies and adjusts the librarian's initial picture of the real need. The librarian's motive appears to be to gain more information relevant to the comprehension of (part of) the need—before the final step of attacking the search problem is implemented.

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In addition, one may suggest a correlation between the more *asymmetrical* negotiation and *semi-fixed* mode. Both display immediate attempts to locate the answer to the need as identified by the librarian—whether right or wrong. User insertions may momentarily lead to some kind of open search. Fixed search procedures have not been observed in the rather few negotiation experiments. The absence of this search attitude may be due to the user's influence. When no immediate results of the search appear, the librarians allow a sort of *repetitive* behaviour in the search procedure. When it occurs, one or two elements out of either the search motive, search routine, use of material, search possibility (topic area) or search concept are repeated. Often the librarian returns to a search possibility that already has failed once, and now re-uses, e.g. the concept of new material.

It is not possible to rank the search modes in order to point out the qualitatively best one. No doubt each serves specific aims—as their dependence on the working domain shows. The main problem seems to be awareness of the search consequences they cause.

Online information retrieval work and training will surely change search routines and thereby the librarian's search procedures in general. The Summit/Firschein investigations into the use of computerized retrieval services by public librarians indicate search problems[42] that probably are caused by search patterns mentioned in this article. For 'intelligent' online assistants employment of some kind of open search mode seems likely to be the most efficient, because it combines heuristic features in the beginning of the search process with more formal solutions later, using the search algorithms built into the IR system in a flexible way.

Since the *crucial* point in information transfer is to comprehend the information need behind a perhaps poorly structured query, and then to convert it into the substructures of the IR system, the user needs more assistance and better consciousness in these tasks. Library and information education needs to draw upon these results, and thus implement conclusions from cognitive theory and applied IR experiences which highlight the mental processes that underly the search. Insights gained from this project can help to develop more adequate teaching aids in solving search problems and in estimating the degree of difficulties in user/system interaction.

AUTHOR'S NOTE

The author dedicates this paper to the memory of Povl Timmermann of the Royal School of Librarianship, Copenhagen, a great initiator and a man of knowledge and vision.

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