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Q-analysis of user–database interaction

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This study jointly employed two research approaches in developing a process oriented methodology for studying information seeking during user–database interaction. A "time-line" structured interview technique was used to gather 26 novice-user accounts of search sessions on NEXIS. These accounts included a description of the search session, questions that occurred to users during this session, and indications on whether answers were obtained. A 17 category descriptive content analysis scheme was developed and Q-analysis was performed on the accounts as coded into this scheme. Results provide a rich description of the search process from the user's viewpoint. Searchers below the mean on a document relevance measure most frequently had questions after being in some way rebuffed by the system. Above mean searchers were also active questionners, but their questions were most frequently associated with string design rather than being rebuffed. The above mean group also rated their questions as less important than did the below mean group. In addition, above mean searchers were more active users of system help features and information provided onscreen in general.

Introduction

The challenge of effective search string design is well known to library and information scientists, but it is only one of the behaviors required of those using increasingly common multifile, full-text information retrieval systems. Cove and Walsh (1988) have argued that browsing strategies are common with full-text systems, and are very different from the deliberately planned searches traditionally practiced by search specialists using bibliographic systems. Tenopir, Nahl-Jakobovitz and Howard (1989) found that users of an on-line full-text magazine not only employed highly varied search strategies, but also had myriad purposes for doing research. These ranged from fact and name retrievals to browsing to the more traditional document downloads. They necessarily involve highly varied patterns of interaction between user and system.

These emerging behaviors apparently include new problems. Trzebiatowski (1984) has noted that users have difficulty choosing appropriate files within a multi-file system. Preliminary research has already been conducted on this subject (Meyer & Ruiz, 1990). Keeping track of one's location in a system presents challenges to users as well. Thompson and Croft (1989) have noted that getting lost in a system is one of the potential disadvantages of browsing in complex text retrieval systems. Studies of "Navigation" (Spence & Apperley, 1982; Canter, Rivers & Storrs, 1985) and "Wayfinding" (Benest & Potok, 1984; Kerr, 1990) have noted design features that may facilitate this location process as well as effects of such features on users.

Research in these and related areas has contributed to knowledge of information retrieval processes. At the same time, this research underscores the complexity of

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the search process as well as the importance of understanding its behavioral enactment through time. Before-and-after research designs provide some basis for making inferences regarding behavioral and cognitive processes. But these designs leave interactive processes for theoretical rather than methodological consideration.

Two research methods have been developed to gather data on user–system interaction as a process. Keyboard monitoring has been practiced for a number of years now, initially welcomed as an unobtrusive and highly detailed trace of user–system interaction (Borgman, 1986). Talking aloud is another useful and commonly employed method. Users who are engaged in database searching talk aloud about their experience while a researcher records this verbal account. The virtue of this method is thought to be an ability to reveal cognitive conditions. Sometimes the monitoring and talk aloud methods have been employed jointly (Katzeff, 1988).

While both methods are widely accepted as useful, they also have their limitations. It is not always clear what cognitive conditions may be inferred from keyboard logs. Talk aloud transcripts are not always conveniently collated and reduced for systematic analysis.

With the aim of complementing existing methods, the present study jointly employed two other research approaches in developing a methodology for studying user–database interaction. The first approach involves a structured interview technique called a time-line. Derived from a Sense-Making approach to communication theory, explained below, the time-line interview is designed to study information seeking. In the area of human–system interaction, it can be used to study a user's need for information regarding the system while interacting with it.

The second approach consists of applying Atkin's Q-analysis to such interviews. Twenty-six interviews were gathered in a previous study of user interaction with a full-text, multifile database system (Jacobson, 1991). This report examines the fruitfulness of Q-analysis in rendering precise and richly descriptive accounts of these interviews, and the combined utility of the two approaches for studying user interaction with complex databases.

Background

The Sense-Making approach was developed by Dervin and her colleagues as a process-oriented, general theoretical approach to information seeking and use (Dervin & Nilan, 1986). It conceptualizes information seeking as an activity taking place during the movement of individuals through "time-space". This movement is metaphorical in that it refers not only to movement of bodies through physical time-space but also to movement of thoughts and questions through cognitive time-space. In the area of human–system interaction, users may be seen as individuals moving through the cognitive time-space of a database search session. The time-line interview technique associated with Sense-Making is described generally here, using examples drawn from the present research project. It is applied in three steps.

First, for any given study, users are asked immediately following a search session to recount their experience from the beginning as if it were "a series of snap-shots conveying everything that happened." These snap-shots are referred to as time-line "events". An interviewer writes each event on a three by five card and then prompts the user for the next event, by simply saying "and then what happened." The following, typical series of events is drawn from the transcript of the present study's first respondent:

Event 1: Usually I can read the functions, but I couldn't understand the first screen at first, but then I remembered.
Event 2: I chose "currnt" but I typed in the entire line. It didn't work.
Event 3: I finally tried just "currnt" and it worked.
Event 4: I typed my string, and it told me certain words were unacceptable, but it was searching anyway.
Event 5: I revised my original question, and I got one story. It was very relevant.
Event 6: It typed over the original search, and I got 9 stories.

The resulting time-line is a description of the search session from the user's viewpoint, in the user's own words. The number of "events" varies from respondent to respondent in any given sample.

The second step in a time-line interview involves going through the events one at a time, asking with specific regard to each whether the user had any "questions, puzzles, or confusions". Each of these questions is written down on a three by five card. The following typical questions occurred within the time-line presented above:

Question from Event 2: Why wasn't the system taking the file?
Question from Event 4: Why wasn't it accepting these simple words, like "there", "what" and "why?"
Question from Event 5: Why [was] only one story [retrieved] with such a large string?

The third and final step involves analysis of the questions. Going back through the questions one by one, the user is asked about each. In this study, users were asked how important each question was, using a ten-point scale, and whether, for each, an answer was obtained.

Research into the role of questions or questioning in information system use is not new. Belkin (1980) has conceptualized the cognitive conditions motivating search processes as Anomalous States of Knowledge (ASK). Allwood & Eliasson (1988) have examined the effects on information processing and task performance of opportunities users have to ask questions after reading word processing documentation. The Sense-Making approach, however, is unique in both conceptualizing and operationalizing question-asking within user-defined behavioral contexts.

Analysis of time-line interviews has typically involved empirical content analysis (Krippendorff, 1980; Weber 1985). In such research, interview events are each classified into a coding scheme, and the distribution of events across the scheme is tested statistically.

Our study employed an alternative method to analyse the interview data. Q-analysis was developed and introduced to the social sciences by English mathematician R. H. Atkin (Atkin, 1981; Gould, Johnson and Chapman, 1984; Johnson, 1990*a,b,c*). Not to be confused with Q-mode factor analysis, Atkin's Q-analysis has its roots in algebraic topology, and is basically a geometrically oriented approach to examining and representing structure in data. It has affinities with both network analysis and cluster analysis (Macgill, 1984), but diverges from these in its extreme concern to avoid imposing structure on data as a methodological artefact.

For our purposes, Q-analysis can be used to elaborate traditional content analysis techniques. Q-analysis uses a non-partitioning approach to classification. That is, units may be assigned to more than one category during coding. This improves the descriptive power of content analysis. Analysis may be performed without, as one theorist has said, so badly "tearing apart" the meaning borne by the interviews (Gould, 1981).

Second, the interdependence of time-line events and information seeking questions may be conceptualized, respectively, as backcloth and traffic. A backcloth constructed of time-line accounts may properly be said to constrain or permit question asking. Indeed, questions can adequately be interpreted only in the context of their associated time-lines. In this sense, the backcloth–traffic distinction maintained in Q-analysis is well suited as an analytic approach for such data. (Backcloth, traffic, and other Q-analysis concepts are defined below.)

Methods

The study sample included 26-respondents, 17 women and nine men, trained for 2 hours in the nature and operation of databases and then allowed to search a predetermined topic on an existing database system. Respondents were undergraduate students from an urban university in a medium-sized American city. Computer skills among them varied, but were on the average moderate. The median number of days per month they used a computer was four, primarily for word processing. While some had taken one or more low-level computing courses, a few reported mild anxiety when confronted with computer assignments.

The system used for the study was Mead Data Central's NEXIS service. NEXIS is a hierarchically presented system of full-text files which can be searched using Boolean operators, wildcards and proximity delimiters. It uses multiple formats for displaying retrieved documents and offers help files containing brief descriptions of file contents as well as descriptions of command features. Prompts are provided throughout the system. In this sort of environment, the user must interact extensively with the system over and above the requirements of choosing keywords and connectors during search string design.

Training was conducted during two lectures. The first provided an introductory lecture in databases. The second introduced the NEXIS service and assigned reading material drawn from Mead's documentation.

When they arrived for a scheduled search session, respondents were instructed to write out, in longhand, a specific question of their choice on the general subject of "AIDS and the Federal Government". To answer this question they were then instructed to design and write down two search strings, one as a backup. They were also told they could modify strings as their search progressed.

A single topic (AIDS) was chosen for a number of reasons. Everyone was expected to know at least a little about it. Also, information on the topic can be found in any of a number of NEXIS files; that is, a search topic was chosen that was judged to be generally interesting and also relatively easy.

The stated search aim was to retrieve and evaluate up to ten documents. Ten-point scales were provided for each potential document retrieved and were to be used as the documents were read. Respondents themselves were asked to rate each document they examined. This procedure follows an approach emphasizing the importance of end user relevance-criteria, rather than librarian specialists' criteria (Eisenberg & Schamber, 1988; Hiltz & Johnson, 1989; Sandore, 1990). Scale responses were later combined to construct a scale of the relevance of retrieved documents.

Any number of searches or files could be used. Some respondents, of course, retrieved more than 10 documents, occasionally many more, on the first search. They had been instructed in such instances to refine their search string and attempt subsequent searches until they felt they had obtained a retrieval set that was reasonably well focused and useful. The time-line interview was conducted immediately following the search session.

A descriptive scheme of seventeen categories was developed into which time-line events were coded. The categories reflected main elements of the interface design, elaborated by the addition of a few categories for experiences commonly represented in the events (see Table 1).

Intercoder reliability was calculated using Scott's coefficient π to correct for chance agreement (Scott, 1955). A score of $\pi = 0.85$ was obtained (from an observed agreement of 0·87 and an expected agreement of 0·12). It should be noted that due to the multiple assignment of units to categories allowed by Q-analysis, the n of coding units used in common reliability calculations must be elaborated. Here, for each single coding unit, it was replaced with number of category assignments

TABLE 1
Descriptive scheme

Category label	Category description
Select	Selecting library or file(s)
String	Designing, modifying and/or using string(s)
Results	Examining and evaluating results
Decide	Making decisions or being forced to do so
Guess	Guessing
Attend	Attending screen, receiving system response
Guidance	Looking for guidance on screen
Interpret	Difficulty interpreting screen message(s)
Blocked	Blocked or unable to accomplish something
Rebuffed	Unsatisfactory result or error message
Repeat	Repeating something
Help	Using system help feature
Specific knowledge	Not knowing something specific
General knowledge	Not knowing generally what to do
System	Evaluating system
Self	Evaluating self
Express	Expressing helplessness
Question	Question was asked
Answer	Question was answered

made by two coders, minus the number of agreements (see Jacobson & Yan, 1991). The resulting codes were then fully dual coded and disagreements were resolved where possible to reduce simple assignment errors.

Results

The median number of documents retrieved was nine, with half the respondents retrieving the maximum of 10 and four retrieving zero documents. Success in retrieving documents relevant to each searcher's specific question regarding AIDS and the federal government should probably be considered moderate. The mean response on the ten point averaged index was 3·5.

Time-line interviews of the search sessions produced a median number of 6·5 events per person, with a minimum of four and a maximum of 17, for a total of 209. The median number of questions was 2·96 per person, with a total of 74. Of these, 34 received answers.

BACKCLOTH

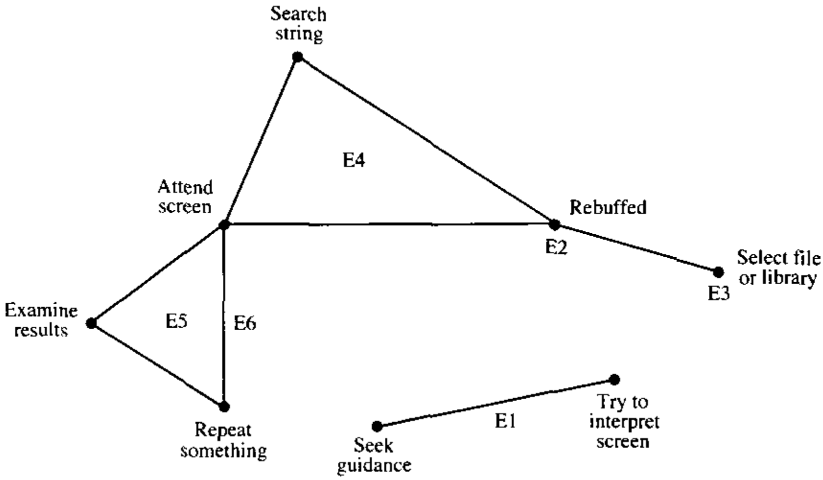
Figure 1(*a*) illustrates a Q-analysis approach to analysing coded time-line events at the individual respondent's level, using the first respondent's time-line as reproduced above. Each event is graphed as a simplex.

A simplex is a geometrical figure of points representing, for our study, descriptors. Straight lines drawn between points transform the points to vertices, with the lines representing connections between the descriptor vertices. In our case a line representing a connection between two simplex vertices means that an event contains both descriptors. The dimensionality of a simplex is defined as the number of points comprising the simplex minus one, and simplices can be joined together into simplicial complexes.

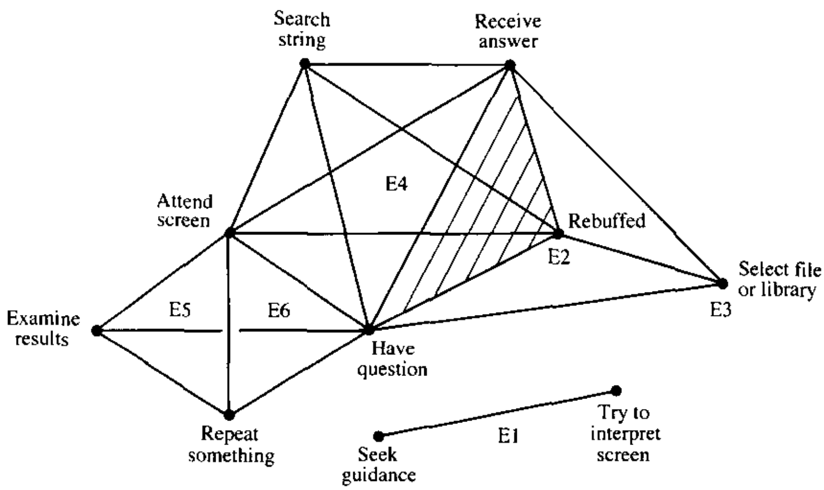
Together, the six simplices E1–E6 produce a simplicial complex of the individual's interaction with the database system. Such a complex can be treated as a "backcloth", or behavioral context with reference to which it is possible to describe "traffic" on the backcloth. Our traffic will be questions asked as well as answers received.

In E1 the respondent had trouble Interpreting the screen and then sought Guidance by looking further for information on the screen itself. The one dimensional simplex {Interpret, Seek Guidance} associated with E1 is represented by a line. In E2 the respondent Selected a library named "currnt" but instead of typing the file name only, as is proper, she also typed a number of extra words. She then received an error message, or Rebuff, from the system {Select, Rebuffed}. In E3 she typed the library name, or Selected the library, correctly, which is represented as a single point {Select}. In E4 she typed a search but received a somewhat confusing error message, so E4 is associated with the two dimensional simplex {Search String, Attend Screen, Rebuffed}, represented by a triangle. In E5 she apparently interrupted the search, revised and Repeated the search question, due to the error message, and then received and examined one relevant document. Finally, in E6, she typed in the original search string and received nine stories.

The simplices comprising individual backcloths can also be combined to analyse



(a)



(b)

FIGURE 1(*a*). Single respondent's event backcloth. (*b*). Respondent's backcloth with question and answer traffic.

the combined time-lines of all respondents, forming a collective backcloth. The coded time-line interview data were entered into a matrix of 209 columns (events) and 17 rows (descriptors). This matrix is mathematically called an incidence matrix and denoted by Λ. The matrix composed primarily of 1 s and 0 s, having four 2 s representing in each case 2 questions having been asked in a single event. These were recoded to 1 and in each case the first question asked was used for subsequent analysis. The incidence matrix Λ was multiplied by its transpose Λ^T, and the matrix product $\Lambda\Lambda^T$ with 1 subtracted from every element gave the connectivities of the simplices in the simplicial complex defined by $K_p(E, \lambda)$.

In Figure 1(*a*), descriptors and connections among descriptors are used to represent individual behavioral events. In $K_p(E, \lambda)$, descriptors and connections among descriptors are used to represent the total behavioral backcloth for all respondents, revealing the connectivities between descriptor-simplices at different *q*-dimensions.

The global structure, or connectivity, for all the 26 respondents' 209 events is presented in Table 2. Attending to the screen was the most frequently reported behavior, appearing at $q = 73$. This means that attending the screen was coded for $q + 1$, or 74, events. Designing, modifying or in some other way using a search string was also very common. Its appearance at $q = 49$ indicates that a number of individuals, as in the case of respondent #1, conducted multiple searches. Also reflecting respondent #1's experience, Rebuffed appears high in the backcloth, at $q = 46$. Examining Results, whether of successful or unsuccessful searches, and Selecting files to search were next most common at $q = 35$ and $q = 34$, respectively.

At $q = 27$ the first connection appears with the merger of attending the Screen and designing a String, forming a joint component, {Screen, String}. The typical sequence of selecting a file, designing a search, and then noting the system response appears at $q = 12$ {String, Screen, Select}. And at $q = 10$, a typical beginner's cluster appears, which includes selecting a file, designing a string, attending to the system response, and being rebuffed {String, Screen, Select, Rebuffed}.

TRAFFIC

This backcloth portrays selected collective behavioral and cognitive processes of 26 user interactions with the database. During the interaction process each individual may or may not have had questions related to specific events, treated here along with potential answers as traffic. In Figure 1(*b*), respondent #1's questions have been combined in a graphic illustration with her backcloth, along with answers obtained.

The first question, which was answered, occurred in E2. It asked why the system did not accept a file request. Question 2 occurred in E4, in response to a screen message notifying the user that prepositions, connectors and certain other parts of speech are not searched by the system. This respondent apparently did not understand the message at first, which is why it was a Rebuff, but she did eventually figure out that it was not a serious problem.

Answers were obtained in both cases. The fact that both E2 and E4 had question and answer traffic is represented by a shared two-dimensional "face", or triangle, in Figure 2. The third and final question occurred in E5, asking why only one story was retrieved when using a lengthy search string. This was not answered.

Table 3 presents an analysis of traffic on the backcloth for the whole sample of events, following a method used by Gaspar and Gould (1981: p. 195). Data on questions asked and answers received were added to the original incidence matrix, and a simplicial complex was produced that includes both the backcloth and the traffic, or $\lambda \subseteq E \times D \oplus T$. Here we see that questioning was active, appearing at $q = 69$. It is notable that questioning begins well before respondents actively seek

TABLE 2

Time-line event backcloth

q-level	Q*q*-level	Components
$q = 73$	$Q_{73} = 1$	{*Screen*}
$q = 49$	$Q_{49} = 2$	{Screen} {*String*}
$q = 46$	$Q_{46} = 3$	{Screen} (String} {*Rebuffed*}
$q = 35$	$Q_{35} = 4$	{Screen} {String} {Rebuffed} {*Results*}
$q = 34$	$Q_{34} = 5$	{Screen{ {String} {Rebuffed} {Results} {*Select*}
$q = 27$	$Q_{27} = 4$	{Screen, String} {Rebuffed} {Results} {Select}
$q = 22$	$Q_{22} = 5$	{Screen, String} {Rebuffed} {Results} {Select} {*Repeat*}
$q = 21$	$Q_{21} = 6$	{Screen, String} {Rebuffed} {Results} {Select} {Repeat} {*Guidance*}
$q = 19$	$Q_{19} = 7$	{Screen, String} {Rebuffed} {Results} {Select} {Repeat} {Guidance} {*Used Help*}
$q = 12$	$Q_{12} = 6$	{Screen, String, Select} {Rebuffed} {Results} {Repeat} {Guidance} {Used Help}
$q = 11$	$Q_{11} = 7$	{Screen, String, Select} {Rebuffed} {Results} {Repeat} {Guidance} {Used Help} {*Decision*}
$q = 10$	$Q_{10} = 6$	{Screen, String, Select, Rebuffed} {Results} {Repeat} {Guidance} {Used Help} {Decision}
$q = 9$	$Q_9 = 5$	{Screen, String, Select, Rebuffed, Repeat} {Results} {Guidance} {Used Help} {Decision}
$q = 7$	$Q_7 = 4$	{Screen, String, Select, Rebuffed, Repeat, Results} {Guidance} {Used Help} {Decision}
$q = 6$	$Q_6 = 3$	{Screen, String, Select, Rebuffed, Repeat, Results, Used Help} {Guidance} {Decision}
$q = 5$	$Q_5 = 5$	{Screen, Results, Select, Rebuffed, Repeat, Results, Used Help, Guidance} {Decision} {*Guess*} {*Blocked*} {*Need General Info.*}
$q = 4$	$Q_4 = 7$	{Screen, String, Select, Rebuffed, Repeat, Results, Used Help, Guidance} {Decision} {Guess} {Blocked} {Need General Info.} {*Interpret*} {*Helpless*}
$q = 3$	$Q_3 = 6$	{Screen, String, Select, Rebuffed, Repeat, Results, Used Help, Guidance, Decision} {Guess} {Blocked} {Need General Info.} {Interpret} {Helpless}
$q = 2$	$Q_2 = 6$	the same
$q = 1$	$Q_1 = 4$	{Screen, String, Select, Rebuffed, Repeat, Results, Used Help, Guidance, Decision, Guess, Helpless} {Blocked} {Need General Info.} {Interpret}
$q = 0$	$Q_0 = 1$	{Screen, String, Select, Rebuffed, Repeat, Results, Used Help, Guidance, Decision, Guess, Helpless, Blocked, Need General Info., Interpret, *Need Specific Info., System Frustration, Self Frustration*}

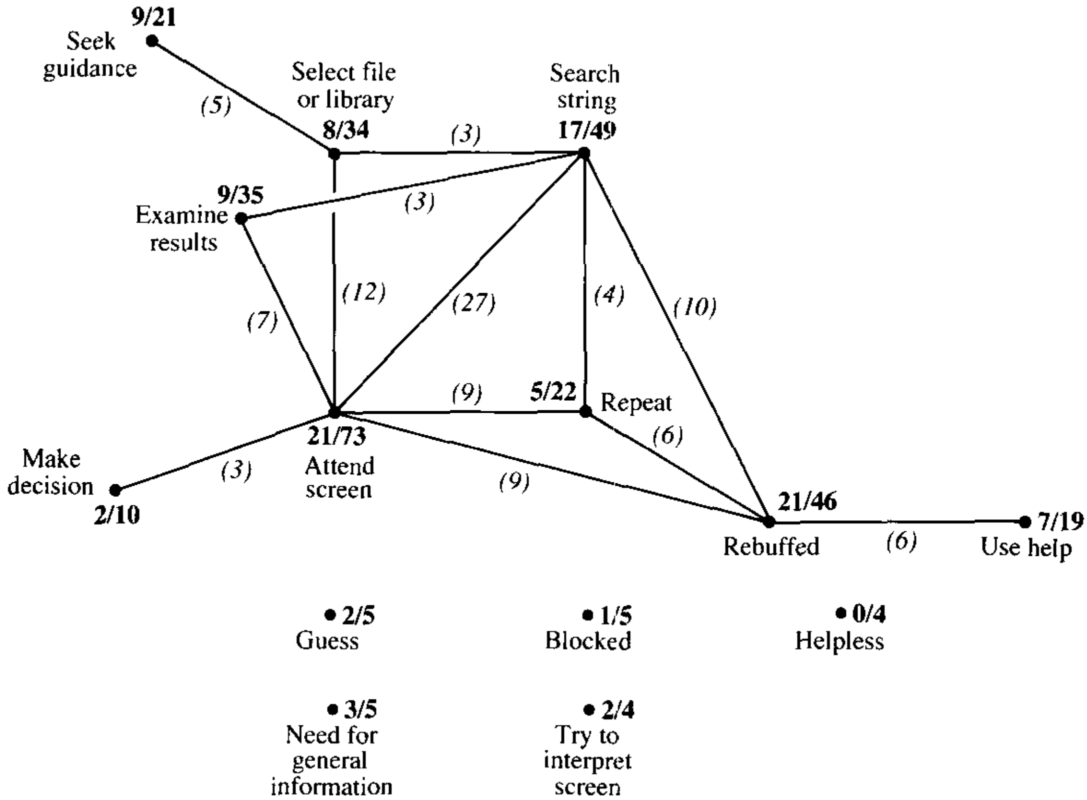


FIGURE 2. Backcloth at $q = 3$ with question traffic on vertices (expressed as questions over vertex dimensionality), and shared face dimensionality on edges.

information. Actively seeking Guidance by rereading the screen or by using Help functions does not appear until far lower in the backcloth, at $q = 21$ and $q = 19$, respectively.

When answers appear they are naturally connected to questions, turning up in the first joint component at $q = 21$ when they join together with Screen, String and Rebuffed.

It is interesting to note that even at low q-levels Questions are not q-connected with all the vertices one might expect. For example, at $q = 3$, Guessing, feeling Blocked, having difficulty interpreting a screen response and feeling Helpless appear but they are not connected with Questioning at this level. Apparently, such conditions are not always to be associated with information seeking.

Figure 2 graphically illustrates the backcloth structure for all respondents at $q = 3$, and includes Question traffic as well. This method of analysis maps traffic onto the backcloth vertices, $T \rightarrow B$, present at a particular q-level or higher (Gaspar & Gould, 1981: p. 202). Bracketed, italicized numerals represent the dimensionality of shared faces between vertex pairs, or in other words the number of events minus one in which the vertex descriptors co-occurred. Question traffic on the vertices is noted in boldfaced numerals as a ratio of the number of questions asked over the dimensionality of the vertex.

TABLE 3

Combined time-line event backcloth and question and answer traffic

q-level	Qq-level	Components
$q = 73$	$Q_{73} = 1$	{Screen}
$q = 69$	$Q_{49} = 2$	{Screen} {*Question*}
$q = 49$	$Q_{49} = 3$	{Screen} {Question} {*String*}
$q = 46$	$Q_{46} = 4$	{Screen} {Question} {String} {*Rebuffed*}
$q = 35$	$Q_{35} = 5$	{Screen} {Question} {String} {Rebuffed} {*Results*}
$q = 34$	$Q_{34} = 6$	{Screen} {Question} {String} {Rebuffed} {Results} {*Select*}
$q = 33$	$Q_{33} = 6$	{Screen} {Question, *Answer*} {String} {Rebuffed} {Results} {Select}
$q = 27$	$Q_{27} = 5$	{Question, Answer} {Screen, String} {Rebuffed} {Results} {Select}
$q = 22$	$Q_{22} = 6$	{Question, Answer} {Screen, String} {Rebuffed} {Select} {*Repeat*}
$q = 21$	$Q_{21} = 5$	{Screen, String, Question, Answer, Rebuffed} {Results} {Repeat} {*Guidance*}
$q = 19$	$Q_{19} = 6$	{Screen, String, Question, Answer, Rebuffed} {Results} {Select} {Repeat} {Guidance} {*Used Help*}
$q = 12$	$Q_{12} = 5$	{Screen, String, Question, Answer, Rebuffed, Select} {Results} {Repeat} {Guidance} {Used Help}
$q = 11$	$Q_{11} = 6$	{Screen, String, Question, Answer, Rebuffed, Select} {Results} {Repeat} {Guidance} {Used Help} {*Decision*}
$q = 9$	$Q_9 = 4$	{Screen, String, Question, Answer, Rebuffed, Select, Repeat, Guidance, Results, Used Help} {Decision}
$q = 7$	$Q_7 = 2$	{Screen, String, Question, Answer, Rebuffed, Select, Repeat, Guidance, Results, Used Help} {Decision}
$q = 5$	$Q_5 = 5$	{Screen, String, Question, Answer, Rebuffed, Select, Repeat, Guidance, Results, Used Help}, {Decision} {*Guess*} {*Blocked*} {*Need General Info.*}
$q = 4$	$Q_4 = 7$	{Screen, String, Question, Answer, Rebuffed, Select, Repeat, Guidance, Results, Used Help} {Decision} {Guess} {Blocked} {Need General Info.} {*Interpret*} {*Helpless*}
$q = 3$	$Q_3 = 5$	{Screen, String, Question, Answer, Rebuffed, Select, Repeat, Guidance, Results, Used Help, Decision, Need General Info.} {Guess} {Blocked} {Interpret} {Helpless}
$q = 2$	$Q_2 = 3$	{Screen, String, Question, Answer, Rebuffed, Select, Repeat, Guidance, Results, Used Help, Decision, Need General Info., Guess, Interpret} {Blocked} {Helpless}
$q = 1$	$Q_1 = 1$	{Screen, String, Question, Answer, Rebuffed, Select, Repeat, Guidance, Results, Used Help, Decision, Need General Info., Guess, Interpret, Blocked, Helpless}
$q = 0$	$Q_0 = 1$	{Screen, String, Question, Answer, Rebuffed, Select, Repeat, Guidance, Results, Used Help, Decision, Need General Info., Guess, Interpret, Blocked, Helpless, *Need Specific Info.*, *System Frustration*, *Self Frustration*}

The joint component having the highest dimensionality in the backcloth, as indicated in Table 2, is Attending the Screen and using a Search String, at $q = 27$. In Figure 2 the Question traffic on these two vertices is seen as 21 and 17, respectively. Rebuffed also received a considerable amount of Question traffic, at $q = 21$. Question traffic was also active on Examining Results, Seeking Guidance, Selecting Files and Using Help.

CUT-POINTS

Of the various tools Q-analysis provides for data examination, cut-point analysis was chosen to distinguish different backcloth and traffic connectivity patterns among more and less successful searchers. A cut-point is a value used to identify subsets of the data being studied for separate analysis. The score for each searcher's success, based on the Relevance index, was associated with each respondent's events. The median success score was then used to identify events associated with more and less successful searchers. Separate Q-analyses were conducted on the events in the upper and lower halves of the sample of events based on search success. To keep the comparison sub-samples equal in number, five events associated with the exact median score were dropped from the analysis, resulting in an n of 102 for both lower and upper halves.

Tables 4(a) and 4(b) present Q-analyses of these sample subsets. Attending the screen is prominent in both but Questioning differs markedly between the two. It not only appears at the highest q-level for the below median group, but at a much higher dimensionality, $q = 41$ compared to $q = 33$. Other descriptors appear higher as well. Rebuffed appears at a higher q-level in the below median group, at $q = 27$ compared to $q = 18$. String appears at $q = 27$ for the below median group compared to $q = 21$ for the higher group, indicating that more searches were employed by this group even though the group's searches were less successful. And Results appears at a lower q-level, no doubt reflecting the relative fruitlessness of the searches.

Joint components reflect other sensible differences among the two groups of searchers. For example, for the above median group, Question and Answer as a pair first connect at $q = 7$ with Screen and String, forming the joint component {Screen, String, Question, Answer}. While for the below median group they first connect at $q = 15$ with Rebuffed, forming {Question, Answer, Rebuffed}, reflecting the problems leading to the repeated searches employed by this group.

Some results seemed to violate initial expectations. Guidance and Help appear at higher q-levels for the above median group, at $q = 9$ and $q = 8$, compared with $q = 3$ and $q = 5$ for the below median group, respectively. One might expect that the below median group would require help more often and would seek Guidance or use Help more often. However, it seems that the above median group members were not only more successful in retrieving documents, but they were also more successful in turning to the system's instructions and help files when they were not sure how to proceed.

In another somewhat surprising result, the above median searchers received fewer answers as a proportion of the total number of questions they asked. This may be due to their questions having been of slightly less importance; perhaps they didn't really seek, or need to seek, answers to all their questions. As described above, question importance ratings were gathered during the interviews. A comparison of

Table 4(*a*)

Combined backcloth and traffic for above median search success

q-level	Q*q*-level	Components
$q = 33$	$Q_{33} = 1$	{Screen}
$q = 25$	$Q_{25} = 2$	{Screen} {*Question*}
$q = 21$	$Q_{21} = 3$	{Screen} }Question} {*String*}
$q = 18$	$Q_{18} = 5$	{Screen} {Question} {String} {*Results*} {*Rebuffed*}
$q = 15$	$Q_{15} = 6$	{Screen} {Question} {String} {Results} {Rebuffed} {*Select*}
$q = 13$	$Q_{13} = 7$	{Screen} {Question} {String} {Results} {Rebuffed} {Select} {*Used Help*}
$q = 11$	$Q_{11} = 7$	{Screen, String} {Question} {Results} {Rebuffed} {Select} {Used Help} {*Repeat*}
$q = 9$	$Q_9 = 8$	{Screen, String} {Question} {Results} {Rebuffed} {Select} {Used Help} {Repeat} {*Guidance*}
$q = 8$	$Q_8 = 8$	{Screen, String} {Question, *Answer*} {Results} {Rebuffed} {Select} {Used Help} {Repeat} {Guidance}
$q = 7$	$Q_7 = 7$	{Screen, String, Question, Answer} {Results} {Rebuffed} {Select} {Used Help} {Repeat} {Guidance}
$q = 6$	$Q_6 = 8$	{Screen, String, Question, Answer} {Results} {Rebuffed} {Select} {Used Help} {Repeat} {Guidance} {*Decision*}
$q = 5$	$Q_5 = 4$	{Screen, String, Question, Answer, Select, Repeat, Rebuffed, Used Help} {Results} {Guidance} {Decision}
$q = 4$	$Q_4 = 3$	{Screen, String, Question, Answer, Select, Repeat, Rebuffed, Used Help, Results, Guidance} {Decision} {*Blocked*}
$q = 3$	$Q_3 = 3$	the same
$q = 2$	$Q_2 = 5$	{Screen, String, Question, Answer, Select, Repeat, Rebuffed, Used Help, Results, Guidance, Decision} {Blocked} {*Interpret*} {*Need General Info.*} {*Helpless*}
$q = 1$	$Q_1 = 4$	{Screen, String, Question, Answer, Select, Repeat, Rebuffed, Used Help, Results, Guidance, Decision, Need General Info.} {Blocked} {Interpret} {Helpless}
$q = 0$	$Q_0 = 1$	{Screen, String, Question, Answer, Select, Repeat, Rebuffed, Used Help, Results, Guidance, Decision, Need General Info., Blocked, Interpret, Helpless, *Guess, System Frustration*}

TABLE 4(*b*)

Combined backcloth and traffic for below median search success

q-level	*Qq*-level	Components
$q = 41$	$Q_{41} = 1$	{Question}
$q = 38$	$Q_{38} = 2$	{Question} {*Screen*}
$q = 27$	$Q_{27} = 4$	{Question} {Screen} {*String*} {*Rebuffed*}
$q = 24$	$Q_{24} = 4$	{Question, *Answer*} {Screen} {String} {Rebuffed}
$q = 16$	$Q_{16} = 5$	{Question, Answer} {Screen} {String} {Rebuffed} {*Select*}
$q = 15$	$Q_{15} = 4$	{Question, Answer, Rebuffed} {Screen, String} {Select} {*Results*}
$q = 13$	$Q_{13} = 3$	{Question, Answer, Rebuffed, Screen, String} {Select} {Results}
$q = 10$	$Q_{10} = 3$	the same
$q = 9$	$Q_{9} = 4$	{Question, Answer, Rebuffed, Screen, String} {Select} {Results} {*Repeat*}
$q = 7$	$Q_{7} = 4$	the same
$q = 6$	$Q_{6} = 3$	{Question, Answer, Rebuffed, Screen, String, Select} {Results} {Repeat}
$q = 5$	$Q_{5} = 3$	{Question, Answer, Rebuffed, Screen, String, Select, Results} {Repeat} {*Used Help*}
$q = 4$	$Q_{4} = 4$	{Question, Answer, Rebuffed, Screen, String Select, Results, Repeat} {Used Help} {*Decision*} {*Guess*}
$q = 3$	$Q_{3} = 3$	{Question, Answer, Rebuffed, Screen, String, Select, Results, Repeat, *Guidance*, Used Help} {Decision} {Guess}
$q = 2$	$Q_{2} = 4$	{Question, Answer, Rebuffed, Screen, String, Select, Results, Repeat, Guidance, Used Help} {Decision} {Guess} {*Need General Info.*}
$q = 1$	$Q_{1} = 3$	{Question, Answer, Rebuffed, Screen, String, Select, Results, Repeat, Guidance, Used Help, decision, Guess, Need General Info.} {*Interpret*} {*Helpless*}
$q = 0$	$Q_{0} = 1$	{Question, Answer, Rebuffed, Screen, String, Select, Results, Repeat, Guidance, Used Help, Decision, Guess, Need General Info., Interpret, Helpless, *Need Specific Info.*, *Self Frustration*}

the mean importance ratings for the two groups indicates that the more successful searchers rated their questions as being slightly lower in importance than did the less successful searchers. The above median group score was 7·5, while the below median group score was 8·5 (Mann–Whitney $U = 459$, two-tailed $p = 0{\cdot}15$). At the same time, some of the questions asked by the above median group may have been more complex and more difficult to answer. A sounder interpretation could possibly be obtained from a content analysis of the questions themselves.

Discussion

The aim of this project was to examine the joint use of two approaches to behavioral analysis in database research. In particular, we attempted to generate data that were highly descriptive of the user–system interaction process. The time-line interview technique had produced transcripts of interaction for a previous study that were rich in detail, representing user–system interaction from the user's viewpoint, and in the user's own words. Conceptually, the transcripts provide a context for user information seeking. Information seeking during system use was defined as Questions. These transcripts were then coded and examined using Q-analysis techniques.

Overall, results provide an excellent picture of user interaction with the database system. A 17 category descriptive scheme quite sensibly indicates the high frequency that should be expected of attending the screen. Using, fashioning or modifying search strings is second most common. Third most common is being rebuffed by the system due to inappropriate command use. Examining results, selecting files, repetitive command usage, and use of help routines also comprise large portions of interaction behavior. The collective backcloth reveals not only the frequency of individual descriptor categories but also the connections among them at different frequencies, or in Q-analysis terms, dimensions.

Traffic analysis reflects not only amounts and success of questioning generally, but specific topics with which questioning was associated. Questioning, or information seeking in Dervin's terms, was common even when users were not in any way troubled and were not actively seeking help about system use. In addition, it is interesting to note that questioning does not necessarily occur when it would seem most likely. Feeling blocked, helpless, or having to guess about how to proceed were not always associated with questioning in our data.

Cut-point analysis was employed by slicing on the median Relevance score. This helped provide a more complete picture of the search process. For example, results indicate that successful searchers used fewer searches. In other words, high numbers of searches seem to suggest casting around in hope rather than efficient use of alternative search strings.

Cut-point analysis was also used to sharpen the traffic analysis. For the below median Relevance group, Questions were associated with being Rebuffed by the system, while for the above median group Questions were associated with successful interaction with the system. In other words, the traffic of one group varies from that of the other, and the specific differences in patterns make sense. Overall, members of the above mean group were active questioners who attached less importance to their questions perhaps because the questions occurred to them in less binding situations. They also sought guidance and used system help files more effectively than did the below median group. Such results raise a question regarding what might be done to improve search skills. It seems obvious that novice users should perhaps be more thoroughly trained to use information-providing features available in the system. But the problem may also lie, at least partially, at a deeper level. Poor searchers seem to have difficulty not only in obtaining answers to their questions, but in generating questions as well.

Only a small part of the Q-analysis repertoire of methods has been employed. For example, eccentricities were not reported because they were not interesting, nor should they be expected to be so on substantive grounds, either for individual searchers or individual descriptors. However, there are some additional techniques that might appropriately be employed in future research of this type. Anti-vertices (Atkin, 1977: pp. 49–50), might usefully be applied to No Answer conditions following Questioning. Here, such conditions were treated simply as the lack of an answer and not explicitly represented as vertices. Another technique that might be useful is application of q-factor weights to the shared face matrix. Following Cowley (1986), this technique may be expected to further reveal structure within large simplicial complexes. Of course, as Johnson (1990*b*: p. 283) has suggested, set definitions used to construct the original incidence matrix may or may not be the best for any given purpose. While the category definitions employed above are useful, other sets may be more appropriate for analysis of specific aspects of the interaction process.

To summarize, Q-analysis and time-line interviewing seem to be compatible research approaches, and jointly exhibit a number of useful characteristics. The time-line interview produces a highly descriptive account of user–system interaction, portrayed as a sequence of events occurring in time, from the user's viewpoint. Q-analysis of these interviews offers a richer and more precise approach to analysing such interviews than can be rendered from more traditionally practiced methods of content analysis. The relations revealed here involve higher dimensionality than cross tabulation procedures would be likely to identify. And the simplicial graphics, along with the traffic analysis, provide more, and different kinds, of detail than can be seen in a cluster solution.

The data examined here concern user–system interaction in a database context. However, Q-analysis of time-line structured interviews would seem productive in other system contexts as well.

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