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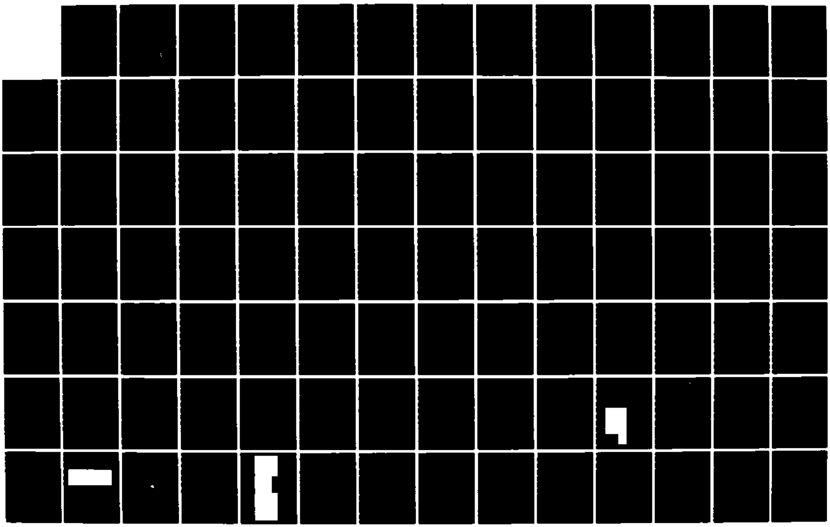

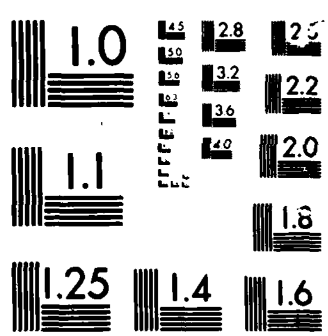

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FIRST CONFERENCE ON COMPUTER INTERFACES AND INTERMEDIARIES FOR INFORMATION RETRIEVAL: SELECTED PAPERS

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The Defense Technical Information Center sponsored a conference on Computer Interfaces and Intermediaries for Information Retrieval to promote exchange and dissemination of research efforts leading toward improvement of information retrieval. Topics included in the selected papers cover the general area of information retrieval. Human-computer interaction, common command language, intermediary systems, and future directions in artificial intelligence were the session topics.

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PREFACE

On 3-6 October 1984 the Defense Technical Information Center sponsored, with the support of the American Defense Preparedness Association, a conference entitled "Computer Interfaces and Intermediaries for Information Retrieval". The purpose of the conference was to bring together experts in the field of user interfaces to promote a sharing of the results of developmental efforts.

Six papers, one abstract, and one summary are included in this group of selected papers. The selection of papers implies a matter of availability rather than judgment. The sessions of the conference were recorded and transcribed; as is often the case, the transcriptions were of uneven quality, presenting extreme difficulty in working some of the presentations into suitable papers. Not included in this volume, but of equal value to the conference, were presentations by Martha Williams, as keynote; Carol Fenichel; Charles Hildreth; Michael Monahan; Alan Negus; Viktor Hampel; Rita Bergman; Tamas Doszkocs; David Toliver; Lionel Bernstein; and Gabriel Jakobson.

The Second Conference on Computer Interfaces and Intermediaries for Information Retrieval was held in Boston 28-31 May 86. The majority of the speakers who presented papers at the first conference on interfaces and intermediaries responded to the invitation to report on progress in their work. They were joined by other distinguished researchers in the field. The proceedings of the second conference on computer interfaces and intermediaries will be available by the end of summer 86.

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SOME DESIGN IDEAS FOR SUBJECT ACCESS IN ONLINE SYSTEMS

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Marcia J. Bates is an Associate Professor with the Graduate School of Library and Information Science at the University of California at Los Angeles. She has an MLS and PhD from the University of California, Berkeley. She has conducted research on subject access in catalogs, and has written widely on search strategy in online and manual information systems.

Dr. Marcia J. Bates

Underlying much current interface design are a number of unconscious assumptions. I want to challenge some of those assumptions. I would like us to go back to the function of information retrieval itself and ask how we might best design it. We're moving forward very rapidly with the existing traditional information system design structure; I'm not at all convinced that that structure is the best use of available technology. So I am going to address some general principles of information systems design and draw implications for interface design.

My first point is that we should design generous systems. I'll say more in a moment about what I mean by that term in an operational sense, but for the moment, let us look at some existing systems.

Current information systems are, as a rule, not generous. The prime example of an ungenerous system is the traditional card catalog, which, between its subject headings and its cross references, averages something like two subject access points per document. In a manual catalog, only the first word of each subject heading constitutes an access point, because there is no way to get access to words that appear later in the heading.

Online catalogs have been a vast improvement on manual catalogs, not so much because system designers changed the indexing, which they did not, but because the searcher can treat individual words in titles and subject headings as access points instead of just the first word in the heading or title. Even this simple step has been such a vast improvement on the previously stingy access available that online catalogs have gotten high rates of use and enthusiasm.

But we still have a long way to go. The results reported in the Matthews book on the national online catalog use survey sponsored by CLR contain the following figures: An aggregate 28 percent of the users found all or most of what they were looking for and 18 percent found more than what they were looking for. Great, but that leaves 40 percent who found only some of what they were looking for and 16 percent who found none. Now, note that most of these libraries were very large academic libraries (though, as a matter of fact, the figures do not vary much across library types anyway). Yet despite the great size of these libraries, over half of the users found less than most or all of what they were looking for. I think it highly likely that in most cases the material was there and the subject access did not connect people with that material.

I propose that the direction we go in is to make online information systems more generous so that we can reduce that 55 percent figure. In general, give people more than they ask for and let them override it if they want by simply ignoring it. Heaven forbid that we should hassle people by giving them material that they really do not want and which is difficult to ignore. I do not want to swamp people and am not proposing that. The override should be simply a matter of ignoring any part or all of a wide array of data that is on the screen. They should be able to pick out parts that they want and leave the parts that they do not want. It should not be any more complicated than that. But I do think that we should put out more information than they ask for, and I will tell you why.

For one thing, our minds are very economical. Once we find the term to label some concept, the presence of that term in our minds tends to block out other variant labels for that concept by a psychological interference process. It is hard to think up several terms for the same concept, yet most information systems require that. Relevant information may be found under several related terms and at several levels of generality. The average person approaching the system to search on "hypnosis" would probably think, "What other term could there be for such a discrete, distinctive phenomenon?" But good information may be found under "hypnosis," "mesmerism," "altered states of consciousness," and many others I cannot recall. Research shows that people look only one place in a catalog the majority of the time; yet in my dissertation I found that they use a term that matches with the relevant information on their topic of interest only about 20 percent of the time. So the rest of the time they thought they were finding the information the library had but were in fact finding only peripheral and far less relevant information.

This is old hat to people like Tam Doszkocs and Richard Marcus who are designing systems that expand searches by providing related terms for the searcher, as they are doing, or provide the searcher with the terms he or she cannot think of and what they would not realize need to be thought of. Subject access is a much more complicated business than most folks realize.

Now let us move to my second reason for being generous. There are basically two kinds of information that we need: information we know we do not know and information we do not know we do not know. With the first kind, there is a gap in the map. One has a pre-existing cognitive structure, say, a knowledge of current political realities in the Nation of Turkey, and one may realize that to proceed further in thinking on that topic at a given time, it is necessary to know the population of Turkey. One then proceeds to plug that hold by acquiring this information. But there is a hole there in the first place because it is surrounded by knowledge that one does have.

On the other hand, where the map has not been charted yet, where the cognitive structure has not been built, then one has no sense of what one does not know. There is no framework for it. If another researcher takes an approach to a problem that has not occurred to me, then I cannot know to look for that approach even though it may be highly relevant to my own work. This may seen obvious when said, but information retrieval systems do little deliberately to help searchers get this second kind of information. By definition, the searcher cannot know to ask for the second kind of information directly. We need to study how we might provide the searcher with information of possible unpredicted relevance.

All current online systems are vulnerable in this regard. When you do not know what you do not know, the best search strategy is to randomly expose yourself to information of possible relevance. This is what browsing is, and it is generally difficult to browse in online systems.

I've given a couple of reasons why I think systems should be more generous. Let me now be more specific about what I mean by that term.

One of the carry-overs from traditional information systems, particularly catalogs and abstracting and indexing services, is the assumption that to enrich access to documents or other forms of information means adding access points (descriptors or index terms) to each document or document reference. That adds a lot of storage and indexing complexity and hence a lot of cost to the system, so we naturally resist the idea of enriching that access for real practical reasons. But somehow in all of this, another approach has been virtually ignored, even though in some respects it was just as possible in the old manual system as it is in an online systems. This is the approach of having a rich complex access structure apart from the indexing of individual documents. The linkage to the document need be made only fairly late in the process.

Design the system so the searcher explores among the terms in broad subject areas with all sorts of hints, suggestions, and lines of thought presented along the way. Such an up-front conceptual structure can be quite complicated with rich inter-connecting networks of relationships--without having to attach all of that complexity to any individual documents. The searcher enters the system with a single term in mind, perhaps one that might be quite inappropriate with respect to the existing document indexing. That is all right because the system responds by showing the searcher what terms are used in the system to index that topic. Further, it asks if the searcher might also be interested in other, related, terms, as well. The system might also note that the stated term can be considered as part of several different topic hierarchies. Is the searcher interested in composition as part of English? As a part of material science? As a part of music? The searcher is shown a rich context for each term used and is thus made indirectly to realize that such a database is richer and more complex and perhaps more interesting than they thought. The searcher sees that perhaps there are better terms or additional terms or that there are whole areas that had not come to mind--in other words, the browsing function. All this occurs without the searcher having yet looked at a single document or document record. This whole structure is up front of the indexing.

If the purpose of information retrieval is to put the user together with the document, then this up-front system is a kind of interface to facilitate that process. In such a system, the searcher moves around in a rich linguistic and conceptual brew before asking for a retrieval on particular documents. He or she may look at some trial records as a probe to see what various terms cover, but the assumption is that the searcher can move around in this conceptual front end--a sort of system mind--before settling down on selecting documents.

Note that I am not merely suggesting an online thesaurus. Thesauri have always been designed for the indexer and only secondarily, if at all, for the searcher. We information types tend to resist putting these thesauri onto online systems or making them available in a manual situation, because they really are designed for the indexer and not the searcher. Thesauri use obscure symbols and abbreviations, include terms not actually indexing documents in a particular system, and have a limited number of cross references. They do not include many of the casual, popular terms or terms phrased in natural language grammar rather than the index-term grammar of thesauri. In short, typical thesauri are ill-suited for helping the end user in the way that I am talking about.

Now there are two points that I want to emphasize about this front-end system that I am proposing. First, there should be many, many entry terms. Currently, we actually make it hard to get into the system in the first place because the searcher must have terms in the right grammatical form to fit the indexing system, and we do not allow people to start with the more colloquial phrasing. Users know they have to "tame" their natural phrasing before they even approach the system. Why not make it easy to get in--provide a vast entry vocabulary--and then guide the searcher through all the terminological possibilities to the terms that actually index documents of interest to someone who started with the colloquial terms? If you have twenty entry phrases for a particular concept, you do not have to index all the documents on that concept by the twenty entry terms. Just pick two or three and let the system tell the searcher which one to use. So one can vastly increase the entry richness without significantly increasing the storage indexing costs.

Secondly, we have not begun to tap the possibilities in creating this front-end mind in an automated environment--there are many interesting possibilities. Terms can be shown not only in alphabetical proximity to entry terms, as they are now with "neighbor" commands and the like, but also in a variety of other ways. For example, a term can be shown in several heirarchies of related terms; many concepts are polyhierarchical in that they can fit logically into several hierarchies. All of these for a term could be displayed at once on the screen, each with the entry term in the center of a small tree of broader and narrower terms.

Another way of displaying relatedness is showing co-indexing. For example, some sample documents can be accessed by the system and all other terms besides the search term which are applied to the sample documents can be shown also. Such displays can be an interesting nudge to serendipity.

Alphabetically proximate terms can be shown from several, not just one, thesauri. Remember, we are just giving people ideas at this point, so it is all right to have several thesauri as long as the searcher is guided at some point to terms actually used in indexing specific documents. There are many forms of connectedness that we can display, some of them quite easy to produce and others more difficult. We can create an amazing richness, I think.

We have not done much of this yet because we keep linking the access to the indexing. We can have a conventional, fairly thin--but I would not recommend too thin--indexing of documents linked with a rich access structure which can be very complex, and which helps the searcher find the best terms before finally selecting--all fairly cheaply.

The irony is that a rich entry vocabulary, such as I have described, could have been provided in manual catalogs a hundred years ago. The argument has always been made that current library subject cataloging is so stingy because each access point represents another card in the catalog and hence, terrible bulk if you have more than a few entries per document. But a rich entry vocabulary, apart from the indexing of documents, could have been supplied in notebookss hanging from chains by the catalog a hundred years ago--without adding a single card to the catalog. Now I want to tackle our assumptions about information system design at an even more fundamental level. The central mode or paradigm of information retrieval research centers around the idea of a match between the search query and the document indexing in the system. The query is broken down into its component terms, which are then, in turn, matched successfully against indexing on all documents in the system. Documents which match, according to whatever algorithm is used, are then disgorged from the system as a retrieved set. This set is then evaluated by the requester or searcher and documents are categorized as to whether they are relevant or irrelevant. Relevance figures are then used to determine recall and precision rates, and systems that have the best recall and precision are considered to be the best systems.

Information retrieval is thus seen as a pinpoint match at one moment. There may be a lot of activity preceding that one moment, a lot of indexing at one end and a lot of modification and design of the search formulation at the other end, but the end result of all of this is that at some moment a match takes place between query and document indexing to produce a retrieved set.

Sometimes this model is elaborated to be an iterative process with the searcher acting on system feedback, but even here the assumption is that the iterations lead to the final best matching set. And so once again, we have this pinpoint match idea.

I would like to propose a different paradigm, or at least one that can exist in parallel to this one. Nicholas Belkin has argued that current systems make excessive demands on the requester. The requester must have a fully articulated, logical coherent request, one that can be put to the system for matching purposes. But as Robert Taylor pointed out a number of years ago, the query goes through a number of stages of development in the mind of the requester from a crude visceral "felt need" all the way up to a fully articulated and rational query adapted to the vocabulary of the information system. Belkin has argued that we require the user to do all the work of rationalizing and translating that query before coming to use an information system. Why should we not enable the user to initiate the search for information earlier in this cognitive process?

Belkin says that the requester has what he calls an "anomalous state of knowledge," or "ASK." He argues that to transform the ASK into a well-defined query is difficult and constitutes an unreasonable demand on the requester. (The basic paradox of information searching is that you are always asking for or about something you do not know.) He argues that the searcher should be able to come to the system in the "ASK" stage, and get the needed information.

Robert Oddy developed a system called "Thomas" based on these principles. The user need only produce a single word and the system then provides a rich array of possible directions to go in. The searcher can explore his or her way through the information, picking up what he or she wants along the way. There is no final single step, rather a learning process in which the original interest is developed and modified and documents and data taken away during this process as the searcher wishes. I do not think Oddy would have articulated it quite this way; I should say that I am adding some of my own interpretations.

Michael Williams, a psychologist at Xerox PARC, has been doing some work along the same lines which he calls "query by instantiation." The searcher does not have to name the need. The system gives suggestions and examples, in turn responded to by the searcher sufficiently to produce an effective process.

Let us call the conventional approach the "matching paradigm" and this one the "exploratory paradigm." In the latter case, the searcher and the system meet earlier in the process, while the need is not yet fully crystallized. With the exploratory paradigm, we, as information scientists, do not have to worry about whether we have provided the perfect match for the perfectly articulated search query as a result of perfect indexing with the ideal vocabulary. Rather, we worry about whether we have provided a rich linguistic and conceptual world to explore in. That world has frequent linkages to actual documents. There is a connection between the system mind and the documents, there is indexing. But it is the searcher's choice whether to follow up on any of these linkages.

In a funny way, we have tried to do both too much and too little in the past for users. We try to design the perfect system so the searcher's first search formulation matches with he ideal retrieved set. This is a tall order and it is debatable whether we can ever do it. On the other hand, we deprive the searcher of doing the exploring that most people like to do with information and need to do at one time or another. But by all means, let us continue to design systems that require as little as possible for the searcher to do. The principle of least effort is an overwhelming factor in people's information seeking. But let us also design systems according to the exploratory paradigm so people can fish around in information, can play with it as they would a video game--so they can take pleasure in a treasure hunt for information on those occasions when that is what they want or need to do.

Mr. Bollinger

We have time for two or three questions if there are any.

QUESTION

Our terminology bothers me. When you say systems, do you include people, instead of just hardware and software, as be a potential interface between somebody asking the question and the retrieval? In other words, someone on the telephone lines helping the asker with interpreting?

Dr. Bates

By all means. I am using "searcher" here to mean both end user and intermediary. I think often even the librarian who has received the request might want to do some exploring that way too, because the end user who made the request does not know about all the possible directions. In other cases, the question will be very cut and dried and the experienced intermediary will know that the one best term for that thing is X, and goes in with X and gets the answer. That is the kind of search that our systems do best now. But I think our system capabilities under-perform for all the other query types.

Comment

There is very little human control.

Dr. Bates

I think the existing systems do not take enough account of certain characteristics of cognitive processing of information. There is a lot of research that we need to do. We in information science do not know enough right now about how minds operate, but we get these little hints here and there like this interference effect I mentioned, namely, difficulty in thinking of other terms once you have a label for something in your mind. There are probably a lot more psychological patterns like that that operate when people confront an information system. We need to research those things and design systems from the user back. We are still technology driven. We design systems from the technology forward instead of from the user back.

Comment

I think it is very stimulating to think through the ideas you presented and it reminded me that maybe in addition to just presenting a rich navigational brew up front, if you will, of things to look at and to be reminded of, which is a very, very useful thing, we should think of the fact that you only recognize things as potentially useful if you already at least vaguely know them. Whereas in real life you can easily see that if you start suggesting, a lot of things will not be known to you and that does not mean that they might not be pertinent. So we should think of--and this has been proposed by people--linking an instructional, definitional component. For example, linking computer assisted instruction type systems--that would be very ambitious--but at modest levels, appropriate levels, to this exploratory navigational tool because for an average person looking for some medical information, they do not know that mumbo-jumbo. Yet, they may be very well concerned about heart attacks and bypasses and what not, and they would like to learn, and a real definitional instructional capability would come in handy quite often.

Dr. Bates

I think there are two senses of that, too. From the heart attack example, you could give the medical definitions and you could also provide scope notes beyond what are traditionally provided in the thesauri or indexes. You could provide scope notes that would explain to the searcher the distinctions that the searcher may have trouble making that the indexer assumes we already know. So you are helping them both with the conceptual content as well as the organizational rules used in that system. That's an interesting idea.

HUMAN-COMPUTER INTERACTION RESEARCH AND INFORMATION RETRIEVAL SYSTEMS
(abstract)

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Human-Computer Interaction Research and Information Retrieval Systems: Issues and Implications

A primary goal of human-computer interaction research related to information retrieval systems is to make systems sufficiently easy to use so that the distinction between skilled search intermediaries and end users ceases to be of importance. One way to accomplish that goal (and a central concern of this conference) is to develop search assistance programs that can serve as "automated search intermediaries," simplifying the interface and alleviating the need for the human intermediary. We must then ask whether this is a realistic goal.

Automated information retrieval systems are widely available and the number of databases and systems is increasing rapidly. But who is using them? The predicted takeover by end users has not occurred and human search intermediaries are not yet an endangered species. We find a similar unwillingness by end users to access online catalogs in libraries, due to the time investment required for learning.

Once people do use the systems, we must ask about the quality of their performance. We are finding that both commercial retrieval systems and online catalogs are difficult technologies for many people to conquer. Search intermediaries seem to have few problems with the mechanics of interactive systems, but still have difficulty with some of the conceptual aspects. In online catalogs, recent studies show consistently high error rates across systems and a tendency to abandon the system before achieving meaningful results.

Can automated intermediaries solve these problems? The currently-available assistance programs are able to assist in the mechanical aspects of searching, but provide little assistance for the conceptual aspects, such as structuring poorly-phrased questions in terms of system capabilities and selecting appropriate databases and vocabulary terms.

Basic and applied research on several of the psychological aspects of human-computer interaction shows promise for alleviating some of these problems. Mental models research suggests that people develop a model of a system for use in interacting with it. Systems and training designed around an appealing and intuitive conceptual model can ease both the learning and use of interactive systems. Research into information processing models promises to optimize screen displays and input devices to human processing limits, increasing efficiency and decreasing error rates. Individual differences research may eliminate problems that certain sectors of the population have with specific systems, increasing access to the technology for all.

THE USER INTERFACE: SOME PRELIMINARY RESULTS FROM THE DARTMOUTH ONLINE CATALOG

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The User Interface: Some Preliminary Results from the Dartmouth Online Catalog

The Dartmouth Online Catalog Project began in early 1979. It has evolved gradually over the past five years. The system is now running on a DEC VAX 11/750 computer. It has 4 Mb of main memory and about 2 Gb of online storage. The online catalog contains a little over 360,000 records. The Dartmouth Online Catalog uses BRS/Search: The Mini/Micro Version as the underlying software. The system is running under the Berkeley 4.2 version of UNIX and the latest version of the interface is written in C.

Dartmouth College is a Telenet node and has installed a local area network to link the campus together. Thus, students, faculty, and other online searchers can get access to the Dartmouth Online Catalog and various other online databases through the local area network and the Telenet connection. There are a number of students in the Amos Tuck Business School who have access to BRS/After Dark. These students have been using BRS/After Dark on their own and have been using it very heavily.

Given the environment at Dartmouth, it would be nice to have the time and staff needed to do some formal research on human factors. Most of our results, however, are based on empirical findings. Charles Hildreth, at OCLC, Inc., is looking at some transaction data from the Dartmouth Online Catalog, and he will be able to provide some more formal information for future analysis.

One of the most significant findings is that user's desired style of online interaction is very different. Of course, one of the difficulties in studying this aspect of online interaction is that new users very quickly lose their naivete, so a new pool of new users is needed very often. However, the type of interface that users want (whether new to the system or not) seems to span a range form those who would prefer a blank screen with perhaps a blinking question mark in the middle of it to those who want a detailed, cook-book-like approach with step-by-step instructions as to how to conduct the inquiry.

Another critical factor is the log-on procedure. It must be kept very simple. It must be very easy for the user to log on and to get started. Dr. Borgman uses the video game analogy, where it is very easy for the new user to insert a quarter and start to play the game.

It must be very easy to perform basic operations. It must also be very easy for users to learn to perform more complex operations. Here again, the video game parlour is a good example. No first-time users are experts, but they all very quickly learn how to play the game and how to advance their skills.

Another important finding is that users need to feel that they are in control of the online system that they are using. They don't want to have any surprises. Ideally, there should be no error messages. The Apple Macintosh has a very positive approach to errors. It is virtually impossible to make a "mistake" using it. The system may not do what you intended the first time, but it never tells you that you did a bad thing. Dr. Borgman makes another very important point when she states that users need a mental model of how the system works. Users may not know how the computer system or search software actually accomplishes what it does, but they need to have an idea in their heads about how they can use the system to accomplish their research needs. For example, they need to know how to get the online catalog to display again the search results from query number 5. Users don't need to understand what the computer system has to do to make this happen, but they need to have a functional understanding of how the system works. That is, users need to understand the relationships between the commands or menu choices that they make and the system responses.

Furthermore, users need a mental map of the system so they understand the relationships among various functions and how they can move from one to another. In addition, users need to know how to go back and review what they have just done, or perhaps to change their minds and execute a particular function again.

As mentioned earlier, users have different desires with respect to the amount of dialogue that they want from the system. Users may also have different needs at different times; for example new users need more elaborate instructions than experienced ones. Infrequent users have other needs--they basically remember from one session to the next how the system works, but they need prompting for the appropriate command syntax and so forth. These users need an easy way to get help from the system any time they forget how to do something or don't remember exactly the command structure.

But these users do not want to be burdened with time-consuming menus and lengthy explanations.

The very experienced user needs to be able to cut through all the menus, explanations, online tutorials, and other user aids and interact with the underlying system at its most efficient level. These users know what all the features do and need ways to enter commands quickly and easily and with a minimum of keystrokes. However, even these highly skilled and trained users may occasionally need to use a new option or feature and then need to get help from the system, so it must be very easy for the user to move back and forth from one dialogue mode to another.

Users also need to be able to stop any procedure at any time without crashing the system or putting it into some kind of limbo. All of us remember instances when we have entered a search term in error or made some other mistake and just want to stop whatever is going on and have the system put us right back where we were when the error occurred.

Users also need some kind of system-to-system similarity. As users move around the country and as they are able to sign on to more and more systems from their local terminals using various telecommunications packages, the need for inter-system consistency becomes ever more important. A common command vocabulary and syntax is extremely important.

Another type of interface that users encounter is the interface to various computer systems. Local area networks are becoming extremely important in enabling users to call up various remote systems, but they do not entirely overcome the problems of incompatible modems, terminals, and cables. The microcomputer running terminal emulation software is a big step forward in overcoming some of these interfacing problems.

As more and more software packages, database managers, and compilers become available, users need various interfaces that will lend some consistency across these various offerings. That is, the fact that there are a number of systems and software packages running together or separately must be transparent to the user. From a functional standpoint, it should appear to the user that there is one system involved--the fact that many separate inter-related systems may be actually supporting the user's activities should be totally hidden from the user.

Finally, the user-to-user connection is extremely important. We must not lose sight of the fact that we are in the business of delivering information, and sometimes a human source may provide the quickest and best response. We must not become so bound up in the "correct" way to do online searching or retrieve information that we forget that the important thing is to get the information to the user in as timely and inexpensive a fashion as possible. The wide variety of online end-user accessible information services supports the contention that users want to be able to get the information themselves and are willing to take the time and trouble to learn how to use these systems, knowing that in the future this knowledge will shorten the time it takes to get information.

Another widely used source of information are the various electronic mail systems and bulletin boards springing up around the world. In many of these, a user can send out a query to the community at large and hope for a response from some fellow bulletin-board user. These can be extremely useful sources of information because they often bridge the gap between published sources and the first-hand expert knowledge that one used to be able to get only from a face-to-face chat or via telephone. These links now make it possible for people all over the world to share each other's knowledge and experience in direct fashion.

RESEARCH IN SEARCH MODELS

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Sitting there listening to the other speakers, I was reminded of a Peanuts cartoon I saw some time ago in which Schroeder and Linus and Charlie Brown were lying on their backs looking up into the sky and they were each saying what they saw in the cloud formations. Schroeder said he saw this montage of all the great composers moving across the sky. Linus said it looked a little like the ceiling of the Sistine Chapel. It finally came to Charlie Brown and in his most typical chagrined expression, he said he was going to tell about the doggy and kitty he saw, but now he wasn't sure he should mention that.

What I want to say to you may sound very simple compared to some of the things we've heard this morning, but I think it's a necessary foundation and so I'm going to get on my soapbox and preach.

As Bill mentioned, I'm with AT&T. I joined them one week after divestiture and I've spent the last eight months focusing my entire attention on changing both the organizational structure and the cultural climate of the group I'm in charge of. That is a disclaimer, because everything I say from this point on has nothing whatsoever to do with AT&T Bell Laboratories, but rather it is based on work that I did before I joined the Labs. (But I hope it will affect what happens at the Labs in the future).

I want to acknowledge the National Library of Medicine Extramural Grants Program for funding the most recent work that much of what I'm going to be talking about is based upon. I said it's the Extramural Program or, as my secretary typed in our Grant acceptance letter, the Extramarital Program which I think may be memorable to them! The work that I'm going to describe to you has been published in two different places. First, the proceedings of the 1982 American Society for Information Science annual meeting, and second in April of this year in the ACM Bulletin of the Special Interest Group on Computer and Human Interactions. So it is available if any of you would like to see it. Check your local library.

I want to mention also why I got into this kind of research in the first place, that is, research on how people actually use information systems as opposed to how the designers think they use them. I was with Battelle for a number of years and was involved in the early design of the BASIS System, which at that time stood for Battelle's Automated Search Information System and since probably stands for something else. But in any case, we began to suspect that the people were not truly using the system in the way we had intended them to. Either they weren't using its full capabilities or maybe they were using it in ways we hadn't anticipated. We decided as designers that we had better find out how it was being used. So we developed and applied an online monitor. At first what we did was just to take the transactions off the day file and extract out the ones that were appropriate to our application, and then start looking at them. From that we went to the design of an on-line monitor built with the BASIS system that captured all the transactions. This gave us a chance to look at individual sessions and to truly identify what was being done. To paraphrase Lord Kelvin, "If you can't measure it, your knowledge about it is meager and furthermore you shouldn't talk about it, if you can't measure it." We decided we should measure what was going on in the system.

What I want to present to you right now are some results of recent monitoring work on the NLM system. First of all, a little credit for the Extramural Grants Program. They provided us with transaction data from the NLM System. We were specifically interested in the Medline database in this case. I might mention, by the way, that this particular study was one of many. I already indicated that we monitored the BASIS system. I've been involved in studies monitoring a variety of systems, including the OCLC on-line cataloging system. The techniques are basically the same, and that's what I want to focus on today using this as an example. I want to talk about the techniques and how you as individuals who can influence system design should be aware of this technique and should be incorporating it.

The methodology was to obtain transaction tapes from the National Library of Medicine and to sort those transaction tapes. They appear in chronological order and we wanted to resort them so we could identify discrete sessions by individual users and then look at what they did in those sessions. We selected only sessions involving the Medline database. (I might mention that John Tolle at OCLC has since analyzed the Catline interactions in a similar way, so we're able to compare between two different databases. I'll get to that comparison later on in terms of why it's valuable.) We then edited out some of the spurious characters in the transactions, tagged every transaction, assigned activity codes to every transaction (and I'll show you what activity codes were assigned). Then we analyzed the entire sample and drew from it subsamples to make comparisons. In this case, they were subsamples based on the frequency of use of the system and we were able to identify users who used it a high degree of the time, moderately, and infrequently. We began to compare those subsamples, looking for differences between different types of users. Finally, we compared our results to what other people had done previously.

How many sessions? Well, almost 40,000 sessions were in the initial sample, representing over 2 million transactions. Now, I would say that applying an on-line monitor to an interactive system provides you with more data than you'd care to analyze, so the real challenge is in developing techniques to analyze that data in a meaningful fashion. I think we have a handle on that. Obviously, it represented a large number of hours of interactive time, as well. (See Figure 1.)

Note that the average number of minutes per session was 11. In comparing the subsamples, I want to comment on that a little later on. The subsamples of frequent, moderate, and infrequent are shown in Figure 2. We tried to look for approximately equal numbers of sessions in each subsample. That meant that since the heavy users had more sessions, we had fewer heavy users in the sample than we had infrequent users. We wanted to try to have a balance in terms of sessions and a relative balance in terms of transaction pairs, although as you know, the infrequent users had fewer transaction pairs.

Note there's a relative consistency across the minutes per session between frequent, moderate and infrequent. The frequent users were on about the same length of time per session as the infrequent users. But there are some underlying structures in what the frequent versus infrequent users do that causes this to be about the same.

I said we tagged every transaction within the system. (See Figure 3.) It's important that you come up with a mutually exlusive and exhaustive set of categories to which you can assign every transaction. If you can boil it down to a small enough number of these categories, you can begin to analyze in gross terms how people are using the system. Then the data doesn't weigh you down--the data is actually useful. That's the set of categories that we applied against the NLM system. I might mention that both Chris Borgman and Carol Fenichel have been applying this same kind of technique. Charles Hildreth has, as well, and a number of other people are now, too. So we begin to be able to compare findings across systems.

Figure 4 shows profiles of the three different user groups--frequent, moderate, and infrequent--on some very basic activities that are performed in the system. What we looked at was the use of the term search, advance term search, Boolean and display across those three subgroups. We normalized the data and tried to compare it between the frequent, infrequent, and moderate groups. So what this graph says is that for every one single term search entered by an infrequent or frequent searcher, the moderate enters about 1-1/2 terms. For every advanced term search entered by the infrequent, the frequent enters about 2. So you can see there's a clear distinction between the profiles of the frequent, infrequent, and moderate users. From this you can begin to draw some implications as to not only how they use the system but how they progress as they become more experienced in the use of the system. There were a large number of findings based on these kinds of comparisons.

I'm not going to go into a lot of detail about all of those findings. You've already heard about some of them by other speakers, but let me just mention a few on this list. (See Figure 5.) First of all, they were log-on problems. That seems to be widely acknowledged. However, when we submitted the results to the National Library of Medicine, they did not acknowledge that there were log-on problems. I think that was partly because it way an implied criticism of the training program. Even though we showed them the data, they said, "well, we think there may be errors in your analysis program or at most, problems with the communications line that cause spurious data." Mostly, they were willing to blame the communications channels. It was only after Michael Cooper got comparable results with a similar subsample from NLM that I believe they accepted the idea that in fact there are log-on problems.

Almost seventy percent of the IDs that we sorted out of the samples were spurious IDs. So that means that people are having a tough time getting into the system. Why? Well we went back into our data and took a closer look at a selected subsample and we found one very simple reason that accounted for many of the errors.

AUDIENCE COMMENT

Just let me interject what makes it worse is that the system drops you off if you made a simple error. That is just most frustrating.

DR. PENNIMAN

Yes. One of the problems that's very common and generated a lot of these sessions that ended with one or two transactions was that people were trying to use a Tymnet format for a log-on procedure while on Telenet, or a Telenet while on Tymnet. Why? They've got two different systems to keep straight. They forget. They enter one and it's an inappropriate format for the other. You can capture that data. You can tell what's going on. You can help the user. But I feel like we have something here that's really powerful and we're not taking advantage of it.

Another problem I'd like to mention--use of the display command. There's been a running debate as to whether or not people that are newly trained on the system are really doing interactive searching or fast-batch. Are they using the display and interactive capability of the system to look at a few documents, then go back in and reformulate their search strategy, and then go back and search again and look at some more documents. There was a lot of conjecture and there were some suppositions about whether or not people were doing that. It was very simple to answer the question. We just look at some of the sessions, looked at whether or not displays were followed by additional Boolean searches, and in fact they were. So we feel we were able to put at rest something that was a running debate with a lot of very opinionated people saying what they thought was going on. We were able to show that both infrequent and frequent users were using the display command embedded between Boolean search commands.

Next I'd like to mention the 80/20 rule. For those of you who are familiar with content analysis and type/token vocabulary, I could explain it quickly. Let me just put it this way. A very small number of the total possible types of transactions account for a very large number of the transactions actually occurring in the sample. In other words, 20 percent of the types of events observed account for 80 percent of the events in the sample. That's true for strings as short as 2 or 3 commands in the sequence, which means that there's not a great deal of diversity of use in terms of the interaction or the commands or capability in the system.

The use of certain commands can distinguish between the groups, which I showed you on the graph before. Also, command pairs can be used to distinguish between different groups. Now, that's very powerful, not only because you can go back after the fact and look at it, but also because you can do it on the fly. Since you can do it on the fly, you can provide the users with adaptive prompting that's tailored to what they're doing in the system and give them instruction. That's what IIDA was all about that Charlie Meadow was working on--individualized instruction in data access including prompting.

Novices search more slowly, but you notice that the time of the session is about the same, which means that they use fewer commands and spend more time on each command. Charlie Meadow has suggested--I don't know that it's every been verified, but I think it's an interesting area for study--that the limit on session length has nothing to do with how many commands you enter, but just your tolerance for sitting at a terminal doing a single task for a certain number of minutes.

The way I define errors is different than the way it's been defined by Carol Fenichel in some of her studies. I simply looked at what people typed in immediately before entering a correction. This indicated at a minimum where they were having typing problems. The most frequent errors occurred in the Boolean entries.

Frequent users did not use advanced select commands. Even the frequent users were not making full use of what was available within the system. I might mention that in the published results of this study, I compared these findings with findings from Carol Fenichel, Janet Chapman and Judy Wanger as well as other people who have studied systems in a similar manner. In some cases we were able to verify their findings; in other cases we think we refuted the findings, particularly when ours were based on hard data and theirs were based on a small sample or interviews. We think that this data is pretty solid based on what people actually did in the system.

As far as the conclusions of that study are concerned, we think the methodology allows for comparison across systems and databases--and I might add also, researchers. The only way you can gain credibility in research is to have results that can be replicated. This technique allows for replication. (See Figure 6.)

I am talking about our studies from a research standpoint. When I go back to the podium I'm going to talk about it from an applications standpoint in terms of systems that are used every day. The methodology allows for testing against previous results. I have to admit the methodology needs further refinement, particularly in terms of some of the models that we've been building. For those of you who are interested, the models are stochastic process models involving transition matrices that show the probability that a user will go from one state to another. We were able to build those on the basis of empirical data.

The extension of the methodology to online public access catalogs (OPAC's) already has been done. Charles Hildreth will tell you more about that and Chris Borgman has already mentioned similar studies. I'm glad to see that it's happening with OPAC's early on, so that we aren't going to continue to design systems under false assumptions about how they are being used.

Now I'd like to go back to the podium and make some comments based not only on that research but also on my general feeling about this whole issue of improving the use of information systems.

First of all, I hear a continual reference to the user/system interface. If it's the user/computer system interface, then I think that may be an appropriate terminology. If we're talking about the user/information system interface, then I really object. The system boundary for an information system is drawn somewhere behind the user, not between the user and that system and unless we take that into account in our design of systems (that the user is part of the system, not outside the boundary of it), we're going to continue to design systems that really don't fulfill their intention. And that's not just semantics. The more we talk about it that way, the more we think about it that way. So just as you hear more and more people saying "his or hers" or "chairperson," I think we ought to be more careful about the way we discuss system boundaries, as well.

I remember the intent of the early online systems. I indicated I was involved in the development of the BASIS system. Some of you out there look at least as old as I am, if not older, so you probably remember also information analysis centers. I cut my teeth on those and the dollars that went into information analysis centers were diverted to on-line retrieval systems. Why? Because there was some conviction that on-line retrieval systems would provide better service and reduce costs from what was currently being spent in the very labor-intensive information analysis centers. I hope there was a conviction of that. I hope that was behind the decision and not just becoming enamoured with technology. In any case, I think that we have to ask ourselves whether that intent has truly been fulfilled, or if we have just spawned a new series of professions and a new series of specialties without really improving service.

I would also want to carry that remark further to online public access catalogs. If we do the same thing in the area of online catalogs that we did with regard to online information retrieval systems, we will essentially be creating card files which the user will not be able to open. The drawers will seem stuck shut. When they finally do manage to get the drawer pulled open, the cards will seem to be stuck together and the poor user won't be able to get them apart. They aren't going to accept that and where are they going to go when they can't even get the drawer open? That's the analogy I see with some of the systems that we are liable to design unless we take into account the human element.

Another thing in terms of terminology I'd like to mention. I have an SDI profile at Bell Labs, the same one I had at OCLC, and "user friendly" was one phrase I couldn't use any more because I got so many hits. Everybody is talking now about user friendly software. I don't know who would claim that their software isn't user friendly. I also think we've heard of terminal-friendly users instead of user-freindly terminals. I don't care whether it's friendly anymore and I think back to the time when I was in the Army and going through basic training. My drill sergeant certainly wasn't user friendly, but he was user informative. He was firm, he was direct. He was unforgiving, but he made it very clear as to what was required and I knew what was required after a very short time and I did it. He was instructive. Maybe we ought to stop talking about being friendly, which is sort of like graceful and forgiving, and start talking about being user informative. How? By tracking what people do and instructing them on what to do. That's where I think the kind of tool that I've just described to you can be a great help.

One final comment I want to make and I know this is going to sound like a pitch for AT&T, but it's not. Maybe it's a pitch for the Apple Computer Company. Apple has an ad for the McIntosh in which they state "Computers won't really be widely used until they're as easy to use as the telephone," and then you turn to the next page and there's the McIntosh. I think they have found something that is going to give them a great deal of success on the market. But isn't it amazing that they had to turn to icons and windows and a mouse and all of that to make it successful. I think we had success right within our grasp with the very simple terminal and star-type network with interactive systems years ago. We had something that was as easy to use as the telephone. I think we blew it and I hope we don't make the same mistake by creating more and more complexity, thus making it harder for the end user to get the information that they're seeking.

QUESTION

Did you run a frequency analysis on the terms that users used at the National Library of Medicine most often?

DR. PENNIMAN

We didn't do it in that system, but we did do it in another system that I monitored and analyzed some time before. Certainly it's possible to do it. You have the data there, you have the first 57 characters of information. That's what's captured and one of our recommendations was that they capture more because when you string terms together you lose the end of the complex Boolean search. I can't answer the question for NLM, but I can tell you that people were using the system in a way we never expected. They were entering search terms that were in display only fields, not searchable fields and from that we were able to conclude that we had better make some additional fields in the records searchable. In the case of NLM, the one thing we did conclude was that the most likely entry to result in a null respone was a single term entry. What that says is that the searcher is still trying to find a common vocabulary with the index system. That's where I think a great deal of help is needed, as well. So while we didn't look at individual terms, we looked at what was most likely to result in a null response and it was individual terms.

QUESTION

Permit me then to comment what this implies you just said. All computer systems, also those abroad, capture this type of information as a matter of business, which means that as we start to search overseas information centers and especially for the Department of Defense, we leave an indelible signature as to what we're after. Now, intelligent gateways can make the searcher anonymous. If the contract with a foreign post is from the Gateway, then those authorized to use that foreign post through the Gateway are not known to the target computers. Which means this is another aspect why Gateways are probably something to be considered well.

DR. PENNIMAN

Yes, you've raised the issue of privacy and I think that's an important one. In some of my previous publications I've addressed that. I would hope that the privacy issue doesn't obscure the fact that you can analyze this data at a gross level, you can put counters on terms in the index of the online system. It isn't necessary to know what a specific user is searching for but it's interesting and informative and certainly necessary for the marketer of these databases to know what terms are being used most frequently. And that, I would argue, is not an invasion of anyone's privacy--to put counters on the terms as they appear in the index. It's also important to know that terms are being entered that do not appear in the index.

QUESTION

Could I come in on that on European systems for a moment, please? This a very great issue you've expressed well, but it's a little relieved, I think, in that most European host systems have a clause in their contract that explicitly prohibits them from storing any data about your usage for any longer than is necessary for serving your request. For example, I've got to keep a record of the documents you want printed off-line so I printed them off-line, all for billing purposes and this is actually a legal requirement in most European countries. So I hope that makes you feel a little easier about it.

DR. PENNIMAN

That's exactly the point that I'm concerned about, though, that those clauses in the contract may preclude individuals from actually capturing data at the gross level that can be used for system refinement. I don't think contracts should preclude such studies. I know that I had a running debate with one of the leaders of a commercial vendor about whether or not their system captured the data online. Clearly I know of no operating system that doesn't keep a log in order for recovery purposes.

COMMENTS

I'm from NLM and I think I probably should point out that the NLM does destroy the logs after a very short period of time--a matter of days or a very few weeks. And I would guess that probably in your case you probably had special permission from the access codes to allow NLM to record the data.

DR. PENNIMAN

The data that was provided to us had the access codes encrypted so we had no knowledge of the individuals doing the searches, but they were encrypted in such a way that we could group them by individual access codes. They then provided us with a key to the encryption that told us the type of organization from which that code came, but not the individual or not the specific organization from which the searcher came.

QUESTION

Do you know whether more than one individual had access to a particular access code?

DR. PENNIMAN

We had no way of knowing whether two people were sharing the same code, and that, of course, is a confounding point in the data; however, even if we were able to look at names we would have no indication that it didn't represent two or more people. But I still see that as no reason to throw this out as a way of measuring what's going on. One confirming point is that Mike Cooper got similar data because he was there as an intern and got a release. But yes, there was authorized release for both of these studies.

QUESTION

John Lawson from NASA. We're going through considerable redesign on our online system. Looking at beginning users, intermediate users, and expert users, can you profile what in general does a beginning user do? What does an intermediate user do? What does an expert user do or not do?

DR. PENNIMAN

Yes, but it's more complex in terms of profile. Let me show you an example of what you can do rather than try to answer specifically because it's a fairly complicated issue. I have another transparency (Figure 7) that I pulled out for the sake of time. I showed you that we assigned codes to every one of the transactions. We were able to look at sequences of transactions for frequent, moderate, and infrequent users and then compare which things occur across all three or two of the three, and which kind of patterns only occur in a single-user category. We were able from that to determine, as an example, that the infrequent user is likely to sit there and hit the display button and go through repeated displays, one after the other. The frequent user on the other hand is not likely to do that but will batch off the print out or just look at a few and then go on. That's one example of what the infrequent user does. I would argue that when you see that happening in the system, there ought to be a prompt built in that gives the individual an option to learn about the off-line print command because they may not know about it, since they're continually hitting the display command.

QUESTION

Why doesn't the frequent user use all the advanced features? I know that's not within your study, but that would seem to be a natural.

DR. PENNIMAN

Right, and that's a natural question that comes out of this that I think NLM should then go back and pursue. They should look at the training program and how features are taught. They should grab some of their frequent users, or their known heavy users, and talk to them.

COMMENT

We need to know your controls. Otherwise we could be going with something without the right ending.

DR. PENNIMAN

Yes, there are shortcomings in this approach, but my major point is that this gives you some signs, some pointers of where you ought to look. Just as the fact that we ended up with all those spurious IDs was a very strong pointer that there were log-on problems. Now the problem is accepted as real.

QUESTION

I sense a danger and have a couple of years about learning how different classes of users actually use today's existing systems, whether novice, intermediate, occasional user, or the expert experienced user. It tends to make some designers think that we have to create two or three levels of interface to be entered at the beginning rather than looking at, as I know you believe and have written about, dynamic adaptive interfaces. Any given user, and I include myself in this, on a given system within the same session is going to have varying ability from expert to novice, depending on how much coffee he's had or how much sleep he's had the night before or what other systems he's used in the previous 24 hours. Experience is a rubber band continuum for any searcher. We should keep that in mind and not go too far with what we learn about existing pre-defined classes of users on today's rather unadvanced, unadaptive systems.

DR. PENNIMAN

That's a good point and it relates to something Carol said about having a bicycle with training wheels you can't take off. On the other hand, it would be nice to have a bicycle which when it started to tip over, all of a sudden the training wheels reappeared. And that I think we can do with adaptive prompting.

QUESTION

We are capturing the log and sequences for different reasons, mainly to trace a possible unauthorized attempt at access and if we do so by looking at by what means the people are coming in (short of having a 9-11 box, which you can get, which can tell you from which telephone the call is placed) and if you create an inverted table on such log-on attempts you'll very quickly find that about 15 percent of the log-ons are not by authorized users. And you may wish to know, as I am sure you do know, that Moscow has access through the International Institute for Applied Systems Analysis is Austria to all international networks, which means a person in Moscow today can search any one of your public systems.

DR. PENNIMAN

Viktor, I spent a year at that Institute in Austria and I know what they're trying to do in terms of becoming a gateway between the East and the West, and you're right. They are trying to provide that interchange of information. The thing I'm concerned about is that you continue to raise this specter in terms of privacy and security. I think it can be addressed and I think it can be addressed in a rational way. I was going to mention that a paper by Wayne Dominick and me in Information Processing Management, January 1980, has that privacy issue addressed in a fairly structured and rational way. I hope that you will consider that rather than whether detente is at its peak or declining at this stage regarding our exchange of technical information with Eastern bloc Countries.

Thank you.

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FIGURE 1

TOTAL SAMPLE SUMMARY

	TOTAL	AVG PER USER
SESSIONS	39,330	25.9
TRANSACTIONS	2,104,977	1385.8
TIME (HRS:MIN)	7274:12	4:47
TRANS/SESSION	-	53.7
MINUTES/SESSION	-	11.06
TRANS/MIN	-	4.8

FIGURE 2

SUBSAMPLE CHARACTERISTICS

	FREQUENT	MODERATE	INFREQUENR
USERS	14	46	149
SESSIONS	1306	1223	1044
TRANSACTION PAIRS	41208	40333	25464
TIME (HR:MIN)	296:11	313:59	210:46
TRANS, PAIRS/SESSION	31.6	33	24.4
TRANS, PAIRS/MINUTE	2.31	2.14	2.01
SESSIONS/USER	93.3	26.6	7.0
MINUTES/SESSION	13.37	15.24	12.07

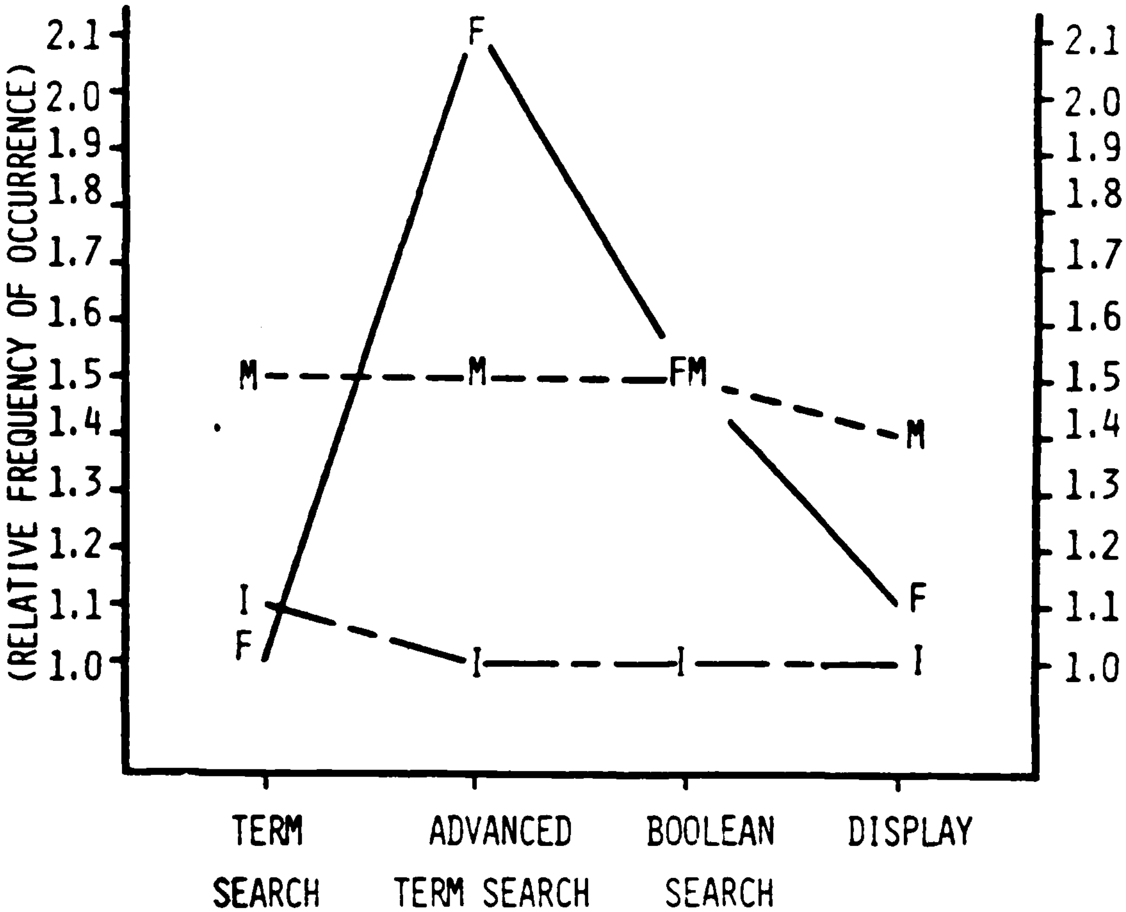
FIGURE 3

ACTIVITY CODE MAPPING

CATEGORY	DESCRIPTION
-	NULL
0	STORESEARCH
1	ERROR
2	NEUTRAL
3	BEGIN
4	DICTIONARY
5	TERM
6	ADVANCED TERM
7	BOOLEAN
8	DISPLAY
9	END
10	OFF SEARCH
11	PRINT OFF-LINE

FIGURE 4

PROFILES OF THREE USER GROUPS



F = Frequent
M = Moderate
I = Infrequent

FIGURE 5

SUMMARY OF RESULTS

- o LOGON PROBLEMS
- o USE OF DISPLAY COMMAND
- o 80/20 RULE
- o SPECIFICITY DECREASES FREQUENCY
- o FREQUENT SEQUENCES SIMILAR ACROSS GROUPS
- o USE OF CERTAIN COMMANDS DISTINGUISH GROUPS
- o COMMAND PAIRS DISTINGUISH GROUPS
- o NOVICES SEARCH MORE SLOWLY
- o ERRORS OCCUR ACROSS ALL GROUPS
- o FREQUENT USERS EMPLOY MORE COMMANDS AND TIME
- o FREQUENT USERS EMPLOY MORE COMPLEX STRATEGIES
- o LONGER STRINGS PROVIDE MORE UNIQUE STRINGS
- o LONG STRINGS NOT PREDICTED FROM SHORT STRINGS
- o INFREQUENT USERS EMPLOY LONG DISPLAY SEQUENCES
- o FREQUENT USERS DID NOT USE ADVANCED SELECT COMMANDS

FIGURE 6

CONCLUSIONS

- o METHODOLOGY ALLOWS FOR COMPARISON ACROSS SYSTEMS AND DATA BASES
- o METHODOLOGY ALLOWS TESTING OF PREVIOUS RESULTS
- o METHODOLOGY COULD STAND FURTHER REFINEMENT
- o EXTENSION OF METHODOLOGY TO OPACS IS PROMISING

FIGURE 7

COMPARISON OF
MOST FREQUENT PATTERNS

FREQUENT	MODERATE	INFREQUENT
7-7-7-7**	7-7-7-7**	7-7-7-7**
7-7-7-8**	7-7-7-8**	8-8-8-8
6-7-7-7**	7-8-7-8*	7-7-7-8**
7-7-7-6	7-7-8-7**	5-5-5-5*
7-7-6-8	7-8-7-7**	7-7-8-7**
7-7-8-7**	5-7-7-7**	7-8-7-8*
7-8-7-7**	5-5-5-5*	7-8-7-7**
5-7-7-7**	8-7-8-7	5-7-7-7**
8-7-7-7	6-7-7-7**	6-7-7-7**
7-6-8-7	5-5-7-7	5-7-5-7

* OCCURS IN ONE OTHER LIST

** OCCURS IN TWO OTHER LISTS

INTEGRATION OF COMMON COMMAND LANGUAGES

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Common command languages, front-ends, uniformizers, interaction languages, searchers workbench, user-cordial interfaces - all of these phrases refer to attempts to develop tools to improve human utilization of computer-based information systems. For the most part, these efforts have concentrated on facilitating use of bibliographic systems although several of the projects provide models which could be useful in a more generic approach.

The various projects have approached this interface or interaction of user and system in a variety of ways although primarily with the same objective: to alleviate the difficulties encountered by a user who must deal with an ever-increasing, heterogeneous collection of on-line databases. Multiple systems offer multiple databases. Different systems structure their retrieval and input/output processing differently. The same system will not be able to treat all files it processes identically except insofar as they have common elements and this is quite often not the case. Furthermore, a given database may change over time and thus exist within a system in multiple versions. A single user may have to contend with intra- and inter-data base differences as well intra- and inter-system variation.

And, now, with the growing availability of tools like the intelligent gateway which make access to widely distributed systems easily available at the user's discretion, another layer of variability is added - the intra-network layer. This additional complexity is probably the factor responsible for the change in attitude that the need to develop effective interfaces has gone from being a theroetical goal in many system designers' minds to being a practical necessity. And it is a necessity since the three factors mentioned by Marcus several years ago are still just as true. (1)

1. established character of existing systems
2. not easy to modify operational systems to improve or
3. standardization is difficult - especially if we're uncertain about what constitutes a good standard.

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The proposed solutions have proceeded along several courses: in some cases an educational approach was taken such as the work by Meadow and others on IIDA. Another approach developed out of vocabulary analysis and switching research. One example of this is the program at the National Library of Medicine. Yet another type of activity has been concerned with standardization of command language per se. The most comprehensive and successful effort to date being the Euronet Common Command Language program. (2)

However, more commonly, efforts to develop solutions to the interface problem have involved a more comprehensive approach. CSIN, CONIT, FRED, OL' SAM, and the National Bureau of Standards work on an intermediary processor are examples of combined tactic approaches. They are of particular interest to us at Lawrence Livermore National Laboratory because they have the potential to interface to (or, in some cases, already incorporate aspects of) gateway technology. Eash has a slightly different focus, for example, CSIN's strong support of chemical system searching or Ol' Sam's evolution and subsequent incorporation in the SCIMATE package offered by ISI.

Before reviewing these particular systems, it is worthwhile to repeat remarks made by John Bennett of IBM in 1972 when on-line information services were still in their infancy. His foresight is impressive: "There are several requirements for further development of the emerging user-interface technology. First, it is imperative to cut through the mass of inessential, application-specific detail and to overcome confusion in terminology so that the basic similarity of user services required in many applications becomes clear. Second, observers of the computer scene have decried the tendency of software designers to produce each system as if others did not exist. To be successful in projecting interactive facilities into new applications, designers must learn to build on the work of others and stop dissipation of resources on unnecessary duplicated effort. Third, adoption of a tool-design approach will make it obvious where human-engineering skills and computer assisted instruction experience can help provide improved interface languages and training techniques" (3)

With Bennett's recommendation in mind, we would like to review the various relevant projects we have identified and then discuss our efforts to integrate such work with our TIS intelligent gateway.

It is interesting to note, as Marcus has, that there has been a shift in attitude from asking whether such intelligent interfacing can be done to asking whether such interfacing will be as effective as a skilled searcher using the selected system(s) and its dialog, help features, etc. directly. (4) Much of his later work has been directed at collecting just such hard figures concerning use of the CONIT system at MIT.(5) Carol Fenichel made this point this morning when she said it was more complicated, in many respects, to learn the new interfaces than to learn the actual system. And what is the cost and is there degradation of search quality.

Growing out of work begun in Project Intrex in the 1960's CONIT provides an intelligent interface to Lockheed, BRS, SDC, and the National Library of Medicine systems. Requests, in near-natural language are transformed into forms appropriate to the system being used and response from the host system are also translated giving the user a view of a "virtual system" rather than the disparate systems he is actually using.

CONIT software was also used by Meadow in his Individualized Instruction for Data Access (IIDA)(6) project which involved using the computer as a tool to train would-be searchers and by the Franklin Research Institute. The Franklin Institute - Drexel University effort was a direct predecessor of Ol' Sam (Online Database Search Assistance Machine) (7) a microcomputer-based system which handles logical multiplexing, access protocol management, command and response translation, search strategy and response storage, user assistance, and search activity logging into RECON/DIALOG and ORBIT/ELHILL based systems.

David Toliver, who worked on Ol'Sam (which no longer is markable) is now managing the group at the Institute for Scientific Information which has SCIMATE as its primary product. SCIMATE, which is variously advertised as a universal searcher and personal file manager, is available commercially for CP/M and MS/DOS personal computers.(8) It accesses SDC, BRS, Lockheed, and the National Library of Medicine systems and incorporates much of the design philosophy of Ol' Sam.

The Chemical Abstracts Searching Terminal,(9) an early product of the CSIN work, of the Computer Corporation of America and Userkit, now Userlink,(10) by Williams and Nivin, are also commercially available, and can provide subsets of the features available in SCIMATE.

Also microcomputer-based but not commercially available is the Searcher's Workbench developed by Scott Preece and Martha Williams at the University of Illinois. (11) Their prototype system, implemented on an Alpha Microsystems microcomputer, accesses five databases on DIALOG and BRS and can communicate with the Vocabulary Switching System at Battelle and the automatic Data Base Selector at the University of Illinois. The latter features allow a user to develop more comprehensive and appropriate search queries as well as identify the relevant databases to query.

Vocabulary analysis and translation is a key feature of the work done at the National Library of Medicine under Charles Goldstein (12) and Tamas Doszkocs(13) Goldstein et al. have worked on a menu-based user cordial interface through which naive users can search the on-line public access catalog (CATLINE) using natural language which is translated into appropriately formatted, controlled headings for user review and selection. Parallel to this effort is the CITE (Current Information Transfer in English) project which features a natural language interface to MEDLINE and provides for ranked output and relevance feedback for use in query refinement/modification. Both projects represent research which could be extended beyond the medical information environment.

Representing a more general approach is the work done by Jakobson and others at the GTE Laboratories. (14) FRED, A Front End for Databases is a combination of hardware and software simulated in Interlisp on an IBM 3033 which provides access to multiple systems with one log-on, selects target databases on the basis of user's query, translates user's natural language commands into appropriate system commands and then converts host responses to natural language for the user, provides processing information (host service information, costs, etc.) and traffic monitoring and billing. Future plans include iuplementing FRED as a special purpose database machine.

Also using such a generic approach is the work by the National Bureau of Standards (Rosenthal and Lucas) (15) and currently continued in a slightly different direction by Sigfried Treu of the University of Pittsburgh. The NBS work resulted in the development of the NAM (Network Access Machine) which supports more general network functions than simply retrieval, but which because it is table driven under the UNIX system can easily be defined to handle varying types of information networks. Also, due to its UNIX orientation, the system is less hardware specific than most of those we have mentioned.

Using the NAM, Treu developed a "uniformizer," an intermediary processor which translate the languages of five systems (BASIS, DIALOG, SDC, MEDLINE/NLM, and DOE/RECON) via a system defined language which can be modified as the system designers identify areas where improvements, extensions, or changes are needed. (16) The dynamic system language is not based on a natural language processing philosophy because Treu feels such language is too imprecise and, therefore, ineffective and inefficient and difficult for users to use in a consistent or rigorous fashion. He would probably agree with David Pennman who feels that a user-instructuve/informative system was preferable to one which was simply friendly (and possibly incompetent). Treu acknowledges the lack of enough data in this field and has designed his approach to allow him to profit by new research as it evolves. Instead, the dynamic system language is rigorously defined and is table driven. Thus, it can be easily modified to incorporate desirable extensions or changes based on increased understanding of user behavior or the classic man-machine interface.

The openended, non-host specific nature of this language, which is also UNIX based, potentially provides a very powerful tool for integration in a gateway type system, for example, such as supported by the NAM. At LLNL, our TIS gateway incorporated the NAM software in 1978. (17) Subsequently, the software has been modified and extended to include additional capabilities.

NAM, electronic mail and the Integrated Information System comprise the basic components of the TIS Intelligent Gateway. As development continues, we expect to incorporate many of the features created in the research projects discussed above.

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INTERMEDIARY SYSTEMS FOR INFORMATION RETRIEVAL

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INTERMEDIARY SYSTEMS FOR INFORMATION RETRIEVAL

1. Background: Intermediary System Research

In the past few years developments have continued to be made in information science and technology. Perhaps the most exciting prospects are those where there appears to be emerging a mutually supportive cross fertilization in which the essential elements of the use of the new technology are captured in models of information processes which are then elaborated and used to fuel the development of new techniques. We have investigated one such line of synergistic interaction involving the modeling of retrieval processes leading to better understanding and more effective analysis procedures and, in turn, more rational and effective information processing techniques themselves.

Modern interactive computerized information retrieval systems have continued to increase their utility in terms of expanded size and comprehensiveness of database coverage and added functionality of retrieval operations. A core element of this development has been the appreciation that the computer systems need to provide more than just some basic tools; they need further to help and assist the users in making easy and effective utilization of these tools.

We and others have pioneered in research into this line of development by way of the mechanism known as the intermediary system. The intermediary system serves as an agent in helping the user to access and operate other information systems. Our investigations have centered on the use of such an intermediary system to provide easier and more effective operation of multiple and heterogeneous bibliographic information retrieval systems.

To evaluate this concept we implemented and tested a series of experimental intermediary systems under the generic name CONIT (standing for COnnector for Networked Information Transfer). CONIT systems allow computer-inexperienced users to access and operate three different retrieval systems: NLM ELHILL (MEDLINE), SDC ORBIT, and DIALOG. CONIT performs the following functions: (1) converses with users in a simple, common language which is self-instructional; (2) assists the users in identifying appropriate databases and formulating search statements; (3) automatically connects to, and performs the login protocol for, a system with the selected database and translates the users' search requests into commands in the language of the connected system; (4) reports the results of the search back to the users; and (5) assists the users in making additional requests of the remote systems to further satisfy their informational needs.
Controlled experiments have been conducted (MARC83b) to compare the effectiveness of the CONIT intermediary with that of human expert intermediary search specialists. Some 16 end users, none of whom had previously operated either CONIT or any of the three connected retrieval systems, performed searches on 20 different topics using CONIT with no assistance other than that provided by CONIT itself (except to recover from computer/software bugs). These same

users also performed searches on the same topics with the help of human expert intermediaries who searched using the retrieval systems directly. Sometimes CONIT and sometimes the human expert were clearly superior in terms of such parameters as recall and search time. In general, however, users searching alone with CONIT achieved somewhat higher online recall at the expense of longer session times. Furthermore, users invariably preferred to do their own searching with CONIT as opposed to undertaking what they perceived as the difficulties of making their problems understood by human intermediary agents.

The results of our experiments have been very encouraging and we have performed additional analyses (MARC81a, MARC82, MARC83b) that indicate that the intermediary solution could be highly cost effective in a number of contexts. The positive results of our research have helped spawn a whole new field of intermediary system development which we have reviewed in (MARC83b).

While these new developments are starting to have a beneficial impact on retrieval system use, especially by the end user, there has been one aspect of our investigations with CONIT which has not yet been fully realized within these developments. That aspect, which has important implications for research in information science theory as well as applications, concerns the <u>modeling</u> of the search process and the incorporation of parts of the model as <u>enhanced search techniques</u> provided for assisting the user by the computer.

At this point it is worthwhile to enumerate those several principles which we believe have contributed to the relative success of our experimental intermediary systems. In particular, we list the following:

(1) The heterogeneity of existing systems is replaced by the commonality of the virtual system.

(2) The complexity of current system/user interfaces is replaced by a simpler and easier-to-use interface.

(3) Effective instruction is given by the computer to assist the user.

(4) Relatively few basic retrieval operations, of the many retrieval functions available on existing systems, are provided; but these satisfy most needs of most end users.

(5) Even among the few basic retrieval functions, beginning end users initially are taught still fewer <u>core</u> functions; additional capabilities may be taught as needed.

(6) Inexperienced users can take advantage of relatively simple methods for developing search strategies that are effective across heterogeneous databases.

These principles are backed up by other techniques and methodologies. One important technique is a simplified command/argument language approach that incorporates elements of natural-language and menu approaches. Also, computer instruction is dynamic; that is, it is given according to the context of the search process. To a considerable extent the intermediary acts as an intelligent agent for the user by, for example, automatically performing connection and login protocols and keeping track of all searches so that they can be regenerated or repeated in other databases as needed.

An important methodological approach is to develop appropriate models of the processes involved. Thus a model of interacting independent processes as message transmitters, interpreters, and responders led to a translating-table, production-rule based interpreter as a software vehicle for mediating between the heterogeneous computer and human systems.

Perhaps most importantly, as indicated above, we developed early in the project a preliminary, informal model of the search process to help prioritize the functions most needed to be incorporated into the common, virtual intermediary retrieval system. This model has led to a technique for effective searching by inexperienced end users across databases with heterogeneous indexes based on a natural-language, content-word-stem Boolean searching of free-and controlled-vocabulary subject indexes.

2. Current Research Directions and Recent Progress

Having demonstrated in our early investigations the potential of the intermediary assistant approach, we began in 1981 to emphasize a particular direction to our research: an investigation of the possibility of developing a comprehensive and formalized model of the search process which could be employed to design truly intelligent search-agent intermediary computer systems.

Our decision to focus on the modeling and intelligent-agent aspects of our research derived from the conclusion that it was these aspects that contributed significantly to the success of our experimental results and, more importantly, that these aspects were key to the possibility of major further advances in the science and techniques of information transfer. From the scientific viewpoint we need the insight provided by models to forward our understanding of the search process and to enable a theoretical analysis of the comparative effectiveness of current and prospective retrieval procedures. From the viewpoint of the development of retrieval techniques it can be argued that while obvious incremental improvements are foreseeable in the way of greater comprehensiveness and user-friendliness for computer assistance, there must be some way to incorporate highly intelligent agents to make another quantum leap in improved retrieval performance.

Our general plan has been to elaborate the retrieval models while enhancing the experimental intermediary systems to test the efficacy of the models for (1) capturing the essence of the search process and (2) providing for improved retrieval techniques through expert computerized search assistance. Progress has been achieved in executing the general plan along four lines: (1) models for the general retrieval process and for particular measures of indexing and search effectiveness; (2) enhancement of computerized search assistance; (3) testing of enhancements; and (4) extension of intermediary assistance to generalized information processing.

2.1 Modeling Progress

A general model of the search process has been developed. As summarized in a recent paper [MARC83a], there are five components of this model corresponding to stages of the search process: (1) formalized problem representation (FPR) including a Boolean-structured topic representation (BTR) and associated problem aspects (e.g., quantified recall goals and search cost constraints); (2) search strategy formulation including database selection and formulation of searches based on the FPR; (3) execution of search strategy; (4) evaluation of such effectiveness; and (5) search reformulation and rerunning including closing the feedback loop back to stage (1) or (2).

An explicit aspect of the general model is the Boolean-based topic representation. Implicitly, therefore, the model presumes effective searching can be achieved in the Boolean framework. In fact, our previous work (see, e.g., [OVER74] and [MARC83b] has indicated that certain augmented Boolean techniques could, indeed, be very effective in searching, especially by inexperienced users in the context of heterogeneous databases.

2.2 Computerized Search Assistance Enhancements

Enhancement of the CONIT experimental intermediary search assistant has been accomplished with two purposes in mind: (1) increased intelligence and sophistication of search assistance, as by incorporating features of the models, and (2) increased suitability of the intermediary system for us and others to perform retrieval system experiments.

One enhancement that serves both modeling and experimental purposes was to incorporate within CONIT a facility to identify and record all computer-related cost components, both from the remote retrieval systems and the intermediary system. (Fo details on this facility see, for example, theses by Feinstein [FEIN82] and Weber [WEBE83].) Costs that must be identified include those associated with connect time for the systems and network connectors and with online and offline print charges. This facility permits not only retrospective review of charges but a prospective analysis of future costs for planning purposes.

Associated with the cost analysis facility is a new accounting facility (see thesis by Lee [LEE83]) which permits individual and group accounts on CONIT and the several remote retrieval systems. Costs for the different accounts are recorded and cumulated dynamically and maximum costs can be set preventing users from accumulating costs beyond set limits.

A new search cataloging facility is nearing completion (see Schwartz thesis [SCHW84]) which permits search statements (and search results when executed) across the network of retrieval systems to be saved in individual and group "catalogs". This facility will permit testing and evaluation of the concept of the (possibly long-term) development of search strategies and their subsequent utilization within individual or group usage scenarios.

Another new facility has provided one more direct example of the incorporation of intelligent aids in intermediary systems. This facility (for details see thesis by Kutin [KUTI84] allows the intermediary system to select an appropriate path through the network to a desired database. Rather than simply take a fixed priority list of paths, this path selection algorithm keeps a record of path selection attempts, as well as retrieval system schedules and database availability, and chooses new connector, network, and system links based on current indications of success or failure.

The main thrust of our experimental development has been to determine how well our search models can be incorporated into the intermediary assistance system. In an early manifestation of this effort Yip [YIP81] implemented an experimental intermediary system, termed EXPERT-0, which had a rudimentary form of the five stages of our search model as described above. EXPERT-0 was implemented after the style of expert systems of the artificial intelligence genre and facilitated a question-and-answer dialog by which the intermediary system assisted the user in preparing a Boolean topic representation and a search strategy. EXPERT-0 then automatically executed the search strategy, led the user to review the catalog records of documents thus found, and prompted the user to revise the search strategy after reviewing this feedback -- particularly in adding or deleting individual search terms and whole concept factors based on relevance considerations.

As we reported in [MARC81b], there appeared to be important potential for enhanced assistance in aspects of EXPERT-0 but a major deficiency in this preliminary implementation was a lack of integration of the expert modes with the "standard" CONIT modes. In particular, we concluded that for a truly effective intermediary assistant one needed not only the relatively few, albeit highly automated, modes of EXPERT-0 but also the many modes and functions provided by CONIT -- including the ability for the user to direct or initiate activity (e.g., through the command mode) as well as for the computer system to direct or control operations. Thus we have striven to design, implement and evaluate an enhanced CONIT that would integrate and extend the computer-directed, expert-styled, formalized planning and evaluative, menu-oriented features of EXPERT-0 with the more extensive user-directed, command-oriented, informally-tutorial features of standard CONIT.

We have made progress toward achieving this mixed-initiative, integrated intermediary system. The basic design for such a system was described in [MARC83a]. Various data structures devised for the catalog system provide a basis for integrating the standard search structures with the new problem representation and evaluation structures. A meta level was added by which usrs could in command mode (1) construct topic representations; (2) generate search strategies from these representations; and (3) execute the search strategy. In addition, we are in the midst of adding a meta-meta level, labeled "ASSIST," which assists users with a question-and-answer menu-oriented mode in performing appropriate construction, generation and execution operations. One unique feature of ASSIST is the explication for the user of the commands that are implied by his menu selection actions and answers to questions so as to help the user understand what, in fact, is being done for him and ease the way to user-directed command operations if and when he chooses to take such initiatives. A main goal of our research is to complete these meta-meta levels, especially in regard to the search evaluation components, and analyze their impact on the modeling and retrieval assistance objectives.

2.3 Experimental Testing and Evaluation

Taking advantage of the new experimental tools described above, we have begun to perform new and wider-ranging evaluation of the models and techniques we have developed. Our current experiments break new ground over our previous experiments in at least four major respects. First, of course, we are starting to get some experience with the new functional capabilities of CONIT. Second we have switched from the strictly controlled environment in which users operated the computer under our direct observation from terminals in our own laboratory, to an "open" environment in which users engage the system at times and places entirely of their own choosing -- generally in their own labs or offices. There is some loss of information in an open environment but this is more than counterbalanced by the greater realism achieved and potential for more extensive user participation in the experiments.

A third experimental variation enables us to obtain additional information: a record of the computer response time and the user response (think) time for each operation -- previously, we could not distinguish these two. A fourth, and highly significant variation, is the user involvement with costs. In previous experimental situation the project bore the full cost of all computer charges; in these experiments the full costs are being borne by his organization and he is made aware of the amount he has spent so far and the maximum amounts expendable for any one session, for himself in all sessions, and for the organization as a whole. Along with the open environment context, then, these experiments have a much more realistic setting than the previous ones.

The experiments are being partially sponsored by the National Library of Medicine and, therefore, we have emphasized medical, biomedical, and health-related topics. The two main organizations participating in the experiments so far are the Hudson River Foundation -- an environmental research organization, and the M.I.T. Laboratory for Computer Science -- particularly its medical (clinical decision-making) group. We are in the early stages of these experiments; as of this date there have been approximately six users. However, four of these users made extensive use of the system for a total of over 24 sessions.

We have not yet made a detailed analysis of these early uses of these new experiments. However, these early results do seem to substantiate a few general observations. First of all, most sessions and most users appear to have obtained relevant and useful document references fairly quickly without any instruction other than that given by the intermediary system. In this respect we are getting evidence to support some of the previous successful experimental results but in the more difficult and realistic context of the open, cost-sensitive environment.

The cost factor does appear to have a major effect on user behavior. For example, while average session times for previous experiments ran about 100 minutes, in these recent experiments session times were on the order of 20 minutes.

In addition to our own experiments we have begun to permit experiments and demonstrations with CONIT by fellow researchers. So far there have been several demonstration users in locations around the country. As explained below, we intend to broaden the scope of this activity so as to make our own work better known and more beneficial to others while enhancing the opportunities for scientific interaction among researchers.

2.4 Intermediary Systems in Generalized Information Contexts

We have begun to analyze the applicability of the intermediary system concept for networking heterogeneous information systems outside the specific area of bibliographic retrieval systems which has been our focus to date. Thus consideration is being given to user assistance for, and the integration of, such functions as computerized messaging and conferencing; test preparation, editing, and composing; and data (numeric) as well as bibliographic storage and retrieval. We mention these new ventures here to point out the potential broader applicability of intermediary systems beyond the text-based document storage and retrieval systems. Certainly, the development of more comprehensive theories and application techniques in information science and technology will require efforts in integrating these various informational activities.

3. Relationships to Other Efforts

As we have mentioned above, our early work in intermediary assistance systems helped spawn a major new activity in the field of information science and technology. In (MARC83b) we described in some detail this burgeoning new activity. Some of the important investigators listed include: M. Williams (WILL80), Meadow (MEAD82), Goldstein (GOLD78), Fayen (FAYE29), Toliver (TOLI81), Doszkocs (DOSZ80), Smith (SMIT80), Lefkovitz (LEFK82) and P. Williams (WILL81) and the intermediary creations they investigated have names such as Searcher's Workbench, IIDA (Individualized Instruction for Data Access), the User Cordial Interface. OLSAM (On-Line Search Assistance Machine), CSIN (Chemical Substances Information Network), NAM (Network Access Machine), CITE, SCI-MATE, and USER-LINK. Since the writing of (MARC83b) the intermediary activities have continued to blossom and we now have such new entries as Searchmaster by SDC, IN-SEARCH by Menlo Corp., and Search Helper by Information Access Co.

Most of the intermediary systems alluded to above have some unique features (e.g., sophisticated analysis of user searching by IIDA, certain natural language analysis by CITE, and search assistance for specialized areas in CSIN). Our experimental CONIT system may be distinguished for the combination of projecting a common-interface (virtual-system) approach to accessing a network of heterogeneous, broad-based systems and databases while providing extensive assistance in generating and executing searching on a broad range of topics. Equally important to our approach is the attention to the information science aspects of intermediary investigations. Our experimental testing and evaluations, along with our analyses for the information science ramifications, have been quite extensive and unique in their mix as compare with other investigations. Our current emphasis on formalized models of the indexing and retrieval processes which can be incorporated into experimental systems and tested in realistic contexts presents another point of departure for our approach.

Many investigators have, of course, studied various aspects of modeling of information systems. A few examples in the area of search models include Bates (BATE79), Jahoda (JAHO74), and Markey and Atherton (MARK78). Our own efforts are in the direction of extending and formalizing these other works and incorporating these models into a concrete form for experimentation and analysis. We believe our efforts in this respect have certain unique aspects -- e.g., the dynamic evaluation of searching and the incorporation of all model components into expert assistance systems.

Acknowledgments

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MENU-BASED NATURAL LANGUAGE INTERFACES TO DATABASES

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Central Research Labs.
Texas Instruments, Inc.

INTRODUCTION

- o GOAL OF NATURAL LANGUAGE INTERFACES

  to allow the user to state complex questions or commands in his own native mode with little training

- o THREE PROBLEMS WITH CONVENTIONAL NATURAL LANGUAGE INTERFACES

  I they are not "easy to use"

  - o "to put constraints on what English is acceptable and what is not violates the spirit of the task"
    --De Jong

  II they are expensive to build and maintain

  III their capabilities are limited

- o SOLUTION APPROACH: The user meets the system half way by MATCHING the user's and the system's capabilities.

  This "match" is realized by a "Menu-based Natural Language Understanding" approach, as implemented in the NLMENU system.

PROBLEM I: EASE OF USE

HABITABLE SUBLANGUAGE

"one in which users can express themselves without straying over the boundaries into unallowed sentences" --[Watt, 1968]

EVALUATION RESULTS FOR CONVENTIONAL NLIs

- o Coverage Mismatch Problems
  - o semantic overshoot = user's queries overreach the capabilities of the system
  - o semantic undershoot = users fail to make use of many of the capabilities of the system

  EX What types of aircraft ar there? <-- accepted by PLANES
  What planes do you know about? <-- rejected by PLANES

- o Other Results
  - o users still require training in the use of a natural language interface. Experiments show that users can use QBE (a dbms query language) with a comparable amount of training
  - o user's queries tend to be short and simple, about 7 words +/-, yet 1/3 of their queries fail
  - o users are often nable to solve their problems using NL

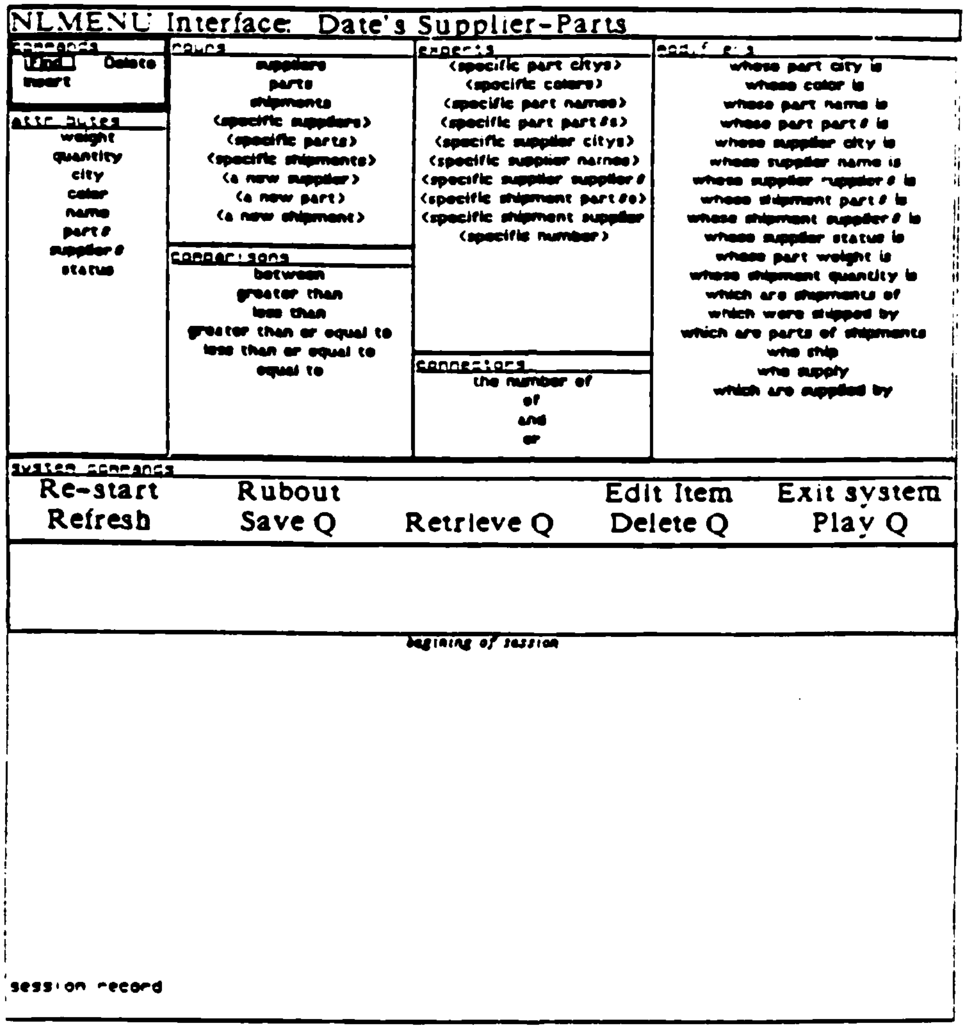


Figure 1-3: An NLMENU Interface to SUPPLIER-PARTS

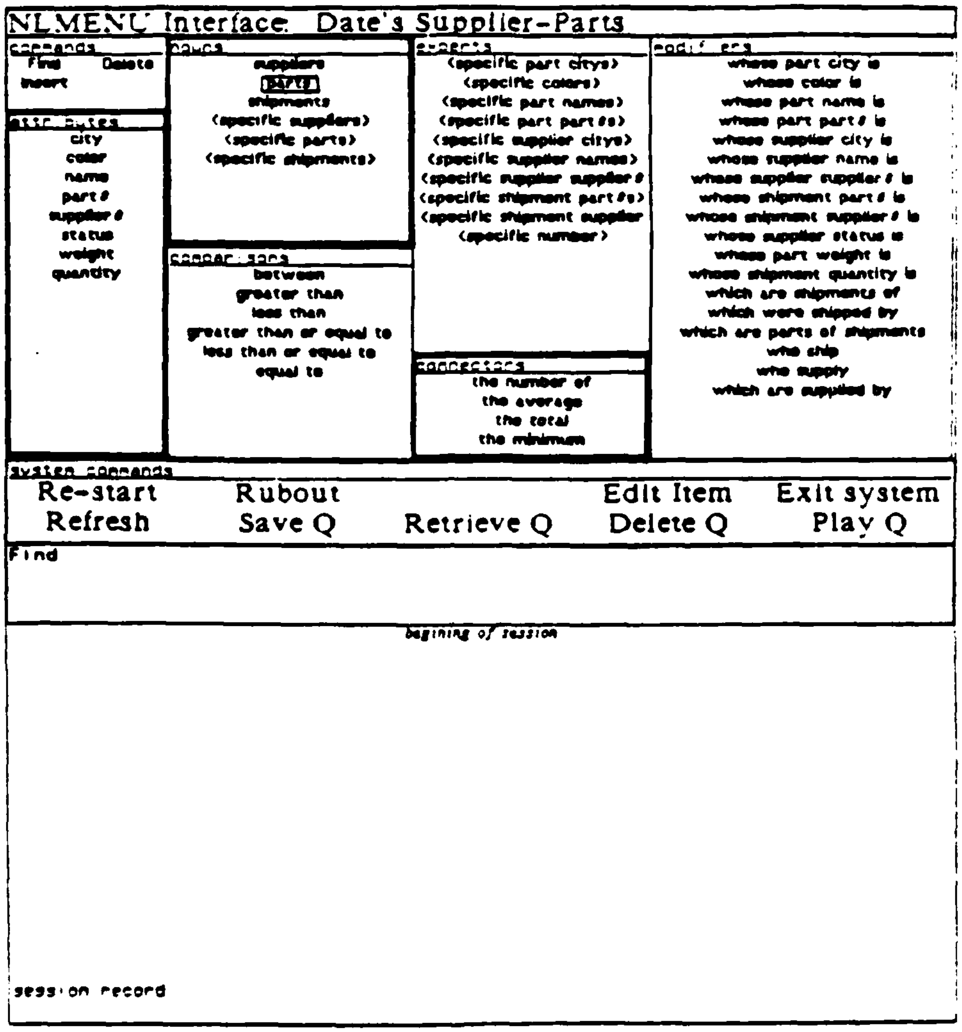


Figure 1-4: The User Chooses "Find"

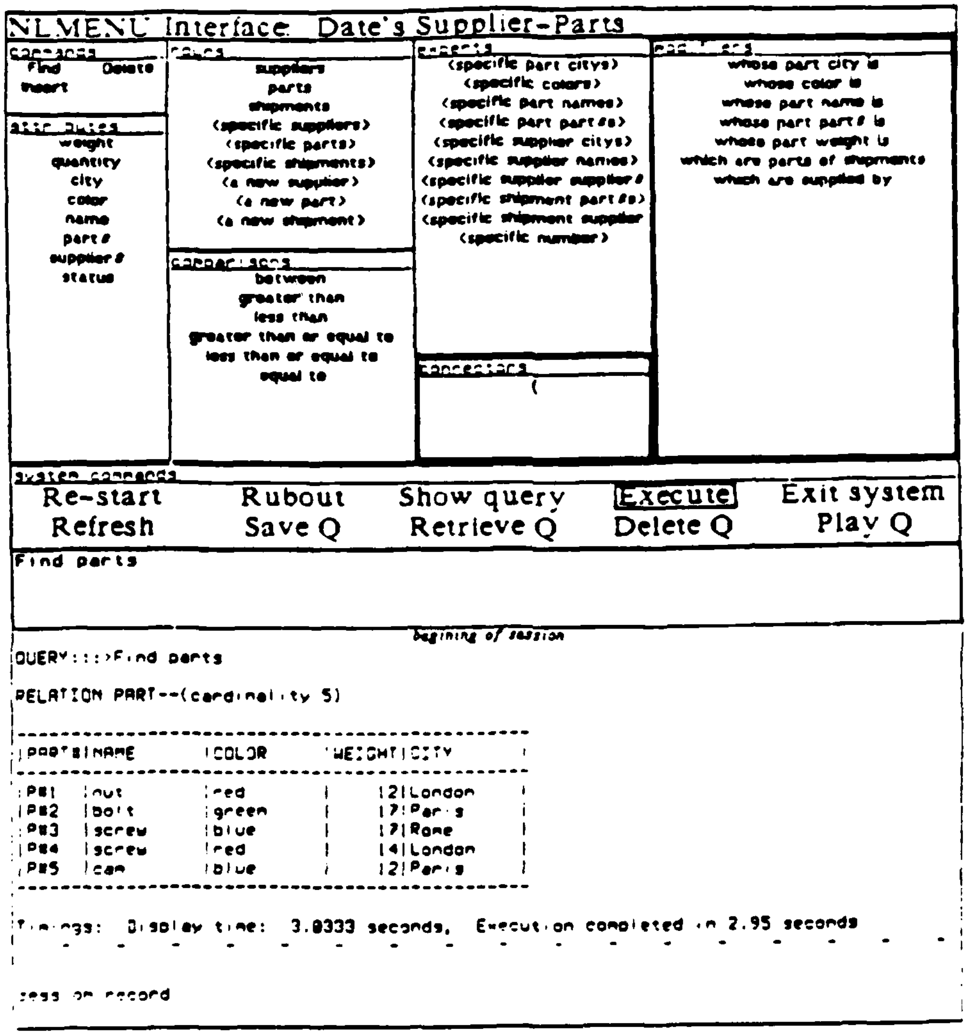


Figure 1-5: The User Executes "Find parts"

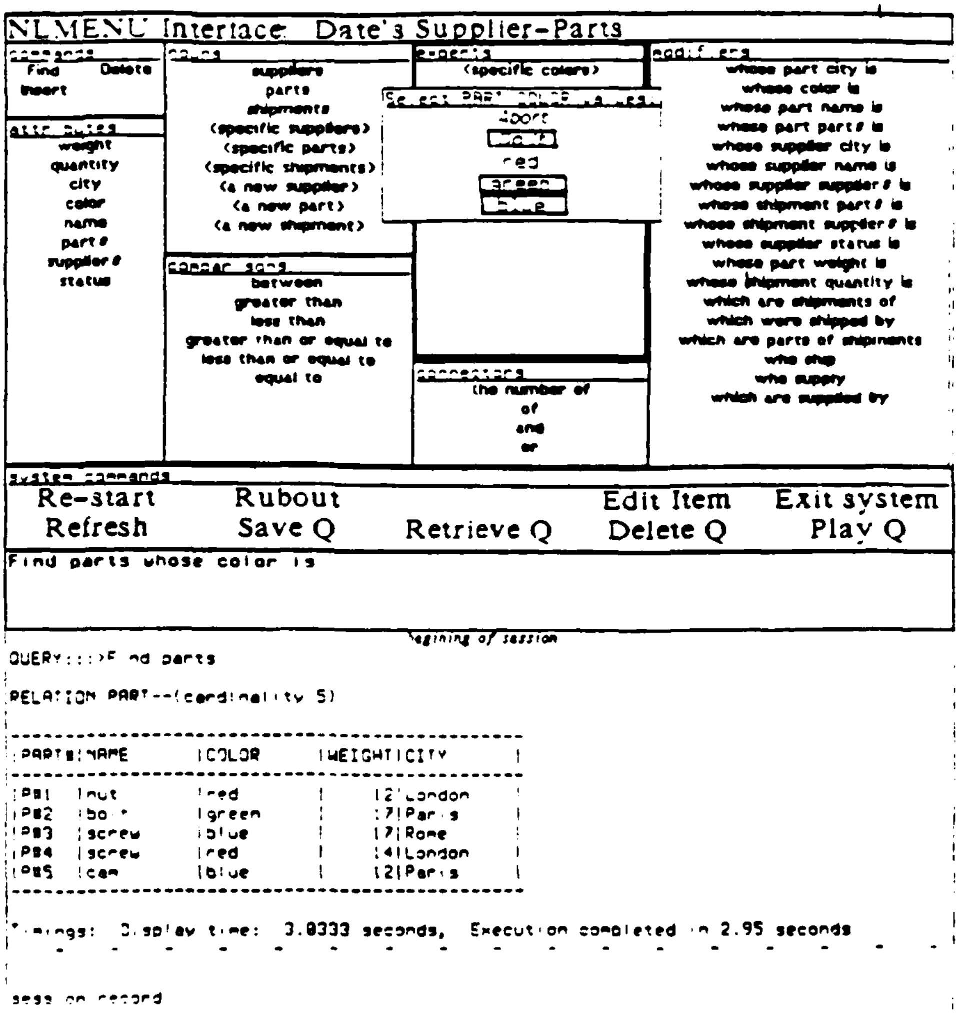


Figure 1-6: The Part Color Popup Expert

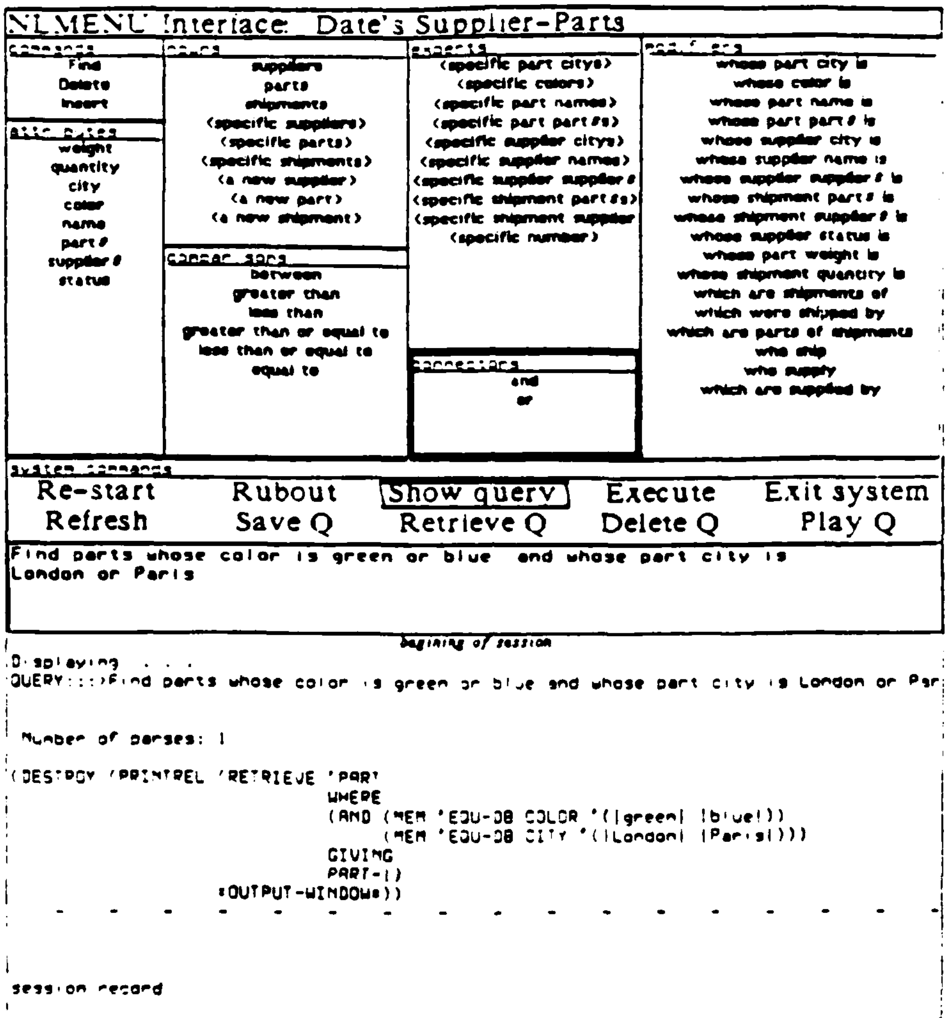
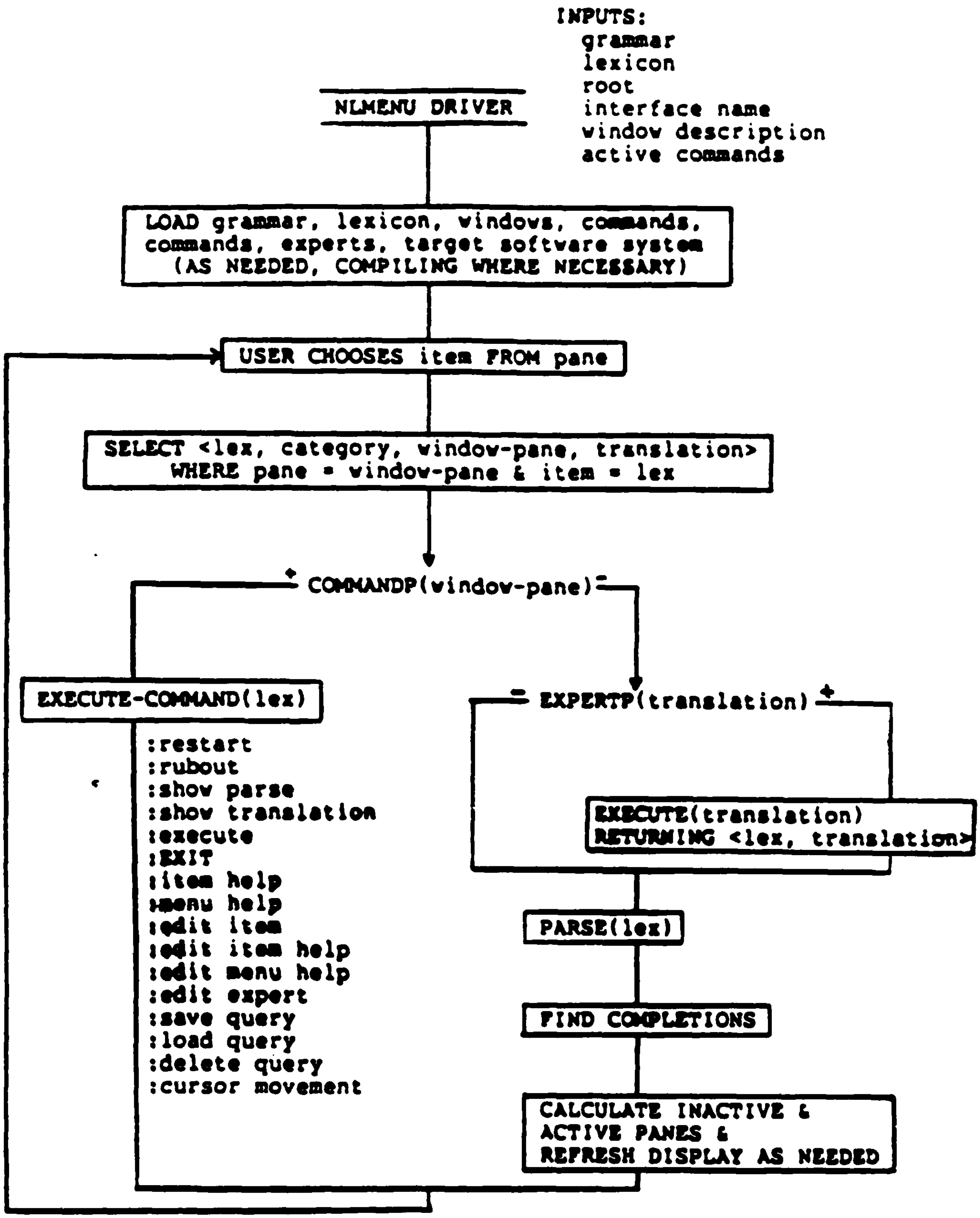


Figure 1-8: Show the translation of a Query

CONVENTIONAL NATURAL LANGUAGE	MENU-BASED NATURAL LANGUAGE
10 - 50% failure rate	0% failure rate
typing required	selection through pointing speech, typing
possible spelling errors	no spelling errors
"creating" a sentence is hard	"recognizing" a sentence is easier
no support for the user during query composition	supports the user during query composition
intimidates users	encourages exploration
users are assumed to be familiar enough with an application to ask questions	users can use NLMENU to explore a new application
user training is required to learn the limits of the system	much less training is required
specific 'help' on using the system is often not available	'help' on system features is only a mouse button away
mysterious about coverage -limitations are implicit -burden is on the user to infer the coverage of the system	obvious about coverage -makes limits explicit

Figure 1-13: Advantages of Menu-Based Natural Language for the End User



MAIN NLMENU INPUT LOOP

PROBLEM II: BUILDING INTERFACES CHEAPLY AND QUICKLY

- THE GOAL: TRANSPORTABLE NLIs

  If you can't make natural language interfaces cheaply, then they won't be widely used. Cost is a function of portability.

  Extremes in portability are: a system that requires complete reprogramming before porting -and- a system that requires no extra effort.

- STATE OF THE ART: AI Corporation's INTELLECT

  - costs around $60K for the system
  - requires two man-months for a trained interface designer to build a single interface
  - interfaces must be empiracally tuned
  - resulting interfaces have all the ease-of-use problems

  SO--NL interfaces will only be built for important applications and users will still need training

- TWO NLMENU SOLUTIONS

  - GRAMMAR WRITER'S TOOLKIT--available on PCs and Explorers

  - INTERFACE GENERATOR--available on Explorers

VARIETIES OF PORTABILITY

- machine and programming language independence: Lisp, C, ...
- source NL independence: English, ...
- target system independence: RTMS, SQL, PROLOG, ...
  db updates, graphs, info retrieval, ...
- application independence:

University	5/23	(#rel/#attr)
Supplier-Parts	3/12	
City Planner	2/32	
Military Demo	4/28	
System Relations	5/33	
Austin Restaurants	1/10	
Baseball Statistics	3/48	
Ladder Blue File	14/72	

- schema independence: EMP-DEPT-SAL DEPT-MGR vs
  EMP-MGR-SAL MGR-DEPT

  use views, defined fields, aliases, and value coercion but then display the schema

  issue: what about updates
- user independence: dbms rights on objects and operations and covered objects and views vary across users

Choose an NLMENU interface:

System Commands:
- Tutorial
- Build Interfaces
- Guided SQL -- Oracle 3.0
- Execute Saved Queries
- Report Writer

EXIT NLMENU SYSTEM

User-owned Interfaces:

Congressmen Toy Demo	THOMPSON	(A-TI-2)	01-08-83	14:40:05
+ Courses	THOMPSON	(A-TI-2)	12-20-82	15:22:19
Courses	THOMPSON	(A-TI-1)	12-20-82	13:29:20
Courses	THOMPSON	(A-SQL)	12-20-82	14:22:34
EG demo	THOMPSON	(A-EG)	12-20-82	14:00:00
OST Packages	THOMPSON	(A-TI-2)	12-20-82	14:00:00
Supplier-Parts	THOMPSON	(A-TI-2)	12-16-82	10:18:45
Supplier-Parts	THOMPSON	(A-TI-1)	12-16-82	10:55:20
Supplier-Parts	THOMPSON	(A-SQL)	12-16-82	10:56:30
TI DBMS Survey	THOMPSON	(A-TI-2)	12-20-82	14:00:00
Upcoming Conferences	THOMPSON	(A-TI-2)	01-14-83	19:22:56
Blue File	THOMPSON	(A-TI-2)	03-14-83	09:51:36
TQA	THOMPSON	(A-TI-2)	03-03-83	12:36:16
+ TQA	THOMPSON	(A-SQL)	03-03-83	12:36:16

Interfaces Granted to the user:

Supplier-Parts	SAENZ	(M)	12-16-82	09:45:32

Public Interfaces:

Jobshop demo	DAVIS	(A-TI-1)	12-25-82	16:27:32
Jobshop demo	DAVIS	(A-TI-2)	12-25-82	17:10:20
Jobshop demo	DAVIS	(A-SQL)	12-20-82	14:00:00
Baseball demo	ROSS	(A-TI-1)	12-10-82	12:40:23
Baseball demo	ROSS	(A-TI-2)	12-25-82	13:37:01
Baseball demo	ROSS	(A-SQL)	12-10-82	12:23:24

+ = Loaded Interface
M = Manually Generated, A = Automatically Generated
TI = Lisp Machine translations, SQL = SQL translations

TEXAS INSTRUMENTS, INC

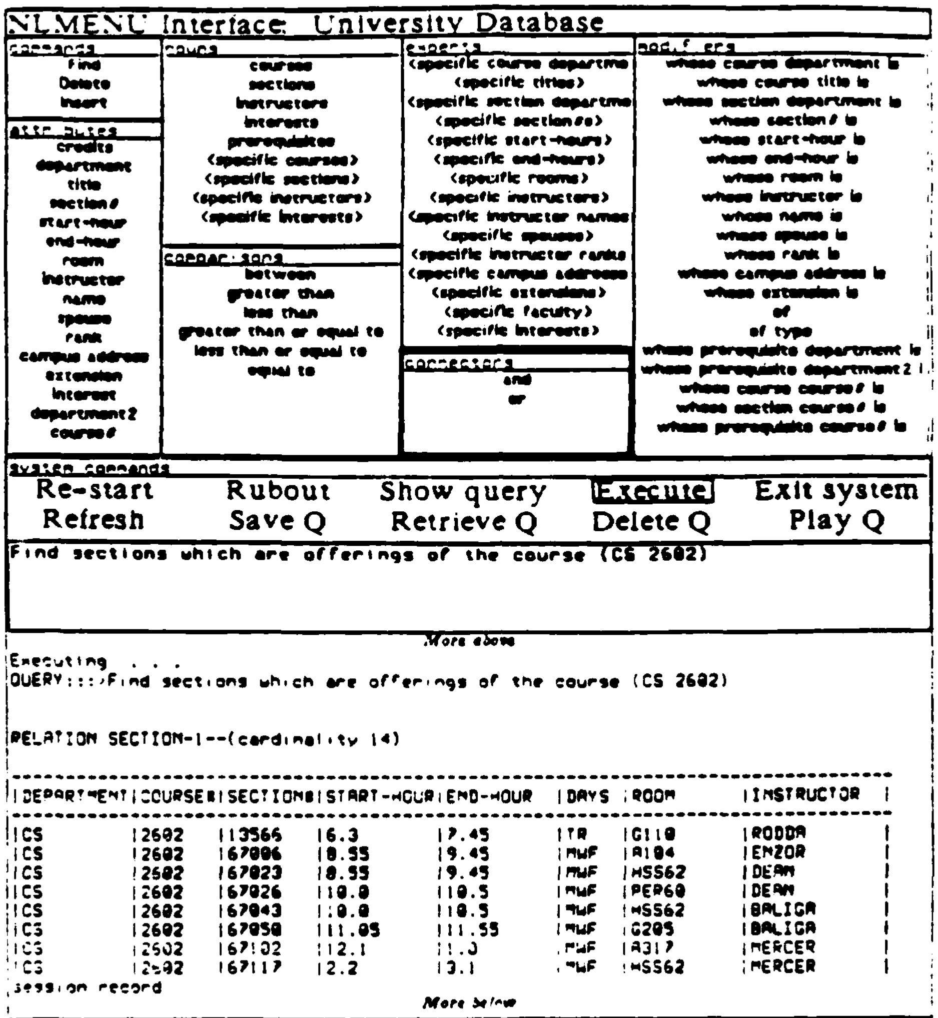


Figure 3-9: An NLMENU Interface to a University Database

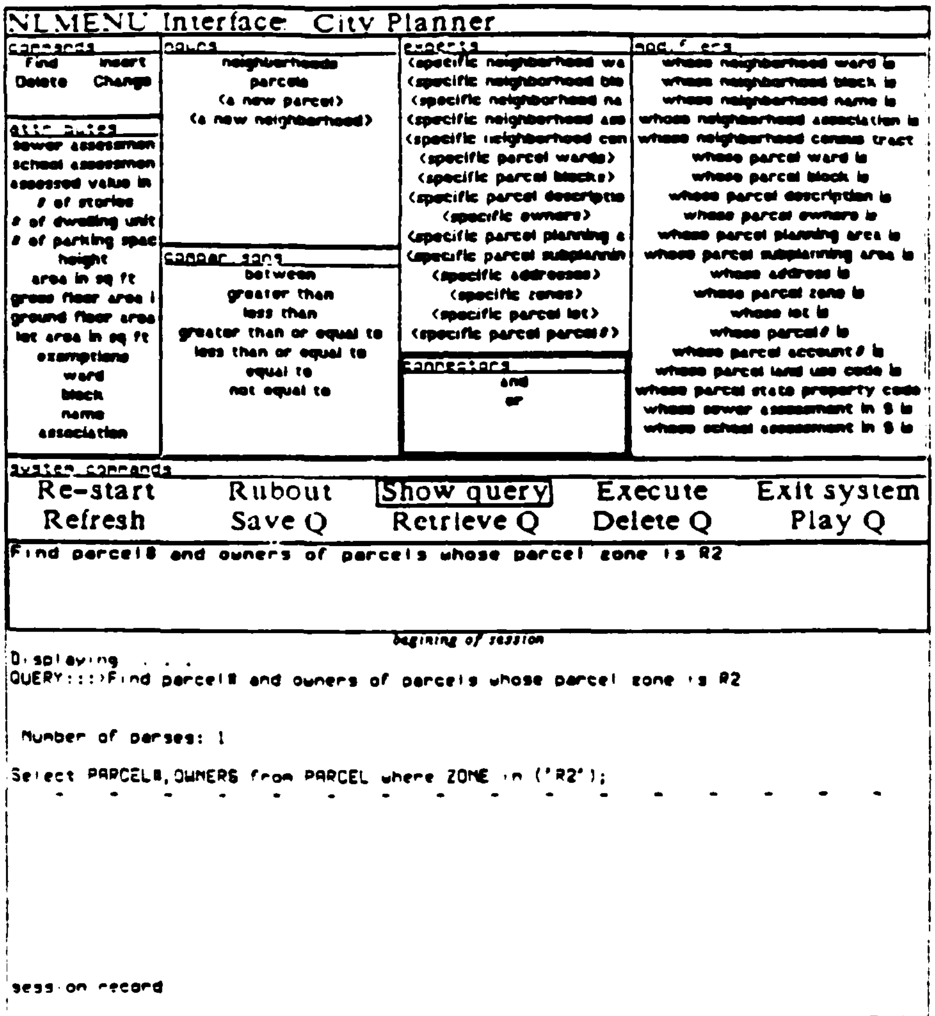


Figure 3-12: An NLMENU Interface to a City Planner Database

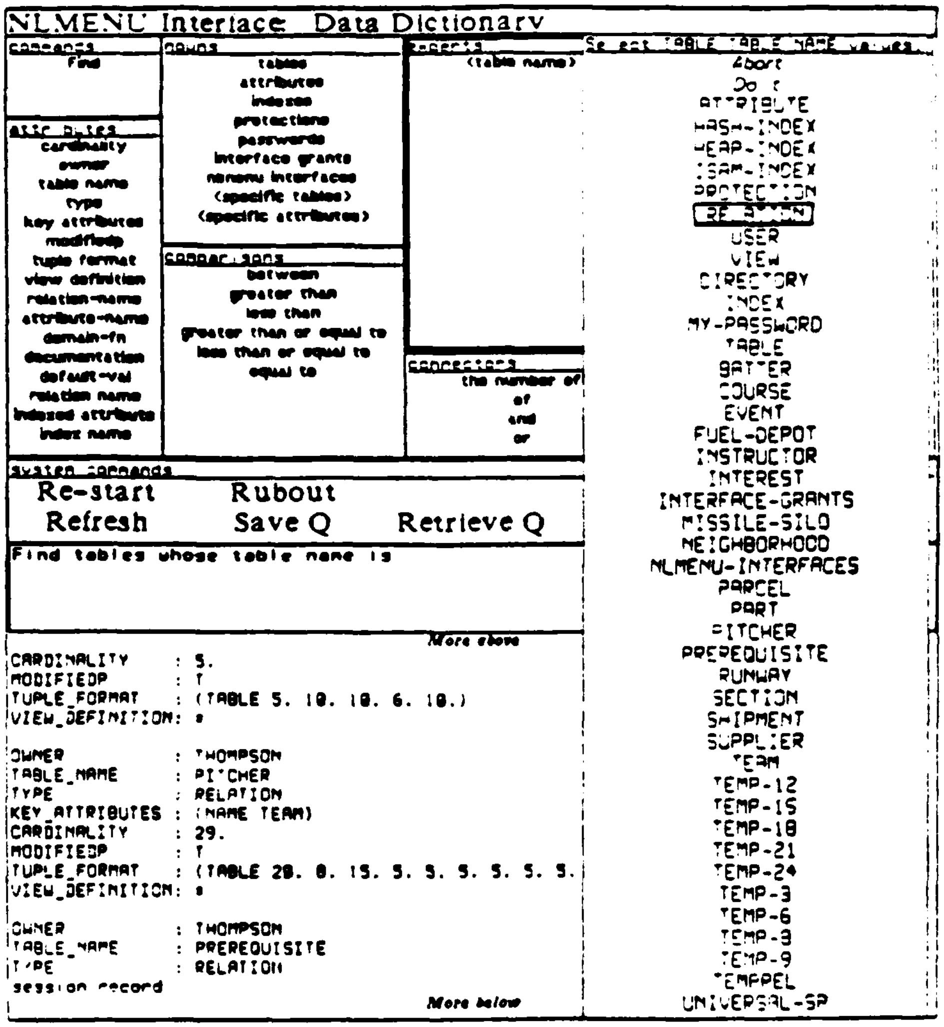


Figure 3-13: An NLMENU Interface to the System Relations

```
                S  -->  Find (PART-ATTRS of) parts (PART-MODS)
       PART-ATTRS  -->  PART-ATTR (and PART-ATTRS)
        PART-ATTR  -->  {color weight part# ...}
        PART-MODS  -->  PART-MOD (and PART-MODS)
         PART-MOD  -->  whose color is COLOR-VALUE
         PART-MOD  -->  whose weight is WEIGHT-VALUE
      COLOR-VALUE  -->  {red blue ...}
```

EX Find part# and weight of parts whose color is red

A SEMANTIC GRAMMAR

```
                S  -->  Find (<ENTITY>-ATTRS of) <entity>s (ENTITY-MODS)
   <ENTITY>-ATTRS  -->  <ENTITY>-ATTR (and <ENTITY>-ATTRS)
    <ENTITY>-MODS  -->  <ENTITY>-MOD (and <ENTITY>-MODS)
     <ENTITY>-MOD  -->  whose <ATTR> is <entity>-<ATTR>-VALUE
       where (ENTITY ATTR) in RETRIEVAL_TABLE_ATTRS

                                 +

RETRIEVAL-TABLE_ATTRS = ((part part#)(part color)(part weight) ...)
part-color-value      = {red blue ...}
part-weight           = integer
```

EX Find part# and weight of parts whose color is red

AN ATTRIBUTED GRAMMAR

CONVENTIONAL NATURAL LANGUAGE	MENU-BASED NATURAL LANGUAGE
recognition paradigm	generative paradigm
must handle ill-formed input	competence = performance
open-ended methodology	closed, controlled methodology control advantages of the NL generation paradigm
1 - 30 man-months per application	1 - 30 man-hours per application (see Chapter 3)
expensive to build and maintain applications	much cheaper to build and maintain applications
requires specially trained users to build usable interfaces to new applications	end users can build their own simple, usable interfaces to an important class of applications with less training
large grammars and lexicons	small grammars and lexicons
requires large memories and a larger processor burden	requires small memories and runs comfortably on a PC

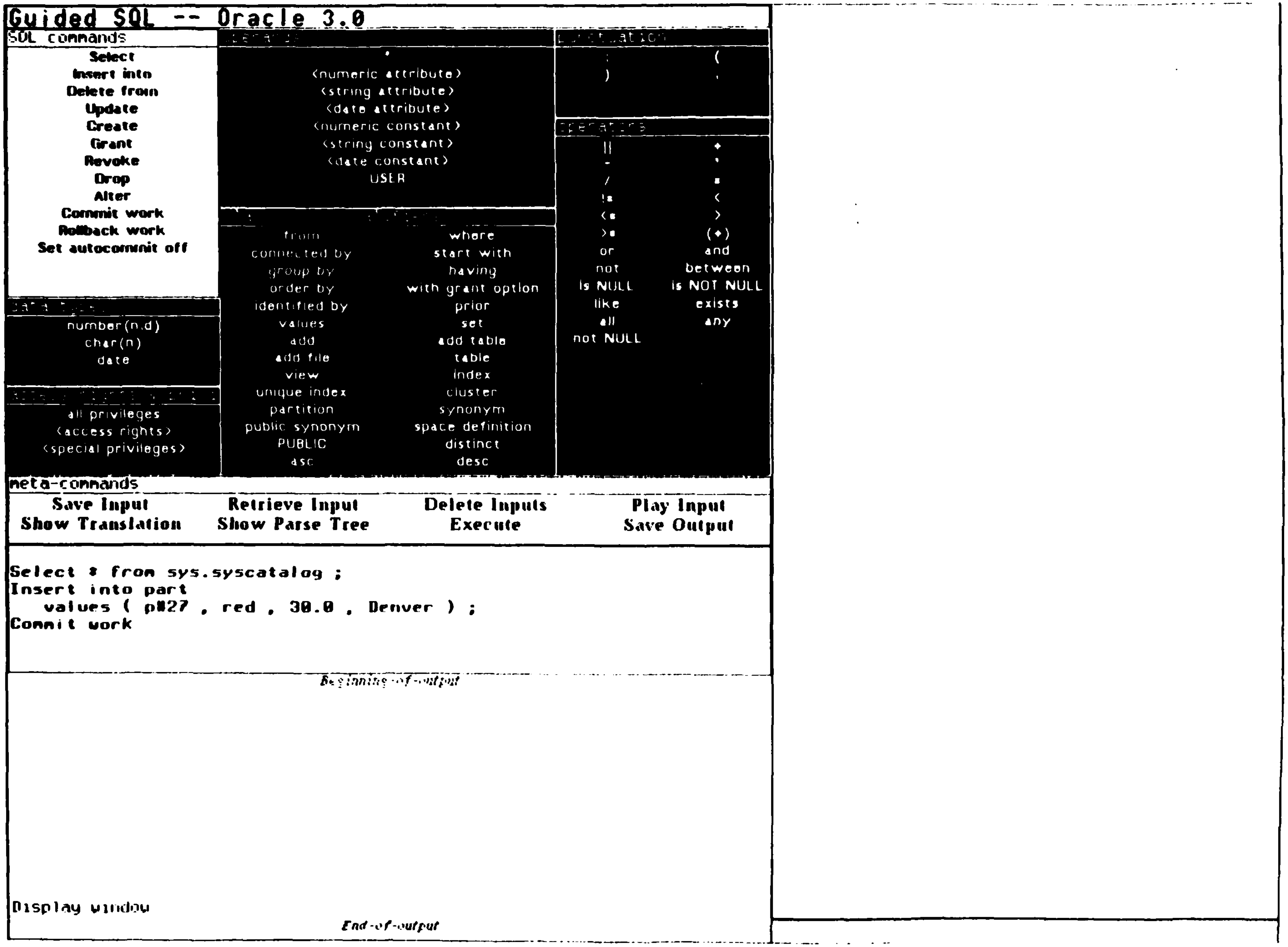
Figure 1-14: Advantages of Menu-Based Natural Language for the Interface Designer

PROBLEM III:

- o Grammar Writer's Toolbench
- o Guided SQL, Dow Jones, PC Focus
- o Complex Interfaces
- o "Define" and Anaphora
- o Information Retrieval Queries
- o Graph-valued Queries
- o Spatial DBMS Queries
- o The "Value Recognition" Problem & Library of Experts
- o Multiple Target DBMSs
- o Dynamic Attributed Grammar Lookahead Parser

GRAMMAR WRITER'S TOOLKIT

- well-formedness of the grammar and lexicon
  - syntax errors in grammar/lexicon/spec
  - find dangling references
- grammar tracing tools: batch tools
  sentence generator
  mouse-sensitive parse tree
- screen configuration tools
- edit items, experts, help interactively
- limited interactive define capability
- data collection tools (*in progress*)
- interface development environment (on the PC)
- interface generator for special domains


Guided SQL -- Oracle 3.0
SQL commands
Select
Insert into
Delete from
Update
Create
Grant
Revoke
Drop
Alter
Commit work
Rollback work
Set autocommit off
number(n,d)
char(n)
date
all privileges
<access rights>
<special privileges>
*
<numeric attribute>
<string attribute>
<date attribute>
<numeric constant>
<string constant>
<date constant>
USER
from
where
connected by
start with
group by
having
order by
with grant option
identified by
prior
values
set
add
add table
add file
table
view
index
unique index
cluster
partition
synonym
public synonym
space definition
PUBLIC
distinct
asc
desc
(
)
||
+
-
*
/
=
!=
<
<=
>
>=
(+)
or
and
not
between
is NULL
is NOT NULL
like
exists
all
any
not NULL
meta-commands
Save Input
Retrieve Input
Delete Inputs
Play Input
Show Translation
Show Parse Tree
Execute
Save Output
Select * from sys.syscatalog ;
Insert into part
values (p#27 , red , 30.0 , Denver) ;
Commit work
Beginning-of-output
Display window
End-of-output

actions
Find
Define
Delete
Insert
Modify
Map

nouns
ships
<specific ship>

features
Page Down

** Top **
all features of
<specific ship features>
<specific class
<specific ship clas
<specific unit f
<specific casualty mo
<specific convoy
<specific convoy mer
<specific employme
<specific move
<specific port
<specific readines
<specific ship positi
<specific weapon
<specific class wea
<specific last answ
<ship record
<class record

comparisons
betwee
greater t
less tha
greater or e

specific attributes
Page Down

** Top **
<map area>
<map point>

SHIPS
Done
Abort

Page Down
Enter Substring

:: Top of List ::
ADAMS, C F (DDG2) US
ADELAIDE STAR (BULK) UK
ADMIRAL FOKIN (CG854) UR
ADMIRAL GOLOVKO (CG855) UR
ADMIRAL ISAKOV (CG500) UR
ADMIRAL MAKAROV (CG501) UR

Enter Substring
KENN

AMERICA (CV66) US
AMERICA STAR (BULK) UK
AMPERMETR (AGI128) UR
AMSTELDIEP (BULK) NE
AMSTELHOCK (BULK) NE
AMSTELHOF (BULK) NE
AMSTELKROON (BULK) NE
AMSTELMEER (BULK) NE
AMSTELMOLEN (BULK) NE
AMSTELSLUIS (BULK) NE
AMSTELSTAD (BULK) NE

modifiers
Page Down

** Top **
whose distance is
with ship uic
with ship vessel control #
with ship intl radio call sign
with ship ship name
with ship ship type
with ship hull #
with ship high interest designator
with ship nationality of registration
with ship nationality of owner
with ship hull type
with ship propulsion fuel type
with ship doctor onboard
with class class name
with class ship type
with class nationality of registration
with ship class uic
with ship class vessel control #
with ship class class name
with unit uic
with unit unit name
with unit ship embarked on
with unit name of co
with unit rank of co

system commands
Re-start
Suspend
Rubou
Output Window
Save Query
Retrieve Query

Find NATIONALITY-OF-REGISTRATION, MAX-SPEED, and MAX-SPEED-RANGE of

begining of session

QUERY:::>Find NATIONALITY-OF-REGISTRATION, MAX-SPEED, and MAX-SPEED-RANGE of ships

UIC	VESSEL-CONTROL-#	NATIONALITY-OF-REGISTRATION	MAX-SPEED kt	MAX-SPEED-RANGE nm
-	9001	US	17	20000
-	11002	US	17	20000

More below

A TOY INFORMATION RETRIEVAL GRAMMAR FOR NLMENU

```
S                 --> Find  REFERENCES-NP  ( Price_them ) ( Order_them )
REFERENCES-NP     --> { references  <reference_subtypes> }  ( REFERENCE-MODS )
REFERENCE-MODS    --> REFERENCE-MOD  ( and  REFERENCE-MODS )
REFERENCE-MOD     --> whose_authors_include  <authors_expert>
                  --> whose_time_of_publishing_was
                      {[between <date> and <date>] [before <date>] [after <date>]}
                  --> whose_topic_involves SEARCH-TERMS
SEARCH-TERMS      --> <search_term_typein> ({and or but_not} SEARCH-TERMS)
```

EX   Find journal articles and papers in conferences
     whose authors include THOMPSON, C* and
     whose topic includes "menu*based" but not "update"

THE MAIN ADVANTAGE here is that the user does not need to learn the syntax of the target query languages or their semantic capabilities.

THE MAIN DISADVANTAGE is that a grammar approach by itself may be too constraining. Some "direct manipulation" approach to narrowing the query set may be better.

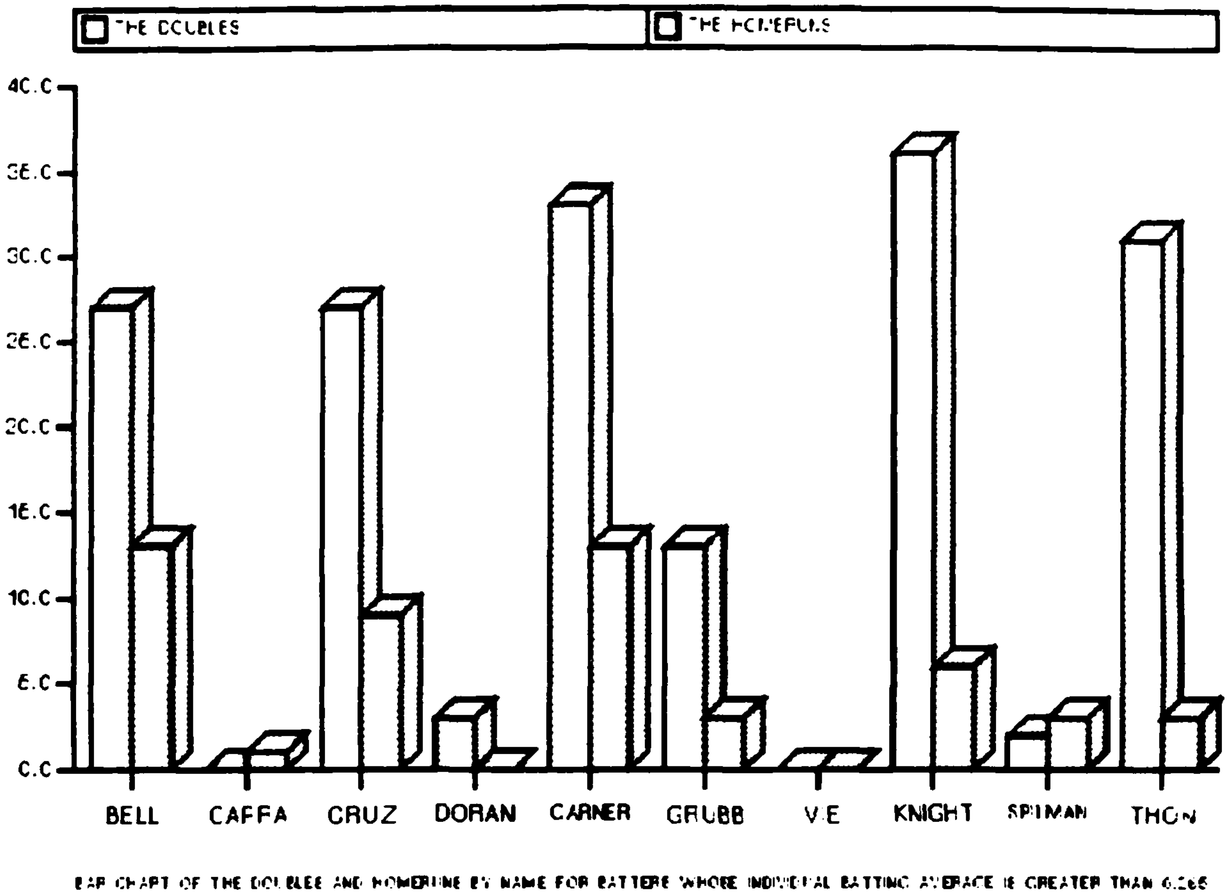


Figure 9: A Bar Chart of the doubles and homeruns by name for batters whose individual batting average is greater than 0.265

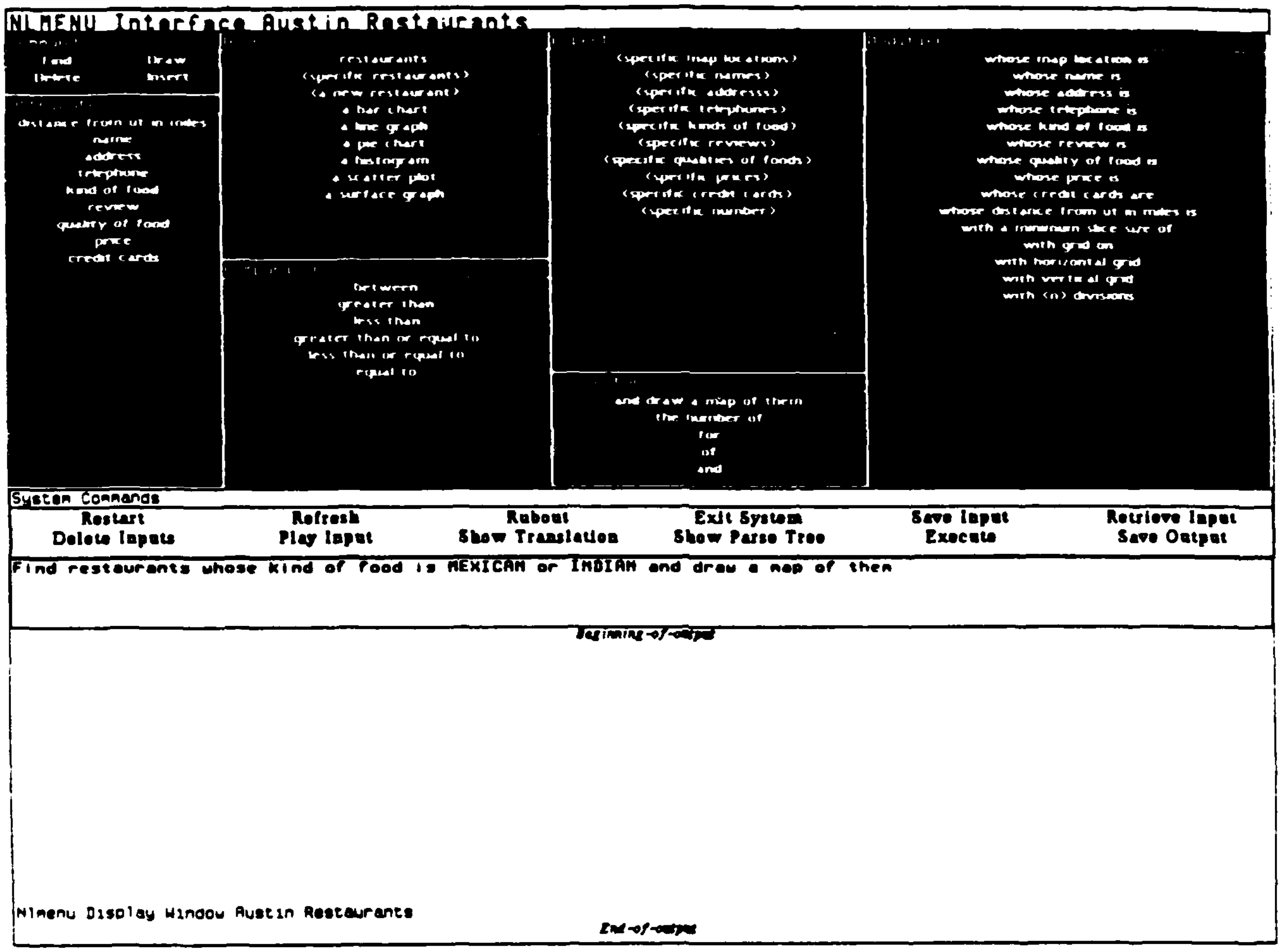
Graph Window 1

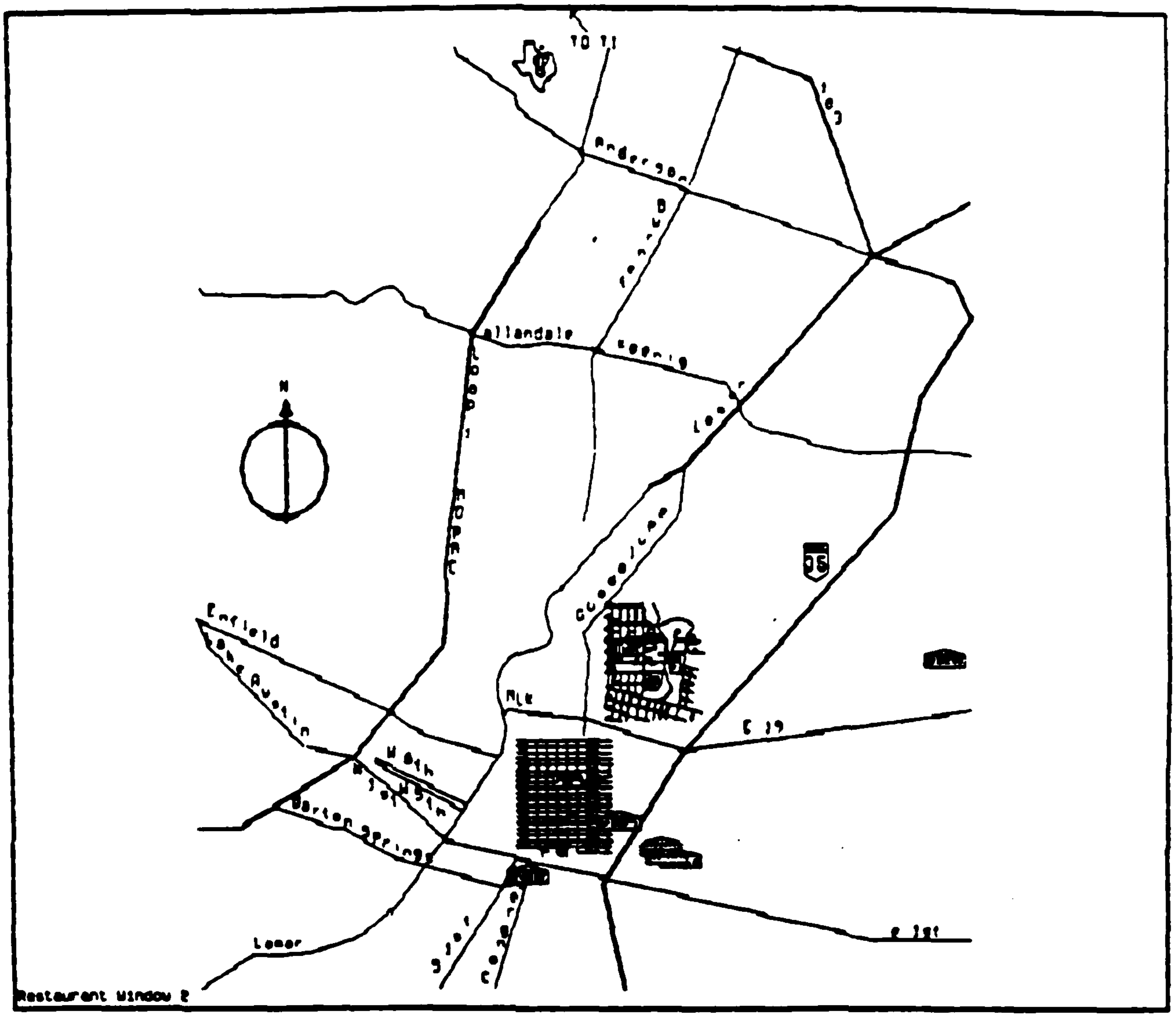
SAMPLE SPATIAL QUERIES

```
EX  Find homes which are located in Plano east of Central and
               which range in price from 70K to 100K and
               which are "for sale by owner" and
               which have 4 bedrooms and
               which are located within 1/2 mile of an elementary school
    and draw them
```

```
EX  Find lakes whose size is greater than 5 acres and
               whose boundary is more than 50% owned and
               which are located less than 2 miles from I30 and I35 and
               which are located less than 30 miles from Dallas
    and draw them
```

```
EX  Draw a posted map on paper
      using photodot and using scale 1" = 2000'
      that shows tight hole wells
      whose location is between 30 and 31 latitude and
                                80 and 81 longitude,
      that were drilled by Texaco
      that were drilled between May 1, 1970 and May 1, 1980,
      that show oil deeper than 2000',
      that have well depth deeper than 5000',
      that are now operated by Shell,
      that are wildcat wells,
      that have a drilling problem,
      that have mechanical logs and
      that have oil analysis available   ;an Explorer-like query
```


NLMENU Interface Austin Restaurants
Find
Draw
Delete
Insert
distance from ut in miles
name
address
telephone
kind of food
review
quality of food
price
credit cards
restaurants
(specific restaurants)
(a new restaurant)
a bar chart
a line graph
a pie chart
a histogram
a scatter plot
a surface graph
between
greater than
less than
greater than or equal to
less than or equal to
equal to
(specific map locations)
(specific names)
(specific addresss)
(specific telephones)
(specific kinds of food)
(specific reviews)
(specific qualities of foods)
(specific prices)
(specific credit cards)
(specific number)
and draw a map of them
the number of
for
of
and
whose map location is
whose name is
whose address is
whose telephone is
whose kind of food is
whose review is
whose quality of food is
whose price is
whose credit cards are
whose distance from ut in miles is
with a minimum slice size of
with grid on
with horizontal grid
with vertical grid
with (n) divisions
System Commands
Restart
Refresh
Rubout
Exit System
Save Input
Retrieve Input
Delete Inputs
Play Input
Show Translation
Show Parse Tree
Execute
Save Output
Find restaurants whose kind of food is MEXICAN or INDIAN and draw a map of them
Beginning-of-output
Nlmenu Display Window Austin Restaurants
End-of-output



TO 71
Anderson
Allandale
Koenig
Enfield
Lamar
Barton Springs
MLK
E 19
W 6th
W 5th
e 1st
35
N
Restaurant Window 2

SYSTEM BLOCK DIAGRAM

"Display highways passing through Dallas"

↓

NLMenu

↓

```
(JOIN* FROM (CITY HIGHWAY)
   WHERE (AND (EQUAL CITY.NAME "DALLAS")
              (INTERSECT_P CITY.BOUNDARY HIGHWAY.BOUNDARY))
   TUPLES T
   PROJECT (CITY.BOUNDARY HIGHWAY.BOUNDARY))
```

↓

RTMS Database with GWIN graphic objects

City Table

Name	Boundary	Pop.
Austin		.5 M
Dallas		1.0 M
Houston		1.5 M

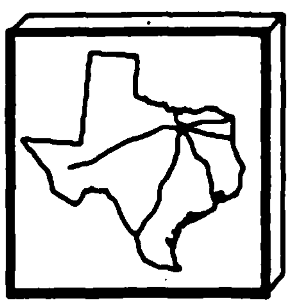
Highway Table

ID	Boundary
I 10	
I 20	
I 30	

↓

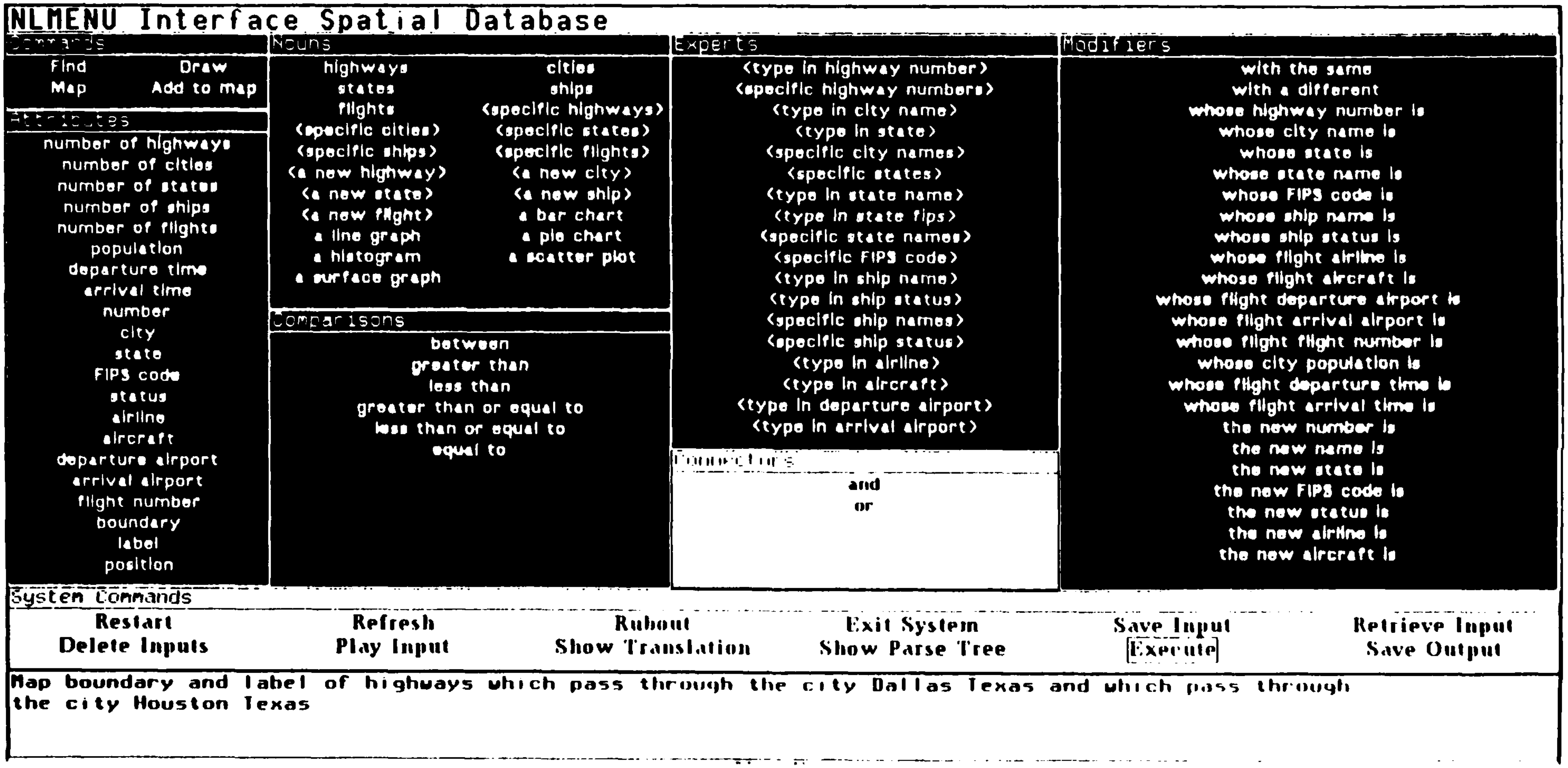
(obj1 obj2 obj3 ... objn)

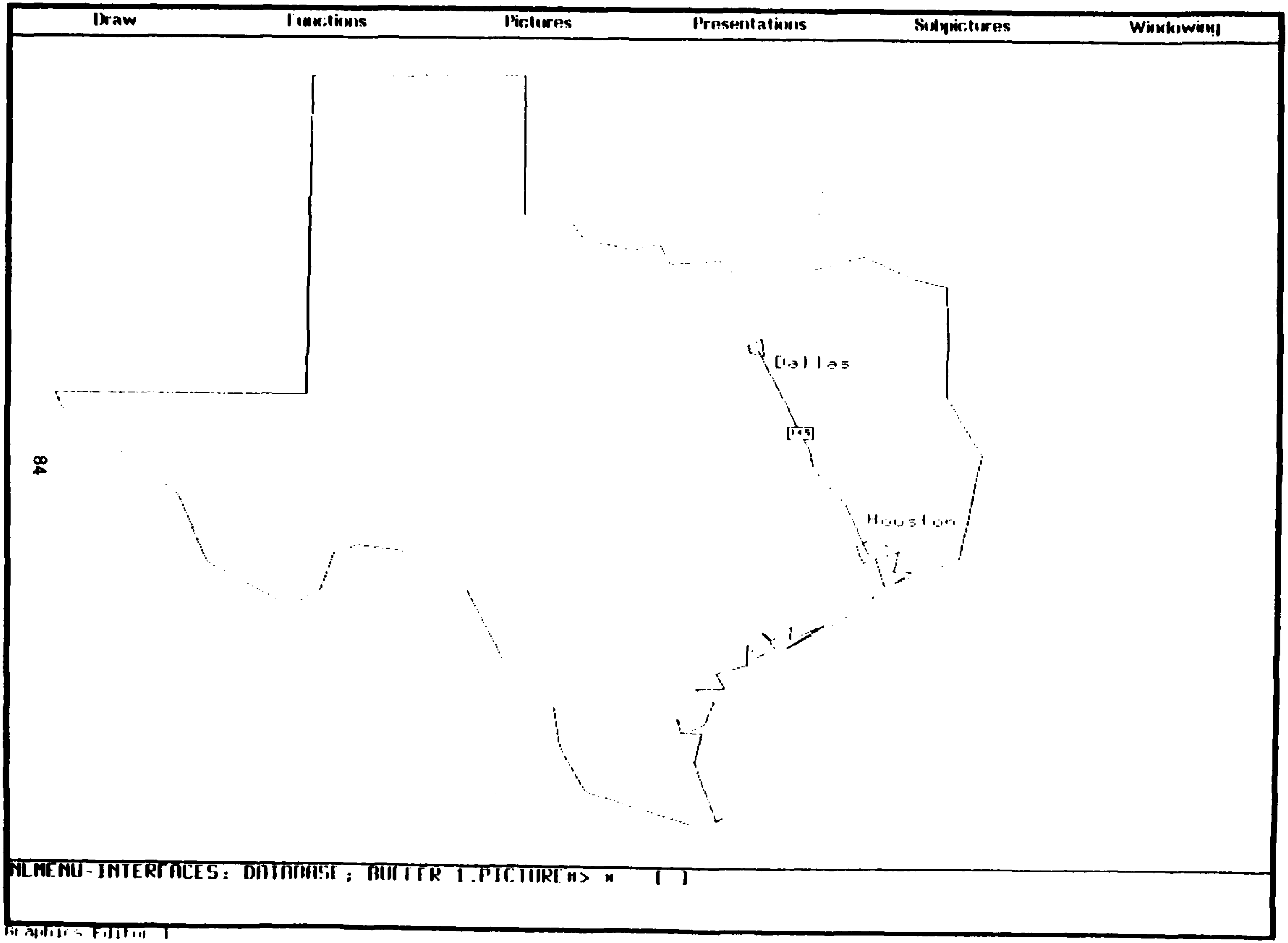
↓



GED

Display


NLMENU Interface Spatial Database
Commands
Find
Draw
Map
Add to map
Attributes
number of highways
number of cities
number of states
number of ships
number of flights
population
departure time
arrival time
number
city
state
FIPS code
status
airline
aircraft
departure airport
arrival airport
flight number
boundary
label
position
Nouns
highways
cities
states
ships
flights
<specific highways>
<specific cities>
<specific states>
<specific ships>
<specific flights>
<a new highway>
<a new city>
<a new state>
<a new ship>
<a new flight>
a bar chart
a line graph
a pie chart
a histogram
a scatter plot
a surface graph
Comparisons
between
greater than
less than
greater than or equal to
less than or equal to
equal to
Experts
<type in highway number>
<specific highway numbers>
<type in city name>
<type in state>
<specific city names>
<specific states>
<type in state name>
<type in state fips>
<specific state names>
<specific FIPS code>
<type in ship name>
<type in ship status>
<specific ship names>
<specific ship status>
<type in airline>
<type in aircraft>
<type in departure airport>
<type in arrival airport>
Connectors
and
or
Modifiers
with the same
with a different
whose highway number is
whose city name is
whose state is
whose state name is
whose FIPS code is
whose ship name is
whose ship status is
whose flight airline is
whose flight aircraft is
whose flight departure airport is
whose flight arrival airport is
whose flight flight number is
whose city population is
whose flight departure time is
whose flight arrival time is
the new number is
the new name is
the new state is
the new FIPS code is
the new status is
the new airline is
the new aircraft is
System Commands
Restart
Delete Inputs
Refresh
Play Input
Rubout
Show Translation
Exit System
Show Parse Tree
Save Input
Execute
Retrieve Input
Save Output
Map boundary and label of highways which pass through the city Dallas Texas and which pass through
the city Houston Texas


Draw
Functions
Pictures
Presentations
Subpictures
Windowing
Dallas
Houston
NLMENU-INTERFACES: DATABASE ; BUFFER 1.PICTURE#> *
Graphics Editor 1

THE "VALUE RECOGNITION" PROBLEM

- THE PROBLEM involves managing that part of the lexicon concerned with database values in queries or commands

- TWO SUBPROBLEMS

  A. recognizing the types of values
  B. associating NL values with the corresponding DB values

- TRADITIONAL APPROACHES

  1. put values in the lexicon
  2. use the database as an extension of the lexicon
  3. avoid representing values by using value patterns
  4. avoid representing values by using surrounding context

- NLMENU SOLUTION: based on "interaction experts"

  solve problem A by letting user choose types
  solve problem B by supporting value specification

- BONUS: a library of experts

HOW EXPERTS SOLVE THE "VALUE RECOGNITION" PROBLEM

I. THE PROBLEM OF LEXICAL AMBIGUITY OF VALUE TYPES IS AVOIDED

at query composition, precise category terms are included in the user's menus so there is no need to guess at a most plausible category or engage in after-the-query, menu-based clarification dialogue

o mirrors detailed operational distinctions

EX ships - whose weight is - <gross weight>
- <dead weight>

o does not require the detailed application-specific knowledge that Schwartz suggested

EX Show me - oil wells - whose drill date is - <drill date>
- whose well depth is - <well depth>
- whose map scale is - <map scale>
- whose location is - <location>

II. THE PROBLEM OF SPECIFYING VALID FIELD VALUES IS MADE TRACTABLE

the selected interaction expert then pops up specialized displays, tailored to the type of a data item, allowing fine tuning of methods for specifying values.

Experts can support the user using the same techniques that data entry interfaces employ.

o Experts can have HELP messages associated with them documenting a semantic domain or attribute-role.

o Experts can validate data items including range checking and format checking.

o Experts can handle errors associated with specifying invalid values.

o Experts can convert user specified values from an external form to an internal encoded form.

o Naturally, experts can not guarantee that the user specifies the value he meant to, only that the value he specified is a valid domain value.

A "LIBRARY OF EXPERTS" YIELDS PORTABILITY

- The NLMENU system defaults to simple experts and is customizable as more complex experts are needed, so users pay a small price for bringing up an application and a larger one only for customizing important applications.
- When special purpose experts can be selected from the library of experts, the cost of building new experts is reduced.
- When special purpose experts must be added, they can be added to the library to reduce the cost of building future applications.

TAXONOMY OF EXPERTS

typein experts

calculator menu experts

units experts

range experts

single/multiple and/or experts

tree menu experts

project expert

domain expert

coded field experts

compound field expert

icon experts

form expert

composite expert

INTERFACING NLMENU TO MULTIPLE DBMS'

I. GENERAL SESSIONER MENU & SYSTEM RELATIONS & INTERFACE GENERATOR

--> create, modify, keep track of, and destroy interfaces

a. core grammar/lexicon with SQL translations

b. core grammar/lexicon with RTMS translations

c. core grammar/lexicon with PROLOG translations

d. ... << it takes 1+ days to add a new target DBMS
<< about 30 lexical translations must be rewritten

II. COMBINING INTERFACES TO THE SAME TARGET DBMS

--> combine PORTABLE SPECs

or

combine generated grammars and lexicons

III. COMBINE INTERFACES TO DIFFERENT TARGET DBMS'

--> easy case: no spanning queries -- combine grammars

harder case: spanning queries -- join phrase has a semantics that requires copying from dbms1 to dbms2. Not implemented yet.

DYNAMIC ATTRIBUTED GRAMMAR LOOKAHEAD PARSER

- o binds domain-specific parameters to a generic grammar at execution time
- o implemented in Prolog
- o ADVANTAGES:
  - o user can change the domain model at execution time
  - o more complex domains can be accomodated
  - o more powerful language constructions are possible

IV CONCLUSIONS

- Near-Term Directions for NLMenu
- Design Considerations--Technical Limits of MBNL
- Is NLMenu "English" Real Natural Language

FUTURE DIRECTIONS

- o IMPROVED COVERAGE

    - o better grammar, database and system coverage is possible

        EX cover INTELLECT
        EX French NLMenu
        EX cover SQL
        EX cover linear programming, CAD applications, software dev.
        EX NLMenu interfaces to expert systems
        EX NLMenu database update grammars
        EX NLMenu interfaces to multiple remote heterogeneous databases like FOCUS, SQL, and Dialog
        EX NLMenu as the hub of the information center

- o CONTEXT SENSITIVITY & STRUCTURE EDITING

    - o when to apply semantics

- ✓ o SIMULTANEOUS EXECUTION & CACHING SUBQUERIES

    - o query reformulation is an iterative process

- ✓ o COOPERATIVE RESPONSE MEETS QUERY OPTIMIZATION

- o SIMULATION-VALUED QUERIES & REAL-TIME DATABASE APPLICATIONS

- o NATURAL LANGUAGE INSPECTOR & ACTIVE MULTI-MEDIA MAIL

- o INFORMATION PRESENTATION

    - o mixing NL and displays of forms, trees, etc

- o SUBLANGUAGE MODULARITY

    - o combining interfaces, turning grammar modules on/off

- o LIMITATIONS & HUMAN FACTORS TESTING

    - o can end-users translate their queries to NLMenu
    - o can end-users build their own interfaces
    - o are NLMenu interfaces effective and useful?

SUMMARY OF PLENARY WORKSHOP ON EXPERT KNOWLEDGE SYSTEMS

Linda C. Smith
University of Illinois

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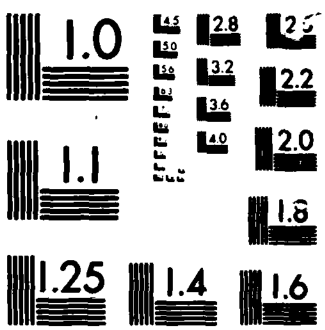
UNCLASSIFIED M E POWELL MAY 86 DTIC/TR-86/10 F/G 9/2 NL



MICROCOP CHART

Plenary Workshops on Expert Knowledge Systems

The discussions on expert knowledge systems were wide-ranging, not limited to the questions on this topic posed by the conference organizers. Although difficult to summarize, major points in the discussion can be presented in a question-and-answer format, reflecting the questions which were in fact discussed.

1. What is an expert system?

The discussion demonstrated that there was not a shared view of what was meant by the term "expert system." Craig Thompson observed that the term is not used consistently in the AI community--it can denote either the rule-based system providing expert assistance in a narrow domain or any component of a system which embodies knowledge and performs intelligently on a particular subtask. It is likely that the latter sense rather than the former is what may apply in enhancing information retrieval systems. In trying to map out possible relationships between AI and IR, we should not prematurely focus only on expert systems, but consider the broader range of AI tools and techniques which are becoming available. To date, AI researchers have focused on question-answering systems, but those of us in bibliographic information retrieval think that it is an interesting and challenging domain worthy of attention as well.

2. What are the contents of the knowledge base?

In the narrow definition of expert system, the focus is on encoding expertise which resides in the minds of experts. But in information retrieval, the knowledge base to which we want to provide access is multi-faceted: bibliographic, numeric, factual, full text, graphics (even notes on napkins).

3. What is an "expert" searcher? What do we know about searcher expertise?

Research studies of searcher behavior and performance have begun to give us an understanding of how searchers interact with online systems, but there is a need for more study of cognitive processes used in search strategy development and how these affect the outcome of a search. Expertise may be tied to particular databases and/or types of search requests. The notion of a "script" is one example of an effort being made to capture the knowledge of an expert searcher in a form which others can use.

4. How do we try to implement enhancements to existing retrieval systems?

In this context it is useful to remember two methods identified in AI research: simulation/modeling where one models the human searcher's approach to the problem vs. performance where one uses machine-based techniques which do not model human techniques but which lead to improved performance.

5. How should we evaluate the performance of an expert IR system?

One possible model is by analogy to Turing's test--if the results of a search performed by the end user with an expert retrieval system are comparable to those achievable by a human expert searcher, then it is reasonable to use the retrieval system in lieu of the human intermediary.

6. What are the questions?

In the past we have perhaps focused our attention too much on the answers (as embodied in databases of various kinds) rather than on the questions. What are the sorts of questions people ask? Why are they looking for information? What level of information is required? Which questions are amenable to processing by existing IR systems? Which could be processed by an enhanced or expert IR system? To match new and more powerful tools to the needs of users, we need a better understanding of what questions people ask. Reference librarians and expert online searchers are a resource to be tapped in helping us better understand the types of questions people have.

In conclusion, we did not spend time talking about available tools (e.g., AI machines as described in the October 1 issue of Business Week or the expert system software as marketed for microcomputers, minicomputers, and mainframes). The discussion groups concluded that use of these tools must be preceded by study of human factors--understanding information retrieval as a problem domain and user needs--as suggested by the questions and answers used to structure this summary.

Computer Interfaces and Intermediaries for Information Retrieval FINAL AGENDA

Introduction - Marjorie Powell, Program Analyst, Defense Technical Information Center

Welcome - Richard D. Douglas, Director, Office of Information Systems and Technology

Commerce Energy NASA Defense Information Progress Report - Gladys Cotter, Technical Information Specialist, Defense Technical Information Center

Keynote - Martha Williams, Professor of Information Science, Coordinated Science Laboratory of the College of Engineering, University of Illinois

Session I Automated Information Systems: The Human Element

Session Moderator: William Bollinger, Information Specialist, Technology Information System, Lawrence Livermore National Laboratory

Panel Presentations and Discussion

Panelists:
Marcia Bates, Associate Professor, Graduate School of Library and Information Science, University of California at Los Angeles

Christine Borgman, Assistant Professor, Graduate School of Library and Information Science, University of California at Los Angeles

Emily Fayen, Director, Library Automation, Baker Library, Dartmouth College

Carol Fenichel, Director of Library Services, Joseph W. England Library, Philadelphia College of Pharmacy and Science

W. David Penniman, Director, Libraries and Information Systems, AT&T Bell Labs.

SESSION II Command Languages

Session Moderator, William Leigh, College of Science and Technology, University of Southern Mississippi

Panel Discussion

Panelists:
Charles Hildreth, Office of Research, OCLC, Chairperson of National Information Standards Organization (Z39) Subcommittee G, Common Command Language for Use in Interactive Information Retrieval

Michael Monahan, GEAC Computers International, Markham, Ontario, Canada

Alan E. Negus, Consultant in Information Systems and Service, Biggleswade Beds., England

Joint Presentation on Integration of Command Languages with Intelligent Gateways:

Viktor E. Hampel, Project Leader, Technology Information System, Lawrence Livermore Laboratory

Hilary Burton, Project Leader, Interagency Computer Network, Technology Information System, Lawrence Livermore National Laboratory

Vendor Presentations

- Dana Ellingen, Menlo Corporation, In-Search
- Helen Bell, SDC, Searchmaster
- Betty Davis, Informatics, PC/NET
- Richard Kollin, Data-Ease, IT
- David Toliver, ISI, Sci-Mate

Session III
Intermediary Systems

Session Moderator: Gladys Cotter, Technical Information Specialist, Defense Technical Information Center

Panel Presentations

Panelists:
Rita Bergman, Branch Manager, Research and Systems Business Development, Computer Corporation of America

Tamas Doszkocs, Special Assistant for Research and Development, Specialized Information Services, National Library of Medicine

Richard Marcus, Principal Research Scientist, Laboratory of Information Decision Systems, M.I.T.

David Toliver, Manager, Software Development, ISI

Session IV
Artificial Intelligence, Future Directions

Session Moderator: Hilary Burton, Project Leader, Interagency Computer Network, Technology Information System, Lawrence Livermore National Laboratory

Panel Presentation

Panelists:
Lionel Bernstein, President, Knowledge Systems, Inc.

Gabriel Jakobson, Senior Member, Technical Staff, Computer Science Laboratory, GTE Laboratories

Linda Smith, Associate Professor of Library Science, University of Illinois

Craig Thompson, Member of Technical Staff, Central Research Lab., Texas Instruments

Plenary Workshops

The following topics will be introduced by the respective chairpersons to the plenary session:

- o Common Command Language - Charles Hildreth
- o Front Ends - Richard Marcus
- o Expert Knowledge Systems - Linda Smith

Attendees will be asked to participate in all three workshops on a rotating basis. The chairpersons will summarize the contributions for presentation on Saturday morning.

Discussion and Resolutions

Each chairperson will present a summary and lead a discussion on the respective topics.

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