Introducing ASK, A Simple Knowledgeable System

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ABSTRACT

ASK, A Simple Knowledgeable System, is a total system for the structuring, manipulation and communication of information. It is a simple system in the sense that its development concentrated on clean engineering solutions to what could be done now with good response times. The user interface is a limited dialect of English. In contrast to expert systems, in which experts build the knowledge base and users make use of this expert knowledge, ASK is aimed at the user who wishes to create, test, modify, extend and make use of his own knowledge base. It is a system for a research team, a management or military staff, or a business office.

This paper is designed to give you a feel for the general performance of the ASK System and overview of its operational capabilities. To this end, the movie you see will continue throughout the talk. Indeed, the talk itself is a commentary on this background movie. The movie is bona fide and in real time, it is of the ASK System in action. (Many of the illustrations from the movie are reproduced in the written paper.)

I. ASK AS A DATABASE SYSTEM

A. Examples of ASK English

To introduce you to ASK, we will start out with a few examples of queries of a simple data base concerning ships. The uninitiated user may wish simply to ask:

```
>How many ships are there?
 7
>What is known about ships?
 some are in the following classes:
     Navy
     freighter
     old
     tanker
 all have the following attributes:
     destination
     home port
 some have the following attributes:
     cargo
 all have the following number attributes:
     age
 some have the following number attributes:
     speed
     length
     beam
>List the destinations and home port of
 each ship.
 ship          destination    home port
 Ubu           New York       Naples
               Tokyo          ---
 Maru          Oslo           Tokyo
 Kittyhawk     Naples         Boston
               Boston         ---
               London         ---
 Alamo         London         London
               New York       ---
 North Star    London         New York
 Nimitz        London         Norfolk
 Saratoga      unknown        Norfolk
>What cities are the home ports of ships
 whose destination is London?
 Boston
 London
 New York
 Norfolk
>Are there ships that do not have a cargo?
 yes
>What is the number of New York ships?
 There are 2 answers:
 (1) New York (destination) ships
 2
 (2) New York (home port) ships
 1
>How many ships are there with lnegth
 greater than 600 feet?
 Spelling correction: "lnegth" to "length"
 4
>What ships that carry wheat go to London or
 Oslo?
          ships that carry wheat
 London   Maru
 Oslo     Alamo
>Does the Maru carry wheat and go to London?
 yes
```

B. The ASK Data Structures

Although in the terminology of data base theory, ASK can be considered as an "entity-relation" system, ASK retains its information in records which are interlinked in a semantic net. One reason we refer to ASK as simple is because it uses only a few kinds of nodes in its semantic net, namely:

- o Classes
- o Objects
- o Attributes
- o Relations

and the obvious corresponding arcs. We speak of this as the COAR structure. Attributes are single valued, e.g., "father", "home port", "title"; relations may be multiple valued, e.g., "child", "cargo", "author". The difference between attributes and relations can be seen in the following protocol.

```
>What is the cargo and home port of the Maru?
 cargo     home port
 wheat     London
>The home port of Maru is Boston.
 London has been replaced by Boston as the
 home port of Maru.
>The cargo of Maru is coal.
 coal has been added as the cargo of Maru.
>What is the cargo and home port of the Maru?
 cargo     home port
 wheat     Boston
 coal      ---
```

C. Extending and Modifying the Data

1. Definitions

To make such a system more knowledgeable, one needs to be able to add definitions that embody interrelationships among the basic classes, objects, attributes and relations of the data. The simplest form of definition is synonym:

```
>definition:tub:old ship
 Defined.
```

Although this form of definition allows one to introduce abbreviations and many forms of jargon, more extensive forms of definition are desirable. Here are three illustrations using the same "ship" file as above. In the third definition, note the use of quotes to create local "variables".

```
>definition:area:length * beam
 Defined
>List the length, beam and area of each tub.
 tub      length      beam       area
           foot        foot      foot**2
 Ubu      231.667      48       11120.016
 Alamo    564.5        84       47418.
>definition:meter:39.37 * (foot / 12)
 Defined.
>beam of the Alamo squared in square meters?
 655.526472343 square meters
>definition:longest "ship":"ship" whose
 length is the maximum length of "ship"s
 Defined.
>What is the length in meters of the longest
 ship whose home port is Naples?
 121.920243840 meters
```

The notion of what is long may be quite different in another context, say in the context of bibliography of artificial intelligence literature.

```
>definition:long:paper whose number of pages
 exceeds 49
 Defined.
>definition:long:book whose number of pages
 exceeds 800
 Defined.
>What AI bibliography items are long?
 There are 2 answers:
 (1) long:paper whose number of pages exceeds
 49
 Physical Symbol Systems
 A General Syntactic Processor
 (2) long:book whose number of pages exceeds
 800
 Human Problem Solving
>What long books were written in 1972?
 long:book whose number of pages exceeds 800
 Human Problem Solving
```

Family relationships make for a good illustration of definitions; we switch to a small family relationship context.

```
>What are attributes?
 individual/individual attributes:
 spouse
>What are relations?
 individual/individual relations:
 parent
>What are classes?
 individual classes:
 male
 female
>What are definitions?
 definition:mother:female parent
 definition:father:male parent
 definition:child:converse of parent
 definition:sibling:child of parent but
    not oneself
 definition:cousin:child of sibling of parent
>List the father and mother of each of Billy
 Smith's cousins.
 Billy Smith's cousins  father       mother
 Baby Boyd              Robert Boyd  Jill Boy
```

2. Verbs

Most verbs embody knowledge specific to the application in which they are used, the exceptions being the copula verbs. Therefore the only verbs initially known to the ASK System are "to be" and "to have". The user can add new verbs by paraphrase.

```
>verb:ships "go" to New York:destination of
 ships is New York
 Defined.
>verb:ships "carry" coal from London to
 Boston:ships have coal as cargo, have London
 as home port and go to Boston
 Defined.
>Each old ship carries what cargo to each
 port?
 old ship       port        cargo
 Ubu            New York    oil
                Tokyo       oil
 Alamo          London      wheat
                            coal
```

```
>What is carried by the Alamo?
 wheat
 coal
>Wheat is carried to London from what ports?
 New York
>What cities does the Alamo carry wheat to?
 London
```

3. Anaphora: Pronouns and Ellipses

In practical systems for experts, abbreviated forms of addressing the computer are common. Thus the ability to handle pronominal and elliptical constructions are of considerable importance. Although there has been progress in the last few years in the linguistic understanding of these constructions, many difficulties remain. However, building on the work that has been accomplished, many of these constructions can be handled by the ASK System. In order to avoid misleading the user when the computational algorithm does not make the correct interpretation, echo is used to inform the user of the interpretation that has been taken.

```
>Is there a ship whose destination is
 unknown?
 yes
>What is it?
 What is it [ship whose destination is
 unknown]?
 Saratoga
>Is its cargo wheat or coal?
 Is its [ship whose destination is unknown]
 cargo wheat or coal?
 wheat   no
 coal    yes
>Does the Alamo's length exceed that of the
 Ubu?
 yes
>What about the Northern Star?
 [the Northern Star?]
 does the Alamo's length exceed that of the
 Northern Star?
 no
>Is its cargo wheat?
 Is its [Northern Star] cargo wheat?
 no
>Is it that of the Ubu?
 Is it [Northern Star cargo] that [cargo] of
 the Ubu?
 yes
>Wheat is carried by how many ships?
 2
>Coal and oil?
 coal and oil is carried by how many ships?
 coal   1
 oil    2
>by the Ubu?
 coal and oil is carried by the Ubu?
 coal   no
 oil    yes
```

4. Extending the Vocabulary and Data Base

New objects, classes, attributes and relations may be added at will. This will be illustrated using the AI Bibliography.

```
>Create the attribute: rating
 The attribute rating has been added.
>Create individuals: seminal, excellent, fair
 and impossible
 The following individuals have been added:
 seminal excellent fair impossible
>The rating of Winograd's 1980 paper in
 Cognitive Science is excellent.
 excellent has been added as the rating of
 Winograd's 1980 paper in Cognitive Science
>Rating of A Framework for Representing
 Knowledge is impossible.
 impossible has been added as the rating of
 A Framework for Representing Knowledge.
>Scripts, Plans, Goals and Understanding's
 rating is seminal.
 seminal has been added as the rating of
 Scripts, Plans, Goals and Understanding.
>The rating of Minsky's paper in The
 Psychology of Computer Vision is seminal.
 impossible has been replaced by seminal as
 the rating of Minsky's paper in The
 Psychology of Computer Vision.
>List the author of each paper that has a
 rating of either seminal or excellent.
 paper
 Scripts, Plans, Goals and Understanding
    R. C. Schank
 A Framework for Representing Knowledge
    M. Minsky
 What Does It Mean to Understand Natural
 Language
    T. Winograd
>relation: keyword
 The relation keyword has been added.
>individuals:context, natural language,
 knowledge representation
 The following individuals have been added:
 context  natural language  knowledge
 representation
>Context and knowledge representation are
 keywords of Scripts, Plans, Goals and
 Understanding and A Framework for
 Representing Knowledge.
 context  knowledge representation have been
 added as keywords of Scripts, Plans, Goals
 and Understanding.
 context  knowledge representation have been
 added as keywords of A Framework for
 Representing Knowledge.
>Natural language is a keyword of Scripts,
 Plans, Goals and Understanding.
 natural language has been added as keyword
 of Scripts, Plans, Goals and Understanding.
>definition:about "books":converse of keyword
 of "books"
 Defined.
>What AI Bibliography items are about
 knowledge representation?
 Scripts, Plans, Goals and Understanding
 A Framework for Representing Knowledge
```

D. Inheritance

Classes, as well as objects, may be the arguments or values of attributes and relations. This raises the question of inheritance of properties and attributes. The answer is to be

found in the following protocol, using the attribute of color; inheritance for relations is handled in similar ways.

```
>class: racing sloop, sports boat, Norwegian
 The following classes have been added:
 racing sloop  sports boat  Norwegian
>attribute: color
 The attribute color has been added.
>individuals: white, blue, black, gray
 The following individuals have been added:
 white  blue  black  gray
>Saratoga is a racing sloop.
 Saratoga has been added to racing sloop.
>Racing sloops are sports boats.
 racing sloops have been added to sports
 boats.
>Alamo is industrial and Norwegian.
 Alamo has been added to industrial
 Norwegian.
>The color of sports boats is white.
 white has been added as color of sports
 boats.
>Maru's color is gray.
 gray has been added as color of Maru.
>Black is the color of industrial.
 black has been added as the color of
 industrial.
>Blue is the color of Norwegian.
 blue has been added as the color of
 Norwegian.
>What is the color of each ship?
 There are 3 answers:
 (1)
 ship        color
 Maru        gray
 Saratoga    white
 (2) Alamo as industrial
 ship        color
 Alamo       black
 (3) Alamo as Norwegian
 ship        color
 Alamo       blue
```

E. Diagnostics

Our objectives in the design of ASK are to respond to the experienced user:

- o with the responses s/he desires in at least 90% of the cases;
- o with a response that includes what s/he desires, but perhaps additional information also, in 90% of the remaining cases;
- o with a response, although not the desired one, but one which clearly indicates the system's interpretation of the request in the remaining cases.

This third objective calls for good diagnostics. The diagnostic capabilities of ASK are illustrated in the following protocol.

```
>attribute:port
 The attribute port has been added.
>What are the ports and U.S. destinations of
 the Maru?
 There are 2 answers:
 (1) There are no ports
 (2) There are no U.S. destinations of Maru.
>Is some European port a portof Maru?
 The following word is not in the vocabulary:
    portof
 Correction:  Is some European port a port of
 Maru?
 There is no port.
>London is Alamo's port.
 London has been added as the port of Alamo.
>Is som European port a prot of Maru?
 Spelling corrections: "som" to "some" "prot"
 to "port"
 There is no port of Maru.
>New York is Maru's port.
 New York has been added as port of Maru.
>Is some European port a port of Maru.
 Is some European port a port of Maru?
 no
```

II. INTEGRATION OF MULTIPLE OBJECT TYPES

A. Extension of COAR to Multiple Object Types

So far we have illustrated ASK capabilities using only two types of objects:

- o individuals, e.g., "John Jones", "Maru"
- o numbers, e.g., "34.6 feet", "length of Maru", "number of ships".

ASK has been designed, however, to facilitate many kinds of objects. This is a capability orthogonal to the simple COAR structure in that for any types of objects there may be corresponding classes, attributes and relations.

B. An Example: Texts and Text Files

We will illustrate this multiple object type capability with the additional object type: text. Once this new object type was added (together with procedures to manipulate texts, i.e., a "word processor") then text classes, individual/text and text/individual attributes and relations were immediately available. It was a small task to add an electronic mail system to ASK; all that was required was an addition to the authorization procedure that assigned to each newly authorized person a new text class as his/her mail box.

```
>Create the text/text relation:comment
 The text/text relation comment has been
 added.
>Create a file: budget correspondence
 The text class budget correspondence has
 been added.
>File the Budget Proposal in budget
 correspondence.
 Budget Proposal has been added to the text
 class budget correspondence.
>Who have I received mail from?
 John Smith
 Peter Jackson
```

```
>Display my mail from John Smith.

 Fred, Your Budget Proposal looks good to me.
 Suggest you submit it as is.
                    John

>File it in my budget correspondence file.
 File it [my mail from John Smith] in my
 budget correspondence file.
 my mail from John Smith has been added to
 the text class budget correspondence.
>Remove it from my mail box.
 Remove it [my mail from John Smith] from my
 mail box.
 my mail from John Smith has been removed
 from your mail.
>Create a budget correspondence named Budget
 Plans
 Please enter text:

 Staff level budget meeting on Wed. at 3 in
 Tom's office. Please send me your comments
 before the meeting; file them as "comments
 on Budget Plans".\

 Budget Plans has been added to the text
 class budget correspondence.
>Mail Budget Plans to each section manager.
 Budget plans has been sent to each section
 manager.

>Display the comments on Budget Plans by each
 section manager.
 Displaying comments on Budget Plans by each
 section manager:
 John Dobbs:
 D(isplay), S(kip), or Q(uit):
 .....
```

C. Adding New Object Types

Although the ASK System has been designed to allow the addition of new object types, this can be done only by an application programmer. The major obstacle is the necessity to provide a procedure to initialize instances of the new object type and procedures that carry out their intrinsic manipulation. However, we expect the addition of new object types to be a common occurrence in the applications of the ASK System. In any potential applicaion areas, using groups have accumulations of data already structured in specific ways and families of procedures that they have developed to manipulate these structures. In ASK, they can identify these data structures as a new object type, design simple syntax for them to invoke their procedures, and thus embed their familar objects and manipulations within the ASK English dialect and within the same context as other associated aspects of their tasks. The class, attributed and relation constructions become immediately available.

III. MORE GENERAL ASPECTS OF THE ASK SYSTEM

A. Response Times

The movie, which accompanied the oral presentation of this paper, demonstrated that the response time, i.e., the time between completion of the typing of the input by the user to the appearance of the response on the terminal, is very good. But the data bases used in the illustrations have been small, toy data bases. The following table gives average response times for a few cases using larger data bases. The query used for this illustration is:

```
>What are the destinations of tankers?
```

The response time is rather insenstitive to the total number of individuals, classes, attributes and relations in the data base, depending primarily on the size of the relation (destination) and its argument (tankers). Suppose that there are m tankers in the data base and that n individuals have destinations, i.e., the size of the destination relation is n. The table gives time in seconds.

		no. of tankers				
	n\m	1	10	100	1000	2500
	10	2	2	2	3	4
no. of	100	2	2	2	3	6
destin-	1000	3	3	4	7	20
ations	2500	5	6	9	22	38

Response Time in Seconds for:
>What are the destinations of tankers?

B. The Concept of a User Context and the Basing Operation

In the terminology of ASK, a user "Context" is a knowledge base together with the vocabulary and definitions that go with it. A given user will usually have several Contexts for various purposes, some of which may be the small "Ships" Context, a (truncated) bibliography of Artificial Intelligence literature and an administrative Context concerning budget matters.

When one initiates a session with the ASK System, one is initially in the Command Context:

```
>Welcome to ASK
 Please identify yourself.
>Fred
>Pass word:
 You have mail.
 Fred is in COMMAND, proceed.
```

At this point, you can list the Directory of Contexts available to you, create or delete Contexts, authorize others to use Contexts which you have created, and enter any of the Contexts in

```
>Directory
context                creator   enter   base
BASE                   MASTER    no      yes
Ships                  Fred      yes     yes
AI Bibliography        Fred      yes     yes
Family                 Fred      yes     yes
Management Matters     Fred      yes     yes

>enter Management Matters
 You are in Management Matters, proceed.
>Who have I received mail from?
 Peter Jackson
 John Dobbs
```

A new Context is created by basing it on an already existing one. Consider a user who has been authorized for basing on the AI Bibliography Context illustrated above and who wants to build a wider bibliography Context (adding new information -- vocabulary, data and definitions), however, without disturbing the old one. To do so, all s/he needs to do is select a new name, say CS Bibliography, and type:

```
>exit
 You are in COMMAND, proceed.
>Base CS Bibliography on AI Bibliography
 The new context CS Bibliography has been
 created based on AI Bibliography
```

The result of this basing action is a new Context. Upon entering this new Context:

```
>Enter CS Bibliography
 You are in CS Bibliography, proceed.
```

one can make additions:

```
>individuals:An Introduction to Database
 Systems, C. J. Date
 The following individuals have been added:
 An Introduction to Database Systems
 C. J. Date
>The author of An Introduction to Database
 Systems is C. J. Date.
 C. J. Date has been added as author of An
 Introduction to Database Systems.
>Keyword of An Introduction to Database
 Systems is database.
 database has been added as keyword of An
 Introduction to Database Systems.
>Who wrote what about databases?
 author
 D. L. Waltz  Natural Language Access to a
 Large Data Base
 C. J. Date  An Introduction to Database
 Systems
```

These additions to the CS Bibliography would not, of course, effect the AI Bibliography Context. However, additions and modifications that are subsequently made in the AI Bibliography Context would automatically be reflected in the CS Bibliography.

```
>exit
 You are in COMMAND, proceed.
>Enter AI Bibliography
 You are in AI Bibliography, proceed.
>individual: Experience with ROBOT, L. Harris
 The following individuals have been added:
 Experience with ROBOT  L. Harris
>The author of Experience with ROBOT is L.
 Harris.
 L. Harris has been added as author of
 Experience with ROBOT.
>Keyword of Experience with ROBOT is database.
 database has been added as keyword of
 Experience with ROBOT.
>Who wrote what about databases?
 author
 D. L. Waltz  Natural Language Access to a
 Large Data Base
 L. Harris  Experience with ROBOT
>exit to CS Bibliography,
 You are in CS Bibliography, proceed.
>Who wrote what about databases?
 author
 D. L. Waltz  Natural Language Access to a
 Large Data Base
 C. J. Date  An Introduction to Database
 Systems
 L. Harris  Experience with ROBOT
```

Several Contexts can be based on a given one, and one Context can be based on several, thus a hierarchical structure of Contexts can be realized. All Contexts are directly or indirectly based upon the BASE Context, which contains the function words and grammar of the ASK dialect of English, the mathematical and statistical capabilities, and the word processor.

C. Transportability

It is easy and fast to apply ASK to a new domain, given that a data base for this new domain is available in machine readable form. The vehicle is the ASK dialogue-driven Bulk Data Input capability, which can be called upon to build an existing database into one's Context. The result not only integrates this new data with that already in the Context and under the ASK dialect of English, but in many circumstances will make the use of this data more responsive to users' needs.

The Bulk Data Input Dialogue prompts the user for necessary information to (1) establish the physical structure of the data base to be included, (2) add necessary classes and attributes as needed for the new data entries. The user also indicates, using English constructions, the informational relationships among the fields in the physical records of the database file that s/he wishes carried over to the ASK Context.

IV. DIALOGUES IN ASK

Some have raised the question whether natural language is always the most desirable medium for a user to communicate with the computer. Expert systems, for example, have tended to use computer guided dialogues. One simple form such a dialogue

might take is illustrated by the following in which a new entry is added to the AI Bibliography:

```
>New bibliography item
>Add to what bibliography? AI Bibliography
>Title: Natural Language Processing
>Author: Harry Tennant
>Keyword: natural language
>Keyword: syntax processing
>Keyword: speech acts
>Keyword:
 Natural Language Processing has been added
 to AI Bibliography.
>Title:
 The "new bibliography item" dialogue is
 completed.
>What AI Bibliography items were written
 by Harry Tennant?
 Experience with the Evaluation of Natural
 Language Question Answerers
 Natural Language Processing
```

Other alternative media for user/system communication are menu boards, selection arrays and query by example. Many other cryptic ways to communicate user needs to a knowledgeable system can be thought of; often the most useful means will be highly specific to the particular application. For example, in positioning cargo in the hold of a ship, one would like to be able to display the particular cargo space, showing its current cargo, and call for and move into place other items that are to be included.

In the past, enabling the system to respond more intelligently to the user's needs required the provision of elaborate programs since the user's tasks may be quite involved, with complex decision structures. The introduction of terse, effective communication has incurred long delays and thus the changing needs of a user had little chance of being met. In the ASK System, the users themselves can provide this knowledge. They can instruct the system on how to elicit the necessary information and how to complete the required task. This ASK capability is quite facile, opening the way for its ubiquitous use in extending the knowledgeable responsiveness of the computer to user's immediate needs. ASK includes two system-guided dialogues, similar to the Bulk Data Input dialogue by which users can instruct the System on how to be more responsive to their needs.

A. Forms Designing Dialogue

The Form is an efficient means of communication with which we are all familiar. A number of computer systems include a Forms package. For most of these, however, filling in a Form results only in a document; the Form does not constitute a medium for interacting with the knowledge base or controlling the actions of the system. The ASK Forms capability enlarges the roles and ways in which Forms can be used as a medium for user interaction. As the user fills in the fields of a Form, the System can make use of the information being supplied to (1) check its consistency with the data already in the knowledge base and, if necessary, respond with a diagnostic, (2) fill in other fields with data developed from the knowledge base, (3) extend the knowledge base, adding to the vocabulary and adding or changing the data itself, (4) file the completed form in prescribed files or in those indicated by the user and also mail it to a specified distribution list through the electronic mail subsystem. Since the Form processing can check consistency and modify the knowledge base, Forms can be used to facilitate data input. Since Form processing can fill fields in the Form, the forms capability includes the functions of a report generator. Letters and memos can be written as special cases of Form filling, automatically adding dates, addresses, etc. and filing and dispatching the result.

It must be easy and natural to add new Forms, if they are to be a convenient tool. That is the function of the Forms Designing Dialogue. Much like the Bulk Data Input Dialogue, the Forms Designing Dialogue holds a dialogue with the the user through which s/he can specify the fields of the Form itself and the processing of the above kinds to be automatically accomplished at the time the Form is filled in. Here is a simple example of a from that was designed using the Forms Designing Dialogue.

```
>What is the home port and commander of each
 old ship?
 There are 2 answers:
 (1) There is no commander.
 (2)
 old ship     home port
 Ubu          Naples
 Alamo        London
>Who is John Smith?
 The following words are not in the vocabulary:
 John Smith
>Inventory of wheat and corn oil?
 wheat and corn oil inventory
 wheat                  86.7
 corn oil           123400.
```

Note that the home port of the Alamo is London and that it does not have a commander, further that John Smith is not known to the System.

```
>Fill shipping
```

(For the purposes of the published paper, in contrast to the film shown at the presentation of the paper, only the initial and final copies of the form are given, underlines indicate fields filled in by the "user", the other fields automatically being filled by the System.)

(before)

```
                Shipping Form

ship:
port:

quantity   item            price      total
                          $   .      $   .

commander:
```

(after)

Shipping Form

ship: Alamo
port: London

quantity	item	price	total
3	wheat	$ 35.75	$ 107.25
500	corn oil	$ 2.50	$1250.00

commander: John Smith

Shipping List for Alamo has been filed in Shipping Invoice File.
Shipping List for Alamo has been mailed to Jones.
mail to:
Fill shipping has been completed.
>List the home port and commander of each old ship.

old ship	home port	commander
Ubu	Naples	---
Alamo	London	John Smith

>Inventory of wheat and corn oil?
wheat and corn oil inventory

wheat	83.7
corn oil	122900.

>What is in the Shipping Invoice File?
Shipping List for Alamo

B. Dialogue Designing Dialogue

In the day-by-day use of an interactive system, users are very often involved in repetitive tasks. They could be relieved of much of the drudgery of such tasks if the system were more knowledgeable. Such a knowledgeable system, as it goes about a task for the user, may need additional information from the user. What information it needs at a particular point may depend on earlier user inputs and the current state of the database.

The user must provide the system with knowledge of a particular task; more precisely s/he must program this knowledge into the system. The result of this programming will be a system guided dialogue which the user can subsequently initiate and which will then elicit the necessary inputs. Using these inputs in conjunction with the knowledge already available, particularly the data base, the system completes the task. It is this system-guided dialogue that the user needs to be able to design.

In the ASK System, there is a special dialogue which can be used to design system guided dialogues to accomplish particular tasks. We call this the Dialogue Designing Dialogue (DDD). Using DDD, the user becomes a computer-aided designer. Since DDD, in conducting its dialogue with the user, only requires simple responses or responses phrased in ASK English, the user need have little programming skill or experience. Using DDD, the user alone can replace a tedious, repetitive task with an efficient system guided dialogue, all in a natural language environment. The ASK Dialogue Designing Dialogue constitutes a high level, natural language programming capability. We hasten to add that it is not a general purpose program environment. It is for "ultra-high" level programming, gaining its programming efficiency through the assumption of an extensive vocabulary and knowledge base on which it can draw. The illustrative dialogue above, which adds a new item to a bibliography, is an example of a simple dialogue designed using DDD.

V. ACKNOWLEDGEMENTS AND CURRENT STATUS

The three System guided dialogues, Bulk Data Input, Dialogue Designing Dialogue and Forms Designing Dialogue, are from the doctoral dissertation of Tai-Ping Ho. The aspects of ASK concerning basing one Context on another are from the doctoral dissertation of Kwang-I Yu. The methods for handling anaphora, fragments and correction of inputs are from the doctoral dissertation of David Trawick.

ASK is implemented on the Hewlett Packard HP9836 desktop computer. To handle Contexts of reasonable size, one needs a hard disk. An HP9836 with an HP9725 disk was used in the illustrations in this paper. Our work is supported by the Hewlett Packard Corporation, Desktop Computer Division.