Knowledgeable Contexts for User Interaction

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ABSTRACT: ASK, A Simple Knowledgeable System, is a total system for the structuring, manipulation and communication of information. The ASK user interface is a simple dialect of natural English. The System includes extensive means by which a user group and application programmer can build a knowledgeable context for user interaction. The users themselves can build, modify and extend their knowledge base. They can add complex definitions which embody knowledge of their domain. They can base a new tentative knowledge base on more stable ones, modifying and extending their new one without affecting the old.

A truly knowledgeable system must also know how to perform complex tasks in response to terse user inputs, taking over complicated but repetitive tasks on simple cue. The ASK System includes three system-guided dialogues that can be used to build such knowledgeability into a user's context.

KEYWORDS: natural language, dialogue, user interface, knowledge based

INTRODUCTION

Systems for experts

It is generally agreed that in computer systems which directly serve a group of users, the system must be knowledgeable concerning the domain in which that group is working. The term "knowledge base" is rapidly replacing "data base" to describe the information availabe to the computer in responding to user interaction. One form of such knowledge based systems that is receiving a good deal of attention is the Expert System. In an expert system, experts build the knowledge base and users make use of this expert knowledge. In the words of Dr. Edward Feigenbaum, of Stanford University, whose seminal work established this important area:

> "Expert systems can be viewed as intemediaries between experts, who interact with the systems in 'knowledge acquisition' mode, and human users who interact with the systems in 'consultation mode.'"

There are, on the other hand, many areas where the using group itself is intimately involved in the building, modifying and extending of their own knowledge base. In the typical research team, management or military staff, or business office the central activity is the maintenance of their knowledge base in the form of plans, data, designs and coordination of their operations. Office and manufacturing automation systems will soon evolve into just such systems. Knowledge based systems that support these activities must provide a very different kind of service to their users than those provided by expert systems. They are, in the words of Dr. Donald Walker, of SRI International, Systems for Experts.

There are certain properties that a system for experts must have. First, such a system must be natural to use. This implies a reasonable facility for natural language but also for accepting the jargon that rapidly builds up within such a using group. It implies a capabilitiy for text and graphic processing, for numerical and statistical calculation, all as an integral part of the knowledge base itself. Such systems must have facile means by which their user groups can add, change and extend their knowledge base as an integral part of their interaction with it. Such changes and extensions can come from many sources. Some will be a ubiquitous part of the users' own interaction: bringing records up to date, writing reports and circulating comments on the work of others, completion of design drawings, scheduling and maintaining the information necessary for coordinating operations. Whole bodies of data may come from other sources such as the incorporation of commercially available data or the

inclusion of the knowledge bases of subordinate groups. Providing facile means for effecting all of these varied kinds of modification and extension is an essential aspect of systems for experts.

When an expert team uses such a system on a day to day basis, many of their tasks will be repititous and, with experience, these tasks will reduce in essence to the specification of a few inputs to control a complex but repetitive process. A system for experts must provide the means for defining such tasks, relegating the tedious details to the system. And the system must know enough to hold a brief dialogue with its user to obtain the necessary instructions for it to complete the task. The specifications of such tasks will be an everyday occurrence in such staffs, and thus the means for such definition must be facile and a natural part of system interaction.

The ASK System, a system for experts

This paper is about such a system, the ASK System, a system for experts. ASK, A Simple Knowledgeable System, exits. It is implemented on a Hewlett- Packard HP9836 desktop computer, in Pascal. The film that you will be seeing behind me is of the ASK System in action. The film is taken in real time. (Many of the examples from the film are repeated in the written form of this paper.) In a single paper it would be impossible to give both a broad coverage and also treat in any depth the various capabilities of this system. In this paper we have chosen the former to give a broad overview of the ASK System. For those who are seriously interested, we would be glad to find an appropriate opportunity to discuss more detailed aspects of the system.

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?
 8
>What is known about ships?
 some are in the following classes:
     Navy
     freighter
     old
     tanker
 all have the following attributes:
     destination
 some have the following attributes:
     home port
     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 is the number of New York ships?
 There are 2 answers:
   (1) New York (destination) ships
 2
   (2) New York (home port) ships
 1
>What about Norfolk?
 What is the number of Norfolk ships?
 Norfolk (home port) ships?
 2
>Wheat is carried by how many ships?
 2
>Coal and oil?
 coal and oil is carried by how many ships?
      ships
 coal      1
 oil       2
>How many ships are there with lnegth greater than 600 feet?
 Spelling correction: "lnegth" to "length"
 4
>What are they?
 What are they [ships with length greater than 600 feet]?
 North Star
 Kittyhawk
>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
```

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 shared with others in the group. You have seen examples from the small"ship" file Context. Lets look at quite a different one, an example of a bibliography of Artificial Intelligence literature (here truncated).

```
>How many articles are there about knowledge representation?
 15
>Which ones were written in 1979 by each author?
 Which [articles about knowledge representation] were written
 in 1979 by each author?
 author          articles about knowledge representation
 G.G. Hendrix    Encoding Knowledge in Partitioned Networks
 R.J. Brachman   On the Epistemological Status of Semantic
                 Networks
>What other articles has Hendrix written?
 What other articles [than articles about knowledge
 representation] has Hendrix written?
 LIFER: A Natural Language Interface Facility
```

Or a knowledge base concerning one's mail:

```
>Who have I received mail from?
 John Smith
 Peter Jackson
>Display my mail from John Smith.
 Fred, Your budget looks good to me. Suggest you
 submit it as is.
        John
>File it in my budget correspondence file.
 File [my mail from John Smith] in my budget correspondence
 file.
 my mail from John Smith has been filed.
```

You have seen examples from three different Contexts. How new contexts are created and related to other Contexts will be discussed below.

EXTENDING USER CONTEXTS

The major emphasis of this paper is on the ability of the users of ASK to structure their own knowledge base. We turn now to those issues.

Extending the knowledge base and adding and changing data

A knowledge base typically contains objects and classes of these objects; it also has knowledge of the attributes these objects might possess and of relationships that might hold among them. The ASK System accepts objects of several types: individuals (e.g, Boston, John), numbers, texts (e.g., the text of a given memo or letter), matricies, etc. The following sequence

illustrates how a user can extend his knowledge base by adding new objects, classes, attributes and relations. We will use the artificial intelligence bibliography Context for this illustration. Note how easy it is to add new attributes, "fields" in the relational data base terminology, and how text objects are handled in a straightforward way as integral parts of the knowledge base.

```
>Create the attribute: rating
 The attribute rating has been added.
>create individuals: semial, 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                                                  author
 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
>Create an individual/text relation named comment
 The individual/text relation comment has been added.
>Create a comment on A General Syntactic Processor
 Please enter text:
 Best paper on chart parsers.\
 A new text has been added as comment on A General Syntactic
 Processor.
>Display my comments on each paper by R. M. Kaplan.
 paper by R. M. Kaplan          comments
 A General Syntactic Processor  Best paper on chart parsers.
```

Definitions

The examples so far illustrate how one can build, query and modify a data base. However, to make such a system more knowledgeable, one needs to be able to add definitions that embody interrelationships among the basic objects, classes and attributes of the data. The simplest form of definition is

synonym:

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

Although this form of definition allows one to introduce abreviations and many forms of jargon, more extensive forms of definition are desirable. Here are two illustrations using the "ship" file Context. In the second 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 bibliography context.

```
>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 relationships 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 Boyd
```

Verbs

Initially, the only verbs known to the ASK System are "to be" and "to have." The user can add new verbs by paraphrase, as in the following illustration:

```
>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
```

Basing one Context on another

We have shown how users can add new vocabulary, data and definitions to their Contexts. However this would be a tedious way to build a large and useful data base from scratch. We now discuss two ways of incorporating bodies of existing data in a

user Context.

Consider a user with the AI Bibliography Context illustrated above 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:

```
Base CS Bibliography on AI Bibliography
```

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

```
>Enter CS Bibliography
```

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
>An Introduction to Database Systems is a book.
 An Introduction to Database Systems has been added to book.
>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, of course, would not 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. 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.

The bulk data input dialogue

There is a great deal of information in existing data bases and a system for experts must facilitate the addition of such data to the knowledgeable user's Context. In the ASK System there is a dialogue, called the Bulk Data Input Dialogue, 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 data base file that s/he wishes carried over to the ASK Context. We will not illustrate the Bulk Data Input Dialogue here, since it is similar to two other ASK System dialogues which will be described and illustrated below.

KNOWLEDGEABLE DIALOGUES

In the day by day use of an interactive system, a user is very often involved in repetitive tasks. He 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.

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 Bibibliography
>Title: Natural Language Processing
>Author: Harry Tennant
>Keyword: natural language
>Keyword: syntax processing
>Keyword: speech acts
>Keyword:
 Natural Language Processing has been added to the 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 ubiquious use in extending the knowledgeable responsiveness of the computer to user's immediate needs.

The dialogue designing dialogue

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 that it needs. 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 no programming skill or experience at all. 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 programming 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.

DDD is based on the notion of an "interaction node." Such a node

represents a point in the dialogue where the computer turns to the user for additional input, i.e., more data or further instruction as to what is desired. At such a node, the system prompts the user as to what information it needs, digests the user's response, takes indicated actions and progresses to another node which it preceives as the next place for interaction. As it does so it maintains its own local context, remembering what the user has told it and what it is supposed to do.

The DDD dialogue sets up all of this, and therefore is itself quite complex in its dialogue paths to elicit the information it needs, information about prompts, expectations of user responses, diagnostic messages, references to the data base, maintenance of the local context, etc. We can only illustrate a small part of the DDD dialogue here, however it should give you some feel of how the DDD dialogue works. Earlier in this paper, we used as an illustration a simple dialogue for adding a new item to the AI Bibliography. Here is the DDD dialogue that defined that "New bibliography item" dialogue that you saw in use above.

```
>new dialogue
>What user input should initiate this dialogue? new
 bibliography item
 Please define each node in turn.
 Designing node 1:
>What is the prompt message for node 1: Add to what
 bibliography?
>If you wish the response to this prompt to be assigned to a
 field, give the field number: 1
>What is the type option for node 1: 1
>What is the response option for a nil response to node 1: 1
>What is the response option for a bad evaluation of user
 response: 2
>What is the response option for a good evaluation of user
 response: 2
>Transfer to what node: 2
 Node 1 is completed.
 Designing node 2:
 The fields that have been assigned on entering this node are:
 <1>: Add to what bibliography?
>What is the prompt message for node 2: Title:
>If you wish the response to this prompt to be assigned to a
 field, give the field number: 2
>What is the type option for node 2: 2
>What is the new word option: 3
>What is the category option for this word: 1
>What is the response option for a nil response to node 1: help
 1: abort the dialogue and exit
 2: reprompt
 3: complete all actions and exit
```

```
 4: a condition - action - transition sequence
 5: transfer to next node directly
>What is the response option for a nil response to node 2: 3
>What is the response option for a bad evaluation of user
 response: 2
>What is the response option for a good evaluation of user
 response: 4
>Condition: otherwise
>Action: <2> is a <1>.
>Action:
>Transfer to what node: 3
 Node 2 is completed.
 Designing node 3:
 The fields that have been assigned on entering this node are:
 <1>: Add to what bibliography?
 <2>: Title:
>What is the prompt message for node 3: Author:
>If you wish the response to this prompt to be assigned to a
 field, give the field number: 3
>What is the type option for node 3: 2
>What is the new word option: 3
>What is the category option for this word: 1
>What is the response option for a nil response to node 3: 5
>What is the response option for a bad evaluation of user
 response: 2
>What is the response option for a good evaluation of user
 response: 4
>Condition: otherwise
>Action: Author of <2> is <3>.
>Action:
>Transfer to what node: 4
 Node 3 is completed.
 Designing node 4:
 The fields that have been assigned on entering this node are:
 <1>: Add to what bibliography?
 <2>: Title:
 <3>: Author:
 >What is the prompt message for node 4: Keyword:
 >If you wish the response to this prompt to be assigned to a
  field, give the field number: 4
 >What is the type option for node 4: 2
 >What is the new word option: 3
 >What is the category option for this word: 1
 >What is the response option for a nil response to node 4: 4
 >Condition: otherwise
 >Action: message: <2> " has been added to the " <1> "."
 >Action:
 >Transfer to what node: 2
 >What is the response option for a bad evaluation of user
  response: 2
 >What is the response option for a good evaluation of user
```

```
 response: 4
>Condition: otherwise
>Action: Keyword of <2> is <4>.
>Action:
>Transfer to what node: 4
 Node 4 is completed.
 Design of "new bibliography item" dialogue is completed.
```

Simple dialogues, like the above, can be defined by the user. However complex decision/action structures and the provision of diagnostics and recovery, complex looping, etc. is the appropriate province of the application programmer. The "node driven" organization of DDD is quite natural for someone with even brief experience in computer programming. Sketching the dialogue one wishes to define as a rough flow chart, then proceeding to the use of DDD, complex processes can quickly be implemented. DDD has a number of features that falcilitate the development of the program, including a variety of validity checks. The super-high level of natural language programming means that low level type bugs are eliminated. Particularly significant is the fact that in the development of such a user dialogue, all of the vocabulary and associated semantics of the immediate application are directly available.

The use of forms as a dialogue medium

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 controling 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

conveniant tool. That is the function of the Forms Designing Dialogue. Much like the Bulk Data Input and Dialogue Designing Dialogue, the Forms Designing Dialogue holds a dialogue with 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 how the Forms Designing Dialogue works. The Forms Designing Dialogue makes many options available, only a few of which are illustrated here.

The protocol to be included here is designed to illustrate the features mentioned above, and does not reflect any actual form. It utilizes the notion of a "field" as in the Dialogue Designing Dialogue, allowing a field to be referred to by number.

```
   >new form
   >form name: shipping
   >start your design:

                Shipping Form

ship: 2222222222222222
port: 2222222222222222

quantity     item                                  price       total
1111         22222222222222222222222222        $111.11     $1111.11

commander: 2222222222222222


                Shipping Form

ship: <1>2222222222222
port: <2>2222222222222

quantity     item                                  price       total
<3>1         <4>22222222222222222222222        $<5>.11     $<6>1.11

commander: <7>2222222222222

   >Please confirm the design ("y" or "n"): y
   >Do you want to repeat some lines? (y/n): y
   >repetition field: <3>
   >repetition field:
    What fields are to be filled by the computer?
   >field: <2>
   >value: home port of <1>
   >if unable, what message should be used:
    <1> does not have a home port.\
   >if unable, what option should be taken: 1
```

```
>field:.<5>
>value: price of <4>
>if unable, what message should be used:
>if unable, what option should be taken:
>field: <6>
>value: <3> * <5>
>if unable, what message should be used:
>if unable, what option should be taken:
>field:
 What conditions should be verified by the computer?
>condition: <3> is less than the inventory of <4>?
>if fail, what message should be used?
 There are not enough <4>s in stock.\
>if fail, what option should be taken? 2
>condition:
 Actions to be taken on completion of the form?
>update data base: Reduce inventory of <4> by <3>.
>update data base: Commander of <1> is <7>.
>update data base:
>name of completed form: Shipping List for <1>
>file in: Shipping Invoice File.
>file in:
>mail to: Jones.
>mail to: ask
The design of form "shipping" has been completed.
```

We will now fill in the form that was just designed. To illustrate the fact that the data base will be changed as a result of filling the form, we first ask the questions:

```
>What is the home port and commander of each old ship?
 There are 2 answers:
 (1) There is no commander.
 (2)
 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 hydrochloric acid?
 wheat and hydrochloric acid  inventory
 wheat                              86.7
 hydrochloric acid              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	hydrochloric acid	$ 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 ship.

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

>Inventory of wheat and hydrochloric acid?

wheat and hydrochloric acid	inventory
wheat	83.7
hydrochloric acid	122900.

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

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