EXPERT SYSTEM APPLICATIONS IN CUSTOMER SERVICE

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Abstract

The competitive edge of using expert system technology is beginning to have an impact on the marketplace. Described here are applications of expert system technology to customer service and many of the ideas presented here are applicable to other areas of business as well. This project was accomplished in cooperation with the Customer Service Department of a major U.S. chemical company, and this paper describes the design, implementation, and results of a diagnostic expert system prototype and the design of an Expert Inquiry Handler for customer service. The prototype design was based on a previously successful design by the authors, and the Expert Inquiry Handler design addresses what it means to do intelligent inquiry handling in customer service and how an Expert Inquiry Handler interfaces with its resources (data base and people) to accomplish its job.

Introduction

ARTIFICIAL INTELLIGENCE

Artificial Intelligence (AI) [4] [32] is quickly becoming a vital technology and there is currently an explosion of interest centering around this field. Both corporations and universities [33] are putting more resources than ever before into A.I. Although Artificial Intelligence has been around for thirty years, it has been just recently that many companies both here and abroad are beginning to use AI applications to assist them in becoming more competitive in the marketplace [9] [11] [18] [22] [25] [33].

AI is a broad field and it includes the subareas of vision systems, game-playing systems, computer-aided instruction, voice synthesis and recognition, natural language translation, robotics, and expert systems. Expert Systems is perhaps the fastest growing subarea of AI and it is a subarea to be dealt with in depth in this paper.

EXPERT SYSTEMS

Expert Systems are software packages that incorporate the knowledge base of experts within a particular domain [13] [14]. These systems are developed through a process known as "knowledge engineering" where "rules of thumb" are extracted from the domain expert(s) by a knowledge engineer and the software is built using an AI knowledge representation (rule-based, semantic nets, frames, etc.). Like the expert, this system can then solve problems by using inference and it does this by interpreting the knowledge and facts contained in its knowledge-base.

Once built, expert systems can be used to aid people in making decisions and they have a major advantage over existing decision support tools [2] [5] [6] [8] [12] [15] [16] [19] [28] for some problem situations because they can develop a line of reasoning based on uncertain or partial evidence. This inductive reasoning capability allows AI expert systems in some cases to solve large, complex, unstructured problems. Other advantages of expert systems include the capability to explain their line of reasoning, permanent formal "working" organization of decision-making, consistency in decision-making, duplication of the knowledge, and documentation of the decision-making.

In this paper the issue is specifically expert systems in business.

THIS PROJECT

The application of expert systems to a variety of business problems is beginning to emerge [3] [7] [8] [9] [15] [22] [33]. The authors currently are working on projects in customer service, transportation, warehousing/materials handling systems, inventory [7] [8], purchasing, production, packaging, and information systems. This

paper will concentrate on describing applications of expert systems to customer service, but the ideas presented - especially those ideas concerning diagnostic system prototyping and expert/database interfacing - are applicable to many other areas of business.

This project was developed in conjunction with the Customer Service Department of a major chemical company in the United States. This company has a number of customer service centers around the United States, each center has a customer service manager in charge of it, each has approximately one customer service expert per department (plastics, agriculture products, etc.) usually with many years experience in the company, and each has a number of less-experienced customer service representatives that are responsible for a specific group of established customers. A non-trivial amount of this paper deals with "Customer inquiries" which are defined to be calls that are initially handled by the receptionist at a center and that are not usually, but that are sometimes, made by established customers.

Specifically described are two parts of this customer service project: 1) the design, implementation, and results of a diagnostic customer service expert system prototype and 2) the design of an Expert Inquiry Handler for Customer Service. Since the design used for the prototype has been utilized previously [7] [8], more time and attention is given to the design of the Expert Inquiry Handler and to the issues regarding what it means to do intelligent inquiry handling and how an expert inquiry handler interfaces with its resources (data base and people) to accomplish its job.

The Prototype

OBJECTIVES AND DESIGN

The objectives of the Customer Service Prototype were:

1. To have the chemical company experience knowledge engineering.

2. To assess the value of expert system technology for solving a number of problem areas in the customer service department.

3. To organize a "cloudy" area.

4. To lay the foundation for establishing performance measurements within areas of the customer service department.

5. To aid the manager of the customer service department in understanding how his employees think.

The design of the prototype was based on a previously-successful diagnostic system design [7] [8]. This design called for the use of personal computers, Tecknowledge's PC-based A.I. expert system building tool, M.1, and a design breakdown as illustrated in the Figure on How the System Works. The system uses goals (standards), previous period information and current period information along with expert evaluation rules to give a resulting grade, explanation of why the grade is given, and a prescription for improving the grade. The goals, previous period information, and current period information are based on company, customer, and competition requirements. Refer to [7] and [8] for more detail.

The scope of the prototype was defined in the design to be the knowledge of expert customer service center managers, with particular interest in Accounts Receivable and Customer Inquiry handling.

IMPLEMENTATION AND RESULTS

The implementation and results of the prototype center around several interviews with each of the two best [2] [24] customer service center managers and a four-part analysis of their knowledge. A description of the interview questions used in each part and the result of each part is given below:

- First, a formal outline of the main responsibilities of the managers was captured through discussion of questions like the following:

  -- What tasks make up your job?
  -- How important are each of these tasks?
  -- How important are each of these tasks in relation to each other?
  -- How do you spend most of your time in a day?

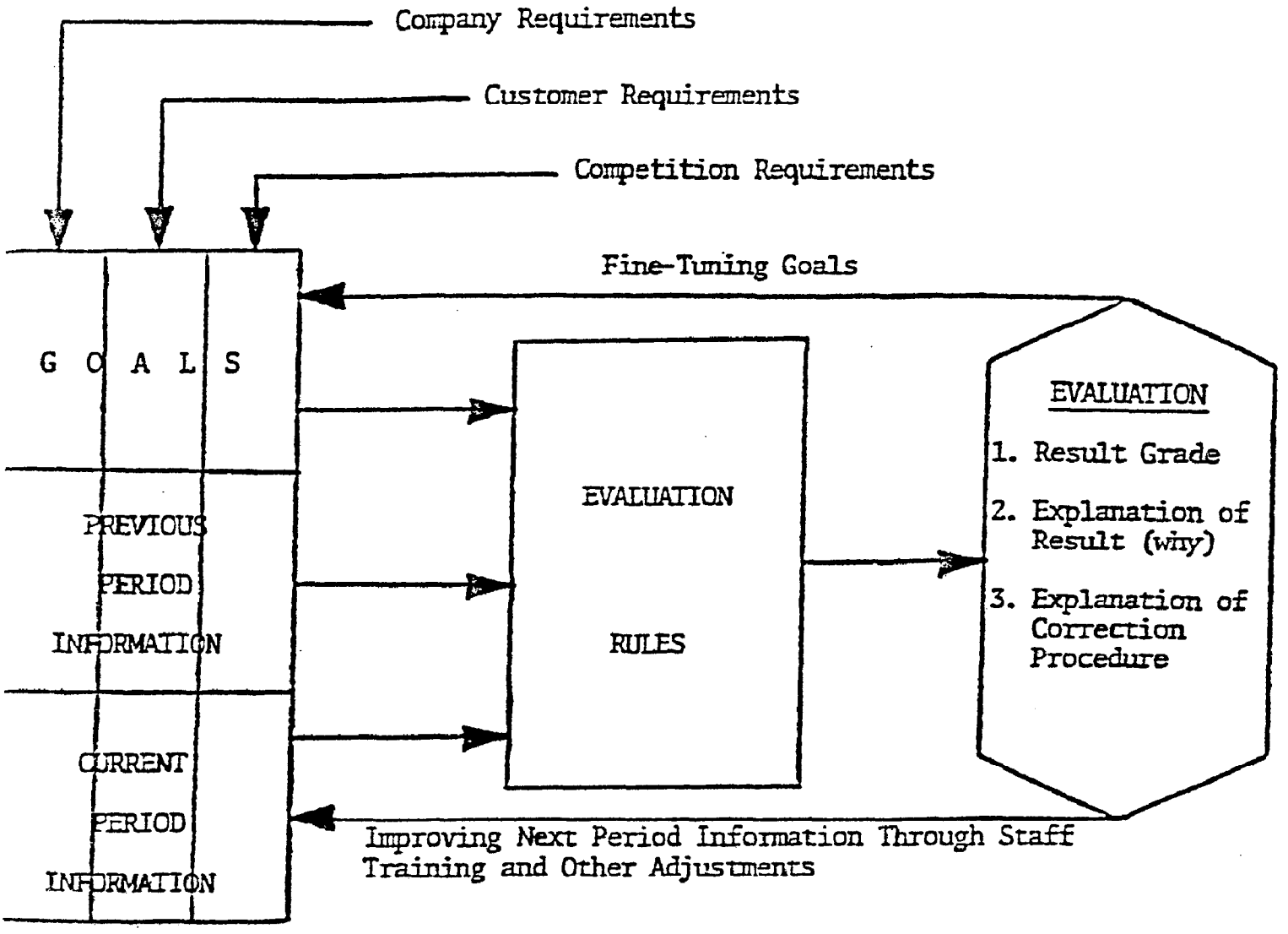
  The resulting four main areas of customer service center management responsibility and how each area relates to the customer service department and the company is given in the figure on Prototype Perspective in Relation to Customer Service.

- Second, once the formal outline was established, an attempt was made to find some simple initial performance measurements to work with in each of the areas of the formal outline. These measurements were captured through discussion of questions like the following:

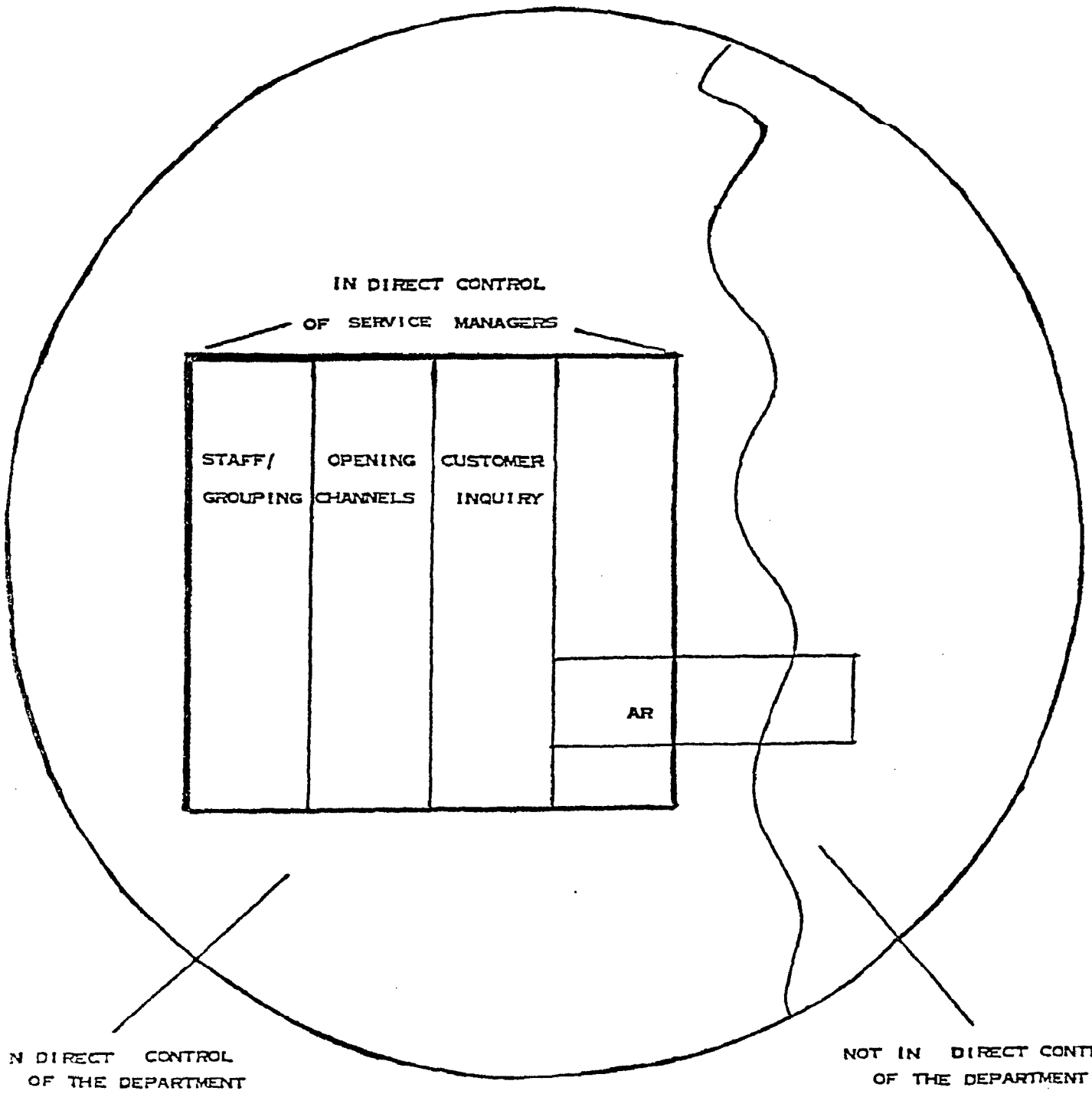
  -- How would you measure this area?
  -- What makes a manager good in this area?
  -- How would you evaluate a manager in this area?

  An example of performance measurements for the staff/grouping and customer inquiries areas are given below.

THE SYSTEM: HOW THE SYSTEM WORKS



PROTOTYPE PERSPECTIVE IN RELATION TO CUSTOMER SERVICE



Performance Measurement Examples

STAFF/GROUPING AREA

Performance is dependent on the performance in:

- hiring new employees
- grouping staff members
- determining individual work assignments

Performance of grouping staff members is dependent on the performance in:

- evaluating and measuring employees
- training employees
- physically laying out employees

Performance of determining individual work assignments is dependent on performance in:

- knowing the jobs
- knowing the individuals

CUSTOMER INQUIRIES AREA

Performance Measurement: Average Transfers Per Inquiry

- Third, once the measurements of the areas were established, an attempt was made to establish evaluation rules and grades based on standards, last period figures, and current period figures. This kind of knowledge was captured through a discussion of a question like the following:

  -- Suppose a manager had this current period measure in this area, the current goal was this, and his measurement for last period was this; is he doing poor, good, or excellent?

An example of the rules to evaluate a manager in the inquiries area is given below.

Customer Inquiries Rules

RULES

- If Current Period Avg Transfers Per Inquiry < Standard AND
  Current Period Avg Transfers Per Inquiry <= Last Period

  OR

  Current Period Avg Transfers Per Inquiry = Standard AND
  Current Period Avg Transfers Per Inquiry = Last Period

  THEN EXCELLENT.

- If Current Period Avg Transfers Per Inquiry > Standard AND
  Current Period Avg Transfers Per Inquiry >= Last Period

  THEN UNHEALTHY.

- OTHERWISE, GOOD.

- Fourth, once the evaluation rules and grade were established, an attempt was made to establish prescriptions to aid a "not excellent" manager. This was captured through discussion of questions like the following:

  -- Suppose a manager had this current period measure in this data, the current goal was this and his measurement for last period was this; what, if anything, is he doing wrong and how would he correct it?

  A summary of example inquiry - area prescriptions is given below.

Customer Inquires Prescription

PRESCRIPTIONS

- Have a "who handles what" list at reception and have the customer request the product by name.
- Separate cases of standard customers from others.
- Limit "run around", if possible.
- Channel to distributor or others where appropriate.
- If all else fails at reception desk then take best guess of which customer service expert should be drafted to handle the call.

The resulting prototype 1) asks the user what area he would like to be assessed in, 2) does readings of the goal(s), previous period figure(s), and current period figure(s) [either automatically or by manually asking the user], 3) provides an evaluation result grade, 4) allows the user to ask what the reasoning behind grade determination is, and 5) provides the user with a prescription if his grade is not excellent.

Expert Inquiry Handler System Design

INTRODUCTION

The emphasis on inquiry handling in Phase II of the project came from an analysis of company problems and from the results of the prototype developed in Phase I. Through customer complaints, customer surveys, and through input from people within the company, it was clear that customer service opportunities existed in the functions related to customer inquiry handling. The prototype of Phase I accomplished its objectives and the inquiry handling area had been developed some in Phase I. Handing customer inquiries was selected as the area to pursue because of the acceptance of the Phase I prototype and the belief that the area offered an excellent opportunity to improve productivity.

At the center of the problems with customer inquiry handling is the simple fact that inquiries are too often mismatched with inquiry handlers. The following cases illustrate typical problems:

1. Established customers may call the receptionist (who handles all inquiries initially) instead of calling their service representative directly.

2. Customers may be on the phone with the service center for quite some time before they find out that the company does not have information on that inquiry.

3. Customers may be on the phone with a particular service center for quite some time before they find out that the service center does not have information on that inquiry. They may go through this with several service centers before they find the right one.

4. Customers who have gotten hold of the right service center may not reach the right person. This means that they may not get enough information, they may get misinformation (wastes to the customer), or they may get too much information (waste to the company).

5. Customers may inquire about products using the competition's product name. This frequently finally results in the customer being told that the company does not carry that product, regardless of whether the company really does carry it by another name.

These cases illustrate several of the situations where the chemical company believes productivity can be increased significantly through a product inquiry expert system.

LEVELS 1, 2, AND 3 OF THE DESIGN

The answer to the customer inquiry handling problems is to have an expert handle the inquiries, and this expert will have to rely on the resources of the service center for help in handling the inquiries. Refer to the figure of Design Level 1 that shows the high-level interaction between customer and customer service center on an inquiry. All inquiries will be initially handled by the Reception Inquiry Handling Module of the Customer Service Center and this module will count on aid from the Non-Reception Inquiry Handling Module and the Data Base Module of the service center for help. Refer to the figure of Design Level 2 for this illustration.

Before the detailed design of the Reception Inquiry Handling Module (the one with the expert system in it) is given, a description of the other two modules is given along with a description of the part each plays in the expert inquiry handling process. Refer to the figure of Design Level 3 for the breakdown of each of the three subcomponents.

The Data Base Module consists of three main sets of files: products, departments, and customers. For each file set there exists a file for each of many levels of detail, from a very detailed file that includes every field pertinent to that file set type to a very generalized file with field summaries. This module will serve as a set of facts to be utilized by the inquiry expert to help answer such questions as:

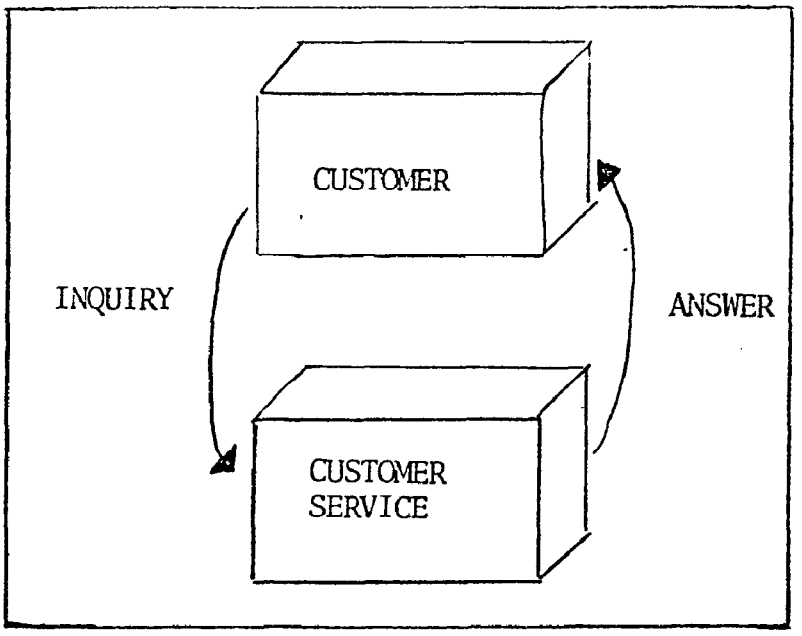
1. Which service representatives handle which customers?
2. Which products are handled by this company?
3. Which departments are handled by this company?
4. Etc.

Extremely important to the Expert Inquiry Handler is the fact that it can access the company files on its products, departments, and its customers at many levels of detail. Behind the use of this module is knowledge of the structure of the data, often referred to in the literature as "meta-data" knowledge [10], knowledge to control the data (read, write, etc.), and knowledge of how to answer the question at hand.

The Non-Reception Inquiry Handling Module is the second resource module to the Expert Inquiry Handler and it consists of the customer service experts and representatives. The service representatives will be needed to handle those calls of established customers who have taken a wrong turn (by "inquiring" through the reception point) and the service experts will handle those inquiries that the expert inquiry handler is unable to handle directly. [A true expert directs questions he is unable to answer to someone who knows more, and that is what is expected of this system.] Behind the use of this module is knowledge of which service

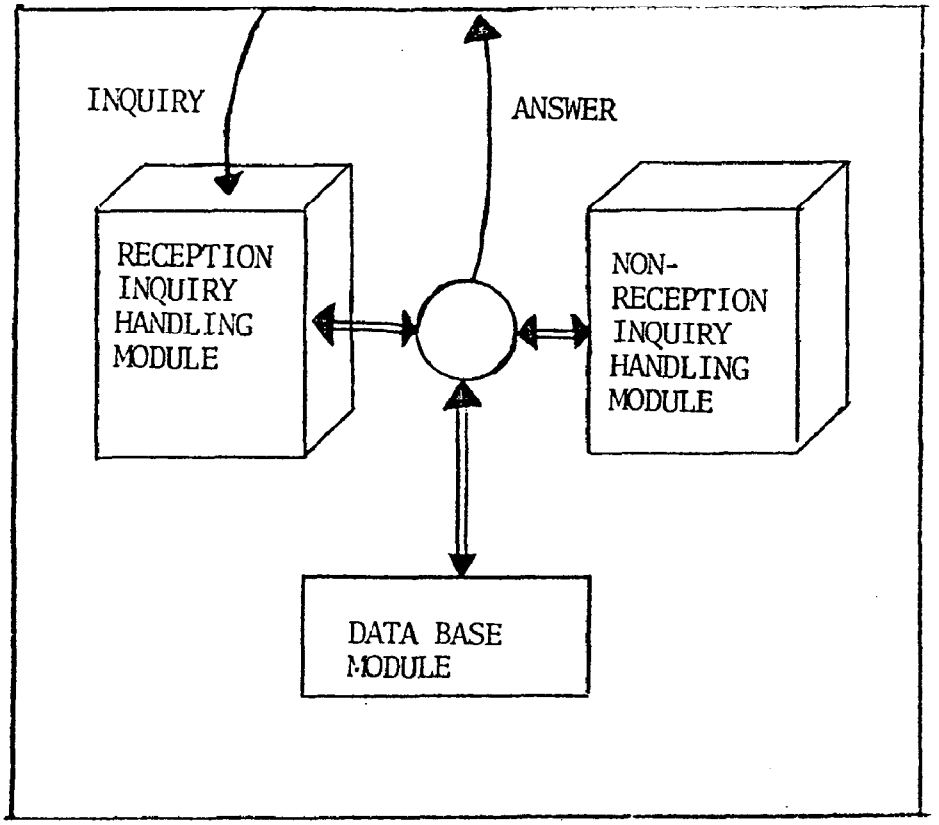
Design Level 1:

Customer/Customer Service Inquiry Interaction



Design Level 2:

Customer Service Components Inquiry Interaction



representatives handle which products/departments, and more complicated other kinds of knowledge (knowing when to direct the inquiry to the customer service experts, knowing when to direct the inquiry to another service center, etc.).

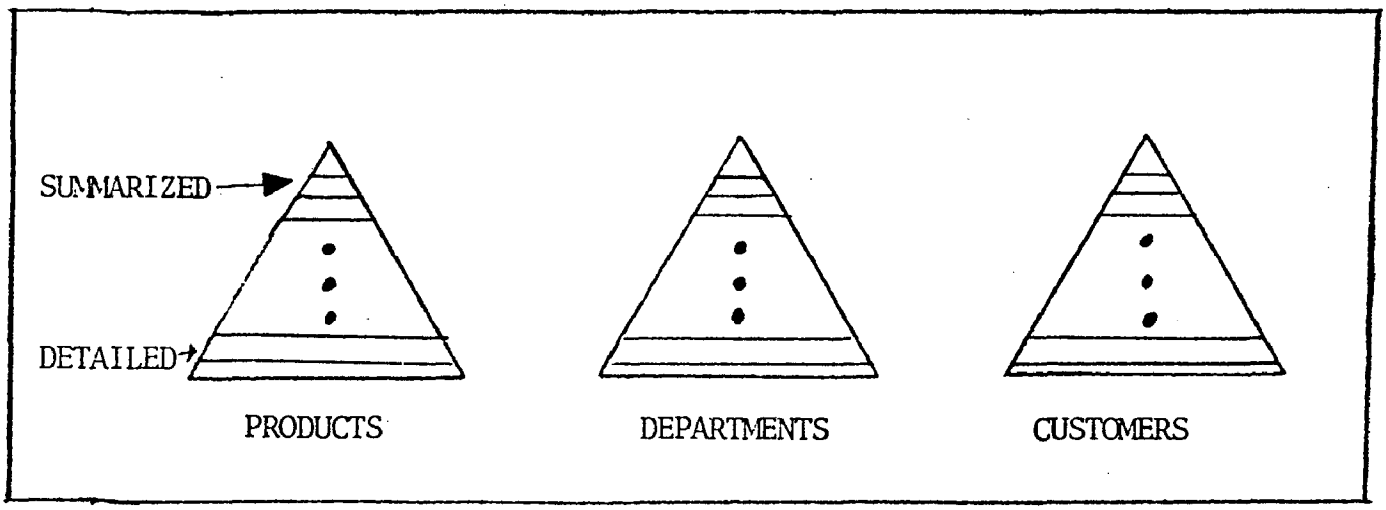
Now that the resource modules have been introduced, it is time to introduce the module that performs the expert inquiry handling: the Reception Inquiry Handling Module. This module is made up of the receptionist and the Expert Inquiry Handler Expert System. Refer to the figure of Design Level 3 for an illustration of the components of this module and a list of its functions.

The Reception Inquiry Handling Module is responsible for expertly handling inquiries that are from established customers, inquiries that are not to be completely answered by the company, inquiries that are not to be completely answered by the service center, and new inquiries that are to be completely handled by the service center. Through use of the Data Base Module and the Non-Reception Inquiry Handling Module, the Reception Inquiry Handling Module is able to expertly handle all inquiries. Refer to the next section of this paper for the kinds of knowledge and the decision-making utilized by the Expert Inquiry Handler Expert System.

Design Level 3:

Customer Service Subcomponent Breakdown

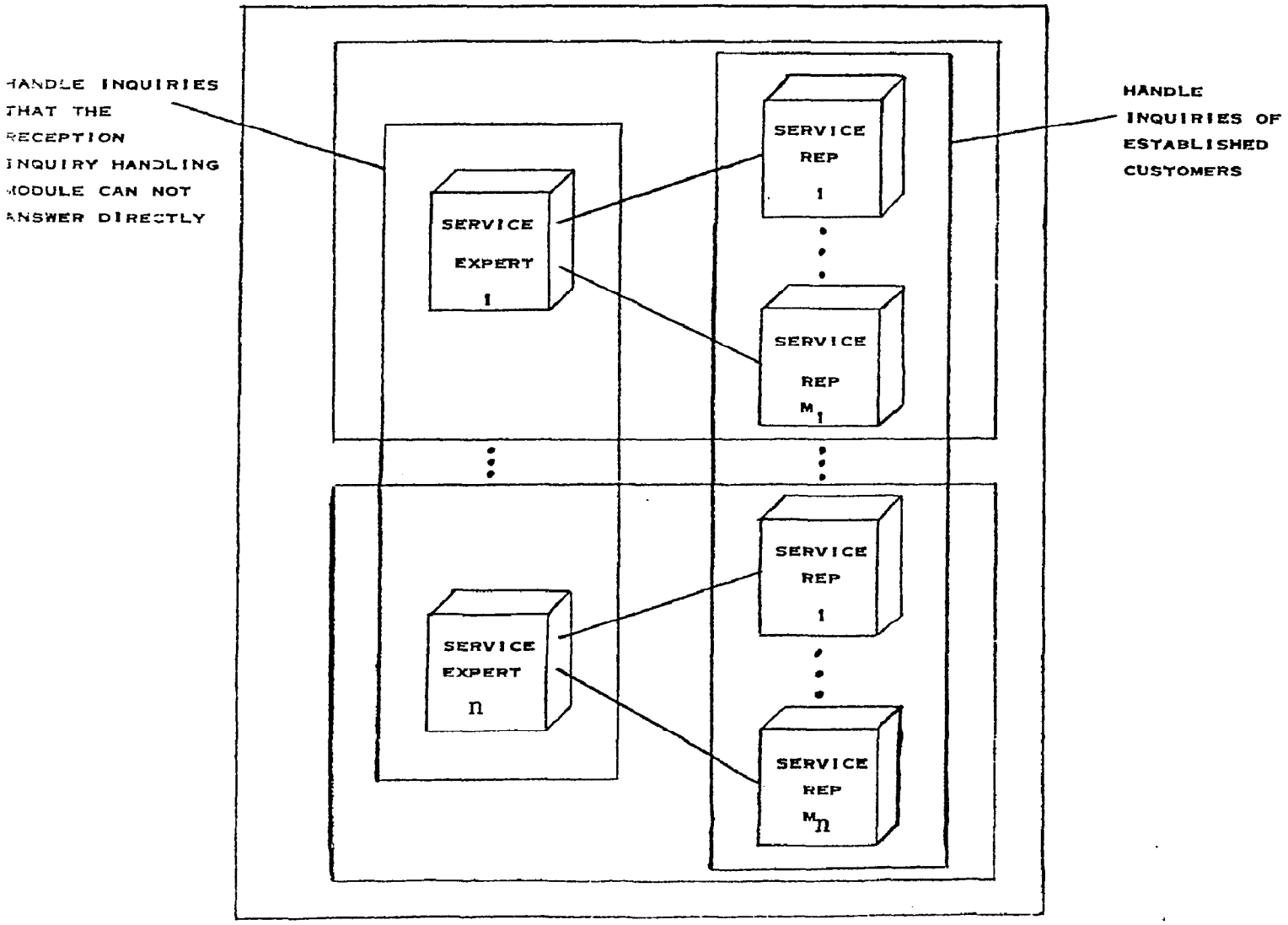
(a) DATA BASE MODULE BREAKDOWN



Design Level 3:

Customer Service Subcomponent Breakdown (Continued)

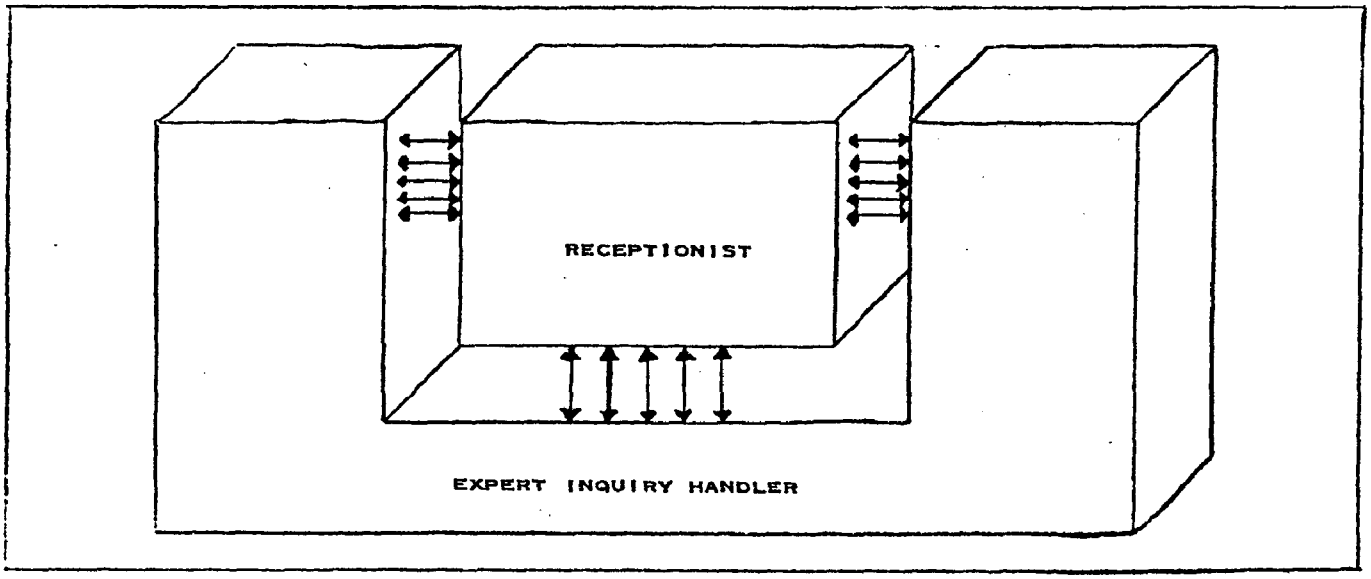
(b) NON-RECEPTION INQUIRY HANDLING MODULE BREAKDOWN



Design Level 3:

Customer Service Subcomponent Breakdown (Continued)

(c) RECEPTION INQUIRY HANDLING MODULE BREAKDOWN



1. For inquiries that are established customers

   a. Give the name and number of the service representative
   b. Notify customer that better service comes from calling service rep directly
   c. Transfer call to the service rep.

2. For inquiries that do not belong to the company

   a. Notify the customer
   b. In some cases (common inquiries or "common company mistakes") suggest who to call and what telephone number

3. For inquiries that do not belong to the service center

   a. Notify the customer
   b. Tell them which service center to call and what telephone number

4. For some inquiries -- answer them directly

5. For all other inquiries -- direct to proper service expert

DETAILED DESIGN OF THE EXPERT INQUIRY HANDLER

The Expert Inquiry Handler design begins to clarify what it means to interface an expert system with a conventional data base [10] [20] [23] [26] [27] [29] [34] in customer service inquiry handling and the decision-making outlined in the design shows the power of constraint propagation [27] [31] [32] over a large search space.

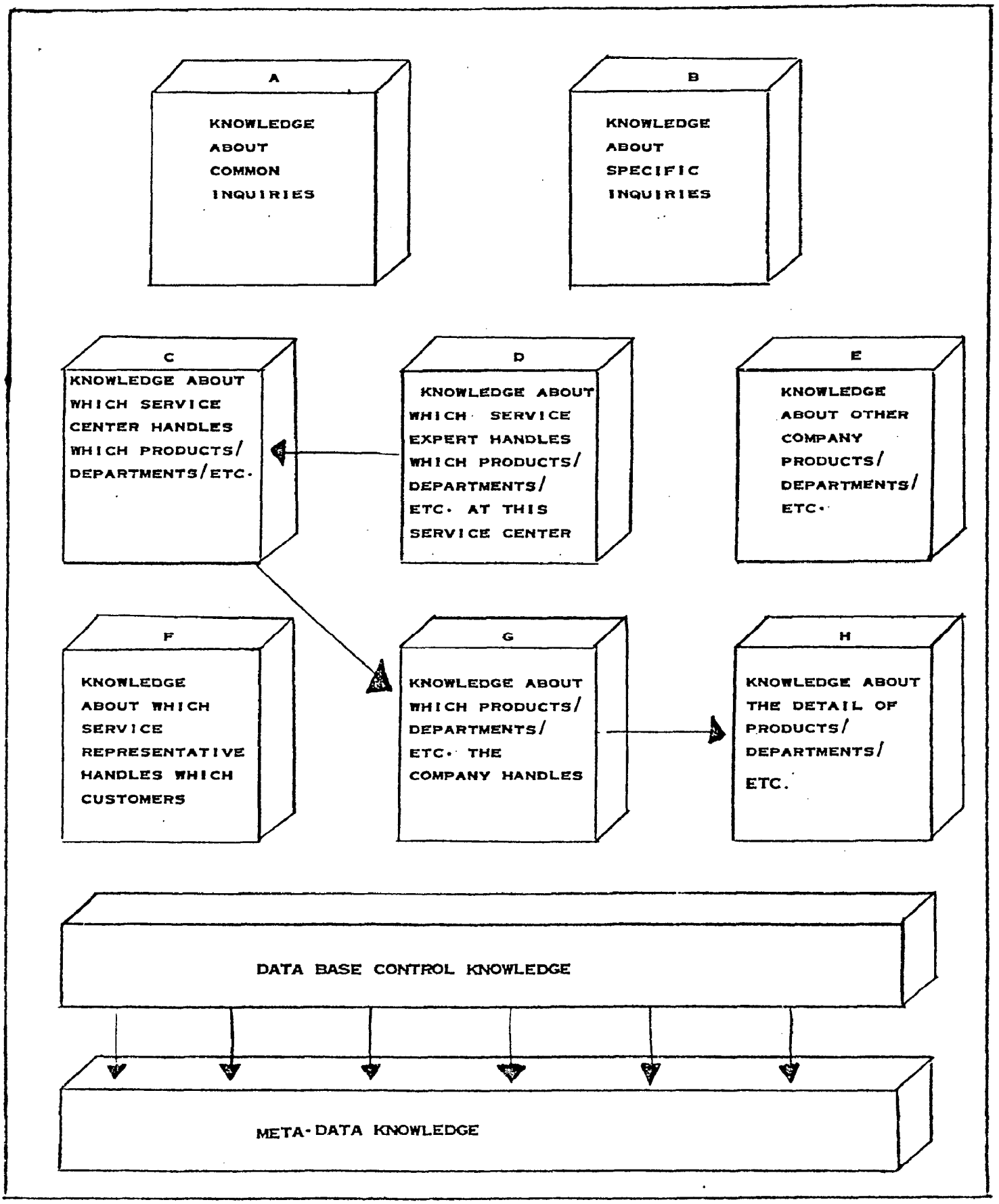
Underlying the interface between the Expert Inquiry Handler and the Data Base Module is Meta-Data Knowledge and Data Base Control Knowledge. The Meta-Data Knowledge knows the structure of the Data Base and the Data Base Control Knowledge knows how to use that structure. On top of these two kinds of knowledge there is knowledge about which service representative handles which customers, knowledge about which products/departments/etc. the company handles, knowledge about what each of the service experts at this center handle, knowledge about other company products/departments/etc., and knowledge about the detail of the company products/departments/etc. Refer to the figure of Design Level 4 for an illustration of the kinds of knowledge in the Expert Inquiry Handler.

The Figure of Design Level 5 illustrates the decision-making done by the Expert Inquiry Handler and it gives references to the kinds of knowledge utilized at each decision point. Through the answering of a set of questions (either answered by the inquiring customer or by the system itself), the Expert Inquiry Handler is able to constrain the amount of its knowledge and the amount of data necessary from the Data Base Module at each decision point. The result of the decision-making is an efficient and effective answer to almost every inquiry.

Note that most of the kinds of knowledge that make up the Expert Inquiry Handler are factual or "control-like" in nature, but the knowledge about common inquires and the knowledge about specific inquires are true rule-based knowledge-bases that would handle "real" service center inquiries. These two rule-based knowledge sources would be developed in cooperation with the customer service experts (refer to [3] for a step-by-step description of the knowledge engineering methodology utilized by the authors) and this development result would define at what point the Expert Inquiry Handler would be unable to handle an inquiry and would need the customer service expert to take over.

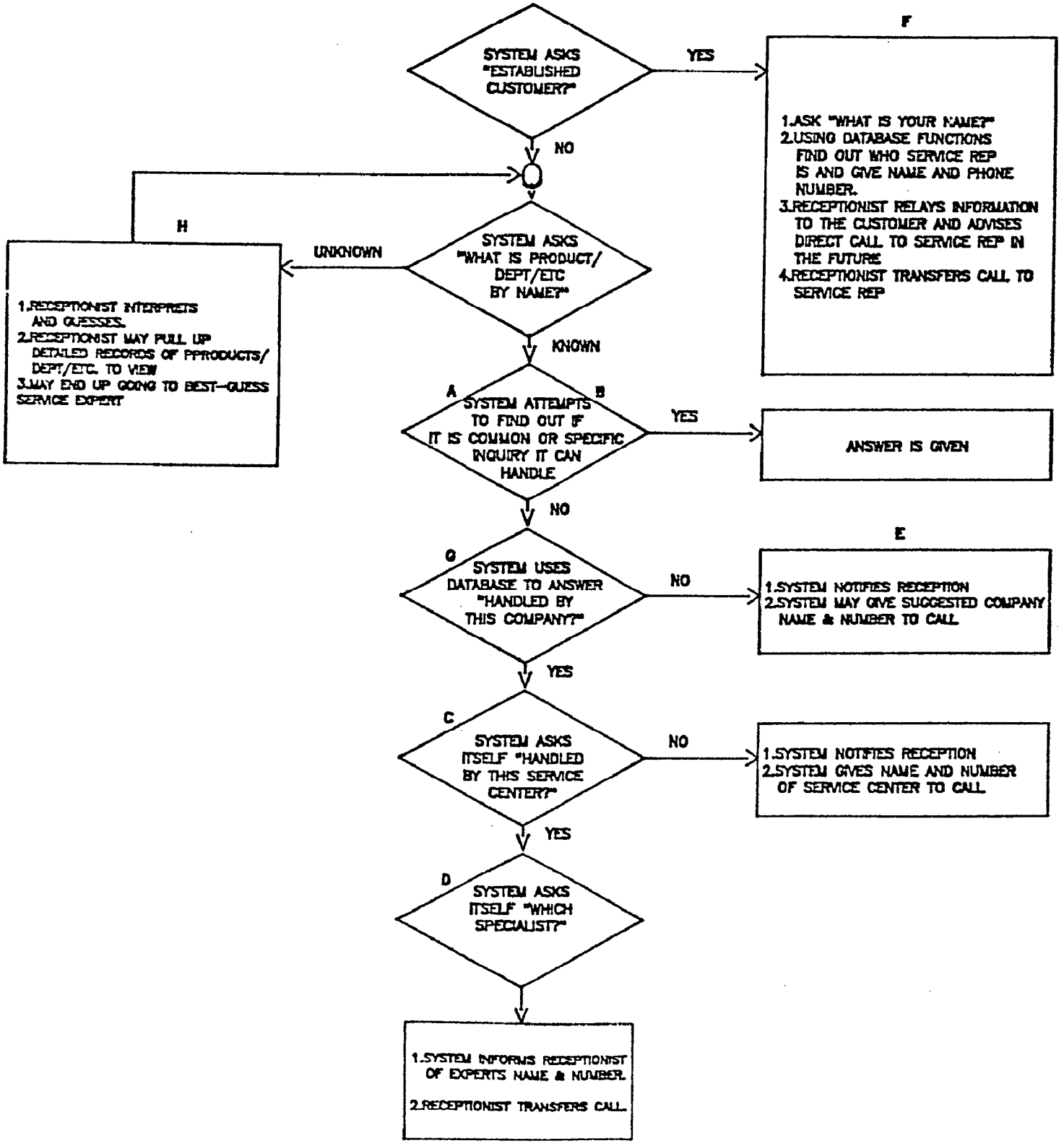
Design Level 4:

Expert Inquiry Handler Breakdown



Design Level 5:

Expert Inquiry Handler Decision-Making



CONCLUSIONS AND FUTURE RESEARCH

What has been described is 1) the design, implementation, and results of a prototype for customer service center managing and 2) the design of an expert inquiry handler for customer service center inquiries. The design used in the prototype had been previously utilized [7] [8], it was enhanced some, and it is expected to be used in other business applications. The strengths of this design include quick prototyping, aid to establishing performance measurements, and a good and effective diagnostic prototype system.

The Expert Inquiry Handler is expected to produce useful utilities for future projects (like the utility knowledge of the Meta-Data and Data-Base Control levels) in the chemical company and useful changes to the data base. An illustration of "useful changes" would be to represent knowledge (facts) about which service centers and service experts handle which products/departments/ etc. by using the database instead of the knowledge-base. Thus, down the road it would be expected that the data base would hold all factual knowledge groups and the Expert Inquiry Handler knowledge-base would hold all rule-based (as opposed to factual) knowledge groups.

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