UTILIZATION OF EXPERT SYSTEMS

IN SELECTED INDUSTRIES

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INTRODUCTION

The concepts of artificial intelligence (AI) and expert systems (ES) are currently receiving considerable attention in research publications. Articles about expert systems' advances are appearing more and more on a regular basis in business journals, research journals, and professional journals. Artificial intelligence is one of the most debated issues in technology today. Many groups are spending large sums of money on research in this field in an attempt to develop artificial intelligence and to discover some of its most promising applications.

AI involves using computers without the assistance of humans to solve problems that require intelligence. It is a search in an attempt to discover and describe aspects of human intelligence that can be simulated by machines. The extent to which machines (usually computers) can perform these tasks independently of people is still limited. Machines currently exhibit only rudimentary levels of intelligence. The possibility exists that machines can be made to show comparable behavior indicative of intelligence equal to or perhaps, superior to that of humans. The new

science of artificial intelligence seeks to create computers that think and react to information that is able to reach unique and accurate conclusions for any given situation.

An expert system (ES) is software that duplicates human reasoning in solving problems. These systems are computer programs that are able to imitate and to equal the performance of human experts on certain specialized, professional tasks. Expert systems are a combination of artificial intelligence programming techniques and knowledge of experts in a particular field. By duplicating decision-making patterns of these experts, expert systems arrive at the most feasible conclusion(s) possible for any given situation. The intent of ES is to provide the computer with the same capabilities as an expert.

Because of the increasing dependence of society on computers, most artificial intelligence experts and specialists believe that expert systems are a vital necessity to mankind's survival. It is believed they hold the key to solving many of the problems we currently encounter with computer usage. Thus, according to Keim (1986), the expert systems of the future should be very exciting!

Statement of the Problem

The problem of this study was (1) to determine the extent of use of expert systems in industry and (2) to obtain quantitative information concerning the present and future

effect and utilization of expert systems applications in industry.

An attempt was made to answer the following specific questions:

1. To what extent are expert systems presently being used in industry?
2. What expert systems are currently being used in industry?
3. What are the future plans for the inclusion of expert systems applications in industry?
4. What types of business applications are handled by ES when first implemented?
5. What types of business applications are currently being handled by ES?
6. What types of business applications will be handled by ES in the future?
7. What types of employee skills are needed to work with and to maintain ES?

Statement of Purpose

The purpose of this study was to provide information about expert systems applications for use in developing future curriculum for artificial intelligence instruction in information processing.

Need for the Study

The perception of expert systems today can be compared to our perception of computers about fifteen years ago. At that time, the computer operators in the back rooms of businesses were the only people who claimed to understand the

new machines. Rarely did anyone else use computers.

Today, personal computers are as common as typewriters and they are no longer mysterious. Expert systems will probably follow the same pattern. Eventually, expert systems will be commonplace in the corporate environment and in society at large.

Lin (1986) reveals that the success of some expert systems has recently caught the attention of business executives and that many expert systems for business applications will become available in the next few years. This being the case, colleges and universities should be addressing the concepts of expert systems in their classrooms in order to meet the growing demand for qualified personnel who are familiar with some of the ES applications of artificial intelligence being used in industry.

As this new technology becomes an integral part of our lives, business educators must seriously look at the curriculum offerings and course content in the computer information processing area. Computer Information Systems (CIS) faculty must meet the challenge by acquainting students with the specifics of expert systems applications through coursework that will prepare them for work in industry.

When knowledge of the current status and trends of expert systems is known, recommendations can be made to administrators responsible for curriculum development and maintenance. This study was designed to collect, analyze, interpret, and report the current applications of expert

systems in industry. It will determine if businesses are actually designing, purchasing, and using expert systems, and if so, what types and sizes, for what applications, and what types of employees are staffed to develop and maintain them. Michaelsen (1983), believes that executives who choose to ignore expert systems may find themselves at a competitive disadvantage within the next decade.

Delimitations

The following delimitations were imposed for the purpose of this study:

1. Only businesses that were members of the Fortune 500 group were part of this study.
2. Each company was limited to one response per department per questionnaire.
3. Only those skills and courses designed, or required, to train employees for expert systems applications were examined.
4. The study was not intended to result in specific guidelines but as a basis for future curriculum development.

Limitations

The following limitations exist for the purpose of this study:

1. The information was accurate only to the extent that the answers to questions were valid.
2. Information analyzed was limited to respondents who voluntarily returned the questionnaire.
3. The respondents may not be representative of the total population.

Definition Of Terms

In order to clarify the wide variety of definitions used in the information processsing area, the following terms are defined as used in this study:

Artificial Intelligence - research designed to imitate human intelligence with the use of a programmed knowledge-base. It is a part of computer science that attempts to use computers for tasks that usually require human intervention.

Computer Information Systems - a name used for a degree program in data processing in some schools of business. It is the combination of communication processes in a business.

Consultation - the process of producing expert advice or solutions to a problem.

Cybernetics - "concerned with control mechanisms which enable biological, organizational, or artificial systems to operate successfully. Artificial Intelligence developed as an offshoot of cybernetics, rather than as a branch of computer science" (Tomeski, 1986, p. 7).

Database - a set of data a company collects that can be accessed by employees whenever needed. It contains information about employees, customers, and vendors affiliated with the company.

Domain - "the application area for which an expert system is being developed" (Liebowitz, 1988, p. 170).

Expert Systems - computer programs that are able to equal the performance of human experts. These programs serve

as decision makers or assistants by providing advice and suggesting solutions in certain situations. The advice is comparable to that which would be offered by a human expert in that problem area.

Heuristics - problems-solving techniques that improve the efficiency of the problem-solving process through successive `trial and-error' attempts at a solution. Its use is usually restricted to those things that are not guaranteed to be successful. Heuristics are used to reduce the time required to solve complex search problems.

Industry - all gainful activity in the production and manufacture of goods and commodities in commercial and professional dealings. It is used synonymously with business.

Inference Engine - uses information in knowledge base to produce new knowledge or conlusions by questioning the user and interpreting the appropriate rules of relationship.

Information Retrieval - searching and extracting information from a database through the use of a computer.

Information Systems - application areas integrating the use of hardware and software to accomplish certain goals. It is the organized computerization of business applications.

Intelligence - "the degree to which an individual can successfully respond to new situations or problems. It is based on the individual's knowledge level and the ability to appropriately manipulate and reformulate that knowledge (and

incoming data) as required by the situation or problem" (Hunt, 1982, p. 137).

Knowledge base - the part of an expert system that contains decision rules used for specific applications that is used to solve a problem.

Knowledge-based Systems - "a program in which the domain knowledge is explicit and separate from the programs's other knowledge. A computer program that applies specialized knowledge to the solution of problems. An expert system is a knowledge-based system that is intended to capture the expertise of human domain experts" (Hunt, 1982, p. 147).

Knowledge Engineer - artificial intelligence programmer who constructs expert systems by interacting with the human expert and codifies his/her knowledge for incorporation into a knowledge base.

Knowledge System - expert system that makes decisions based on logic.

LISP - (LISt Processing) a logic programming language used to develop expert systems, natural language processors, and other artificial intelligence applications. It uses symbols and lists to develop applications.

Logical Decision - a computer's ability to perform a specified function of making a choice between two or more alternatives.

Management Information Systems (MIS) - computing services which provide timely and accurate information to management.

PROLOG - a logic programming language that has been used for more than a decade by computer scientists working in the artificial intelligence field. This language consists of rules for providing relations among objects.

Robotics - science of designing and using robots to perform certain tasks.

Shells - expert systems development tool consisting of two standalone pieces of software.

Tools - software packages used to build an expert system that will contain specific data.

Hypothesis

The following hypotheses were formed to test the data collected from the participants:

1. There is a significant difference in the extent of use of expert systems in various types of industry.
2. There is a significant difference in the current expert systems applications found in various types of industry.
3. There is a significant difference in the required expert systems skills of existing employees in various types of industry.
4. There are significant differences of opinions of respondents concerning expert systems among companies studied when analyzed by company background.
5. There are significant differences of opinions of respondents concerning expert systems among companies studied when analyzed by gross sales.

CHAPTER II

REVIEW OF RELATED LITERATURE

This study concerns the current status and trends of expert systems business applications in industry. The related literature was surveyed with the following purposes in mind: (1) to review current uses of expert systems business applications in industry, (2) to assess the demand for expert systems programs and qualified personnel in this area, and (3) to determine curriculum implications of these uses in information processing programs.

Overview of Expert System Technology

One of the fastest growing applications of artiticial intelligence is the use of expert systems. Expert systems technology is still relatively new. Winston and Prendergast (1984) contend that the technology will be remote, inaccessible, and awkward to work with at first but that eventually the tools will improve, the technology will become accessible, and personal expert systems are likely to be commonplace in the corporate environment and in society at large.

Experts are still divided on an exact definition. Such names as knowledge-based systems, expert consulting systems, and rule-based systems are often used

synonymously with expert systems. Liebowitz (1988) describes an expert system as a computer program that emulates the behavior of human experts within a specific domain of knowledge.

Hunt (1986) explains that an expert system is a computer program that contains both declarative knowledge (facts about objects, events, and situations) and procedural knowledge (information about how to use those facts) to emulate the reasoning processes of human experts in a particular domain.

Hayes-Roth, Waterman, and Lenat (1983) explain that the area of expert systems investigates methods and techniques for constructing man-machine systems with specialized problem-solving expertise, expertise consisting of knowledge about a particular domain, understanding of domain problems, and skill at solving some of these problems.

Regardless of the difference in terminology, since the mid 1960's, there has been considerable success with expert system development. The first-generation systems focused solely on performance, the behavior best understood in expert system development. The second-generation systems focused on explanation and knowledge acquisition. These efforts are in an early stage. Merry (1985) explains that the well-known early expert systems, DENDRAL and MYCIN date from the late 60's and early 70's.

Wos, Overbeek, Lusk, and Boyle (1984) believe that perhaps the best known expert systems are:

1. MYCIN, developed to offer consultation in a limited area of medicine

2. DENDRAL, created to aid in analyzing organic chemical compounds, and

3. PROSPECTOR, programmed to aid in selecting sites for mineral exploration

Hart (1986) also suggests three additional systems as some of the better known ones:

1. R1 or XCON, a commercially used expert system which configures VAX computer systems

2. PROGRAMMER'S APPRENTICE, assists programmers in the tasks of software construction and debugging

3. TAXMAN, a system to interpret tax laws and suggest arrangements that can be chosen to meet financial objectives

Other applications of expert systems to be developed in recent years include games of strategy. Games such as checkers, chess, backgammon and the game of go are examples of programs which have been produced that play better than the majority of people who play these games.

For several reasons the development of expert systems to play games is interesting. The first reason is that no single basic algorithm has been found that provides the basis for a program that plays several different games well. The second reason for the development of expert systems being interesting is that the development of expert game-playing programs offers the opportunity to study the stages of development that an expert system might go through. In addition, such programs can be used as teaching devices. They can evaluate a player's moves, recommend alternatives that are better, and offer precise reasons for the choices (Wos, Overbeek, Lusk, and Boyle, 1984).

Hayes-Roth, Waterman, and Lenat (1983) report that most knowledge-engineering applications fall into a few distinct types. These categories are:

* Interpretation - inferring situation descriptions from sensor data (surveillance, speech understanding, image analysis, signal interpretation)

* Prediction - inferring likely consequences of given situations (weather forecasting, demographic predictions, traffic predictions, crop estimations, military forecasting)

* Diagnosis - inferring system malfunctions from observables (medical, electronic, mechanical, software diagnosis)

* Design - configuring objects under constraints (circuit layout, building design, budgeting)

* Planning - designing actions (automatic programming of objects that perform functions, i.e. robots, project, route, communication, experiment, military planning problems)

* Monitoring - comparing observations to plan vulnerabilities (computer-aided monitoring systems for nuclear power plant, air traffic, disease, regulatory, fiscal management tasks)

* Debugging - prescribing remedies for malfunctions (for correcting a diagnosed problem)

* Repair - executing a plan to administer a prescribed remedy (debugging, planning, and execution capabilities)

* Instruction - diagnosing, debugging, and repairing student behavior (diagnose weaknesses and identify appropriate remedy)

* Control - interpreting, predicting, repairing, and monitoring system behaviors (air traffic control, business management, battle management, mission control)

These few accomplishments tell us that expert system technology is still experimental but is rapidly growing and developing into a science of its own, even though we have experienced limited development so far. The road has been laid for researchers to begin to develop theories for prospective applications to be used in various areas of industry and, in particular, applications in business.

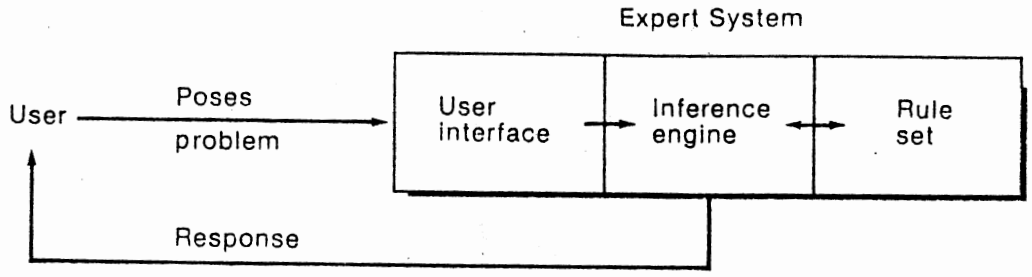
System Structure and Development

According to Michie (1982), expert systems can vary considerably from one another in terms of system design and capabilities.

Townsend and Feucht (1986) agree that a knowledge system has certain characteristics that distinguish it from other types of systems:

1. It is limited to a specific domain of expertise.
2. The knowledge base and the reasoning mechanism are distinct entities. In fact, it is often possible to use the reasoning mechanism with other knowledgebases to create a new expert system.
3. It is generally best at problem solutions involving deductive reasoning.
4. It can explain its reasoning in a way that can be understood by the user.
5. The output is qualitative (as opposed to quantitative).
6. It is modular in design and can grow incrementally with the knowledgebase.

Basically, an expert system is comprised of three main components. They are the knowledge base, the inference engine, and the user interface. Figure I illustrates the structure of a conventional expert system and the structure of a business expert system as illustrated by Holsapple and Whinston (1987):



Structure of a business expert system

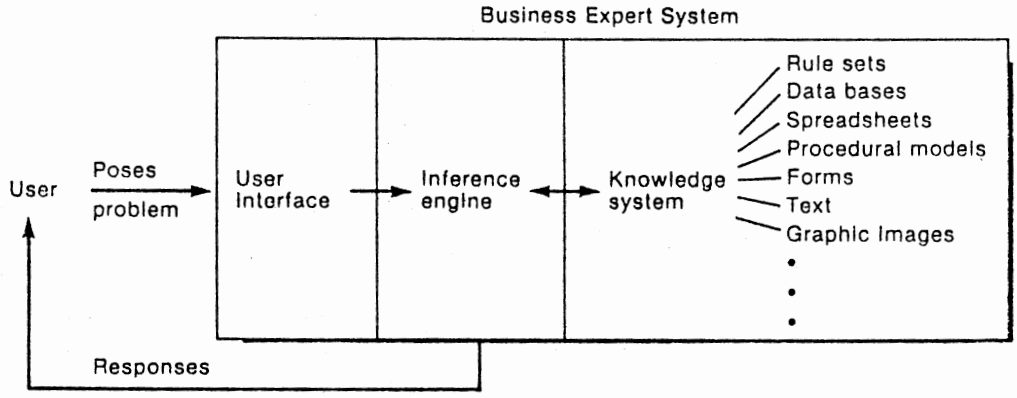


Figure 1. Structure of a conventional expert system and a business expert system

The knowledge base holds the knowledge about a particular topic in the form of facts and relationships. It is generally stated in if/then rules that are declarative and procedural (as procedures and functions in a particular programming language) knowledge that pertains to a specific problem. The inference engine uses this knowledge to infer new knowledge by questioning the user and interpreting the appropriate rules of relationship. It is the component referred to as a generalized reasoning machanism which interprets the rules in the knowledge base and performs logical inferences. The inference engine's reasoning ability draws upon the rules in the knowledge base to arrive at a solution to the problem.

The first step in development of a field is to research case studies. One idea at a time is tested and evaluated as one single point of emphasis. As these ideas accumulate, certain patterns may begin to develop. These patterns allow researchers to make observations they continue to test. The work on expert systems is currently somewhere between developing case studies and that of collecting informal rules of thumb developed during the research process.

The stages in expert systems development are similar to traditional computer systems development. The following list suggests a sequence of stages of development of an expert system (Winston and Prendergast, 1984):

* System design
* System development

* Formal evaluation of performance
* Formal evaluation of acceptance
* Extended use in prototype environment
* Development of maintenance plans
* System release

Hart (1986), however, identifies stages in expert system development that are not as clearly defined as the traditional development process. These stages are:

* Identification
* Knowledge acquisition
* Design
* Development and testing
* Use

The identification stage is necessary to define the objectives of the expert system according to available resources such as equipment. Once this has been done, extracting the knowledge of experts is the next step. This requires the specialized skill of knowledge engineers. It is the responsibility of knowledge engineers to prepare for knowledge elicitation from experts by researching the problem and doing background reading of published materials in order to know as much about the domain as possible before interviewing experts. The knowledge engineer must also identify appropriate experts who can be used for the project. Once this information is gathered, the design phase begins based on the type of knowledge base and inference mechanism that must be used in the system. After careful testing,

which may take considerable time, the expert system is ready to be implemented, while still being monitored until it can be used with confidence.

Expert systems development requires working with knowledge as opposed to working with procedures. Therefore, an important step in the development process is experts' knowledge elicitation by knowledge engineers.

Hart (1986) stresses that all the knowledge must be acquired before it can be represented, and it is this area which is restricting expert system development at present.

There are different methods of knowledge acquisition to be used that include observations, group discussions, interviews, and questionnaires.

A study by O'Shea (1985) reports the following information as it relates to data elicitation as a major problem in the acquisition of knowledge by knowledge engineers:

> A major problem in the development of knowledge based (`expert system') systems is the acquisition of knowledge from domain experts. The prevailing method for such knowledge requisition is the interpretation of verbal data, usually obtained during interviews with the expert, in terms of a formalism suitable for implementation. Although verbal data seem to be the most convenient source of information for knowledge acquisition--due to their richness, expressiveness and the natural way in which they are used to communicate knowledge in general- there are a number of serious problem with the elicitation, interpretation and quality assessment of verbal data.

There is a number of methods for the elicitation of verbal data, ranging from rather open interviews to self-report data obtained in highly controlled experimental situation. We have found five basic methods (Breuker & Wielinga, 1983). In the traditional interview, a number of topics is addressed (focussed interview), or a number of concepts is explicated by deep probing (structured interview). Introspection refers to a situation in which the expert gives an account of how he would solve an imaginary, but typical case. In self report the expert produces an on-line thinking aloud protocol while solving a real problem. Such problem solving can be performed in interaction with a user (via teletypes), thus simulating interactions of the prospective expert system: user dialogues. Finally, the expert may be asked to review protocols obtained earlier. Within each methods, various strategies may be employed. In Table I the basic methods with some strategies are presented. The kind of data that can be obtained by each method, differ widely, as is summarized in this table as well (p. 3).

TABLE I

KNOWLEDGE ELICITATION METHODS AND NATURE OF DATA

Method/Strategy	Data on
focussed interview probing incident reclassification	factual knowledge types of problems critical functions of expertise environment (objects, agents) user characteristics
structured interview socratic dialogue 20 questions	structure of concepts (part of) mental model reasoning/explanation
introspection hypothetical case forward scenario	global strategies justification evaluation
self report secondary task selective report	use of knowledge sources heuristics reasoning strategies
user dialogues real life via teletype	user-expert interaction problem 'negotiation'
review of data of prototype	repair of gaps in data interpretation of data justification

Although verbal data are in principle an ideal source for knowledge acquisition, in practice their interpretation is often problematic. It is well known that verbal data can be interpreted in a variety of ways, depending on the viewpoints of the speaker and listener, the assumed background knowledge and possible social effects. Besides the fact that verbal data are hard to interpret in a consistent way, these data are almost always incomplete (Ericsson & Simon, 1980; Breuker, 1981).

Some of the reasons for incompleteness are:

* Omissions. In recalling some cases, or cases in general, the expert may forget to mention many essential features or special conditions.

* The knowledge states may be hard to express in language, because they are very rich, or require drastic transformations.

* Many knowledge states are not accessible for inspection by the mind's eye; the knowledge is 'compiled'.

* In language use, much information is communicated by simple reference to knowledge that is assumed to be known by the receiver (pragmatics). The receiver has to account for such 'gaps'. In an interview, an expert may not further elaborate some issue, assuming that the rest is known, but often the interviewer has no means to evaluate whether more is involved.

* Experts may not be motivated to reveal their inner thoughts. There are many reasons to believe that an expert is a priori uncooperative.

* Most experts have little or no experience in giving report of their thinking. Particularly, presenting on-line self report requires skill, analogous to on-line translation.

Apart from being incomplete, verbal data are often--though not inherently--inaccurate. Subjects, when asked to explain their behavior, often `fill the gaps` by sensible guesses, rather than accurate data (Ericsson & Simon, 1980). Self-report data suffer least from this problem but are seldomly used in knowledge acquisition (Welbank, 1983, Grover, 1983, Hayes-Roth, 1983). The reasons for not using self-report data become clear when the requirements for use and interpretation of the different types of data are concerned. With the order presented in Table II, the following requirements for the use of a method become more severe:

* The amount of acquaintance the knowledge engineer has with the basic concepts in a domain.
* The amount of cooperation that is required from the expert. Experts prefer interviews to self report.
* The amount of interpretation tools to process the data in a consistent way.

Although self-report data provide the most reliable information, planning self-report sessions requires considerable knowledge of the domain and the types of problems that the expert normally solves.

Further, the interpretation of self-report data requires a much more powerful model than does interview data (Welbank, 1983).

The process of developing an expert system is one of constant, incremental growth and improvement that will

continue during the entire useful life of the system. It is a substantial investment of time and manpower (Winston and Prendergast, 1984).

Evaluation of Expert Systems

Evaluation is an important part of expert system development because it determines whether the expert system is meeting its intended objectives. According to Liebowitz (1988), evaluation measures the software's accuracy and usefulness. Evaluations help to determine how accurate the knowledge base is, as well as the accuracy of its conclusions. Therefore, a standard needs to be developed as a guideline for acceptable answers with which system results can be compared.

The effectiveness of expert systems is usually verified by field use or by having a panel of expert judges evaluate the system's problem solutions (Michaelsen and Michie, 1986).

The evaluation process should be ongoing, starting with the design phase of development. In the beginning, system evaluation can be simple; but as the system begins to grow, a more structured evaluation process should be utilized.

Some individuals feel expert systems should not be evaluated at all because systems are continually being developed once they are implemented in industry. Instead of evaluating expert systems, their opinion is that time should be spent on building them.

Some aspects of a computing system's performance are more appropriately evaluated than others at a particular stage in the system's development. By the time a system has reached completion, however, it is likely that every aspect will have warranted formal assessment, including (1) the quality of the systems' decisions and advice, (2) the correctness of the reasoning techniques used, (3) the quality of the human-computer interaction (both its content and the mechanical issues involved), (4) the system's efficiency, and (5) its cost-effectiveness (Hayes-Roth, Waterman, and Lenat, 1983).

Performance evaluations should be designed before a system is built, not after it is built. This will help knowledge engineers gather the proper kind of data needed to effectively construct a system according to preestablished objectives.

Advantages of Expert Systems

Because expert system applications can operate at or near the level of human experts, certain advantages of expert systems for business can become reality. Liebowitz (1988) believes this is particularly advantageous in cases where one needs expert advice but is unable to get a human expert because of high costs, unavailability of human experts, or time constraints. He reinforces this thought by suggesting an expert system can be used to support and verify a human expert's opinion and that it can be used in situations in

which an individual may become easily flustered because of time and pressure constraints.

Townsend and Feucht (1986) address these knowledge system advantages over the human expert:

1. The knowledge system is not biased.
2. The knowledge system does not jump to conclusions.
3. The knowledge system applies a systematic process, considering all details, often working to the best possible alternative.
4. The knowledge base can be very, very large. Once stored, the knowledge is always accessible.
5. Knowledge systems are not "noisy." An expert is easily influenced by knowledge and perceptions that do not relate to the specific problem being analyzed. Knowledge systems, unencumbered with knowledge outside of the domain of interest, are inherently less noisy.

Hart (1986), however, stresses the following advantages as:

1. Availability of experts
2. Consistency of correct answers
3. Comprehensiveness of knowledge from more than one expert

Limitations of Expert Systems

The conventional expert system development tools used in industry present some problems for developing business expert systems. Certain limitations of knowledge systems exist when compared with the human expert. These problems have discouraged widespread use of expert systems' business applications. The limitations cover a wide variety of topics. Some of the problems, however, are common among

users of these systems. Common complaints are that systems are not user-oriented, they cannot apply intuition, and dialog is often slow. Townsend and Feucht (1986) believe the biggest problem remaining is that of getting the knowledge of the expert into a codified form that can be understood and used effectively by a computer.

One other problem is the programming of software applications. Companies that develop conventional tools used for developing expert systems have no experience in developing business software. On the other hand, companies that create business software lack the skills to develop expert system development tools. Holsapple (1987) feels that as they develop their AI skills or interests, business software companies will be well suited for producing expert system development tools that fit into the business-computing world.

Another problem is the specialized training required in expert system development. Business personnel do not normally possess programming skills in languages such as LISP or PROLOG required for development of these tools. There is a personnel shortage of knowledge engineers because this field is new, and they are the individuals responsible for acquiring, representing, and programming expert knowledge.

Still another problem is the number of potential applications for business that are numerical in nature. Conventional tools are limited in number-handling capabilities.

It must be mentioned that another problem arises from the availability of special hardware needed to run advanced conventional tools. Microcomputer and minicomputer applications are becoming available that are capable of operating these programs but which cannot support business software.

In order to represent reasoning knowledge in expert systems, an increasing number of reasoning rules must be implemented. When the number of reasoning rules begin to increase to the point the knowledge engineer is unable to maintain these rules, it detracts from the performance of the system. This results in a less-efficient expert system.

Mention must be made that some expert system development tools may have no built-in controls for modifying software behavior or performance in certain reasoning activities. This means that what may reason well for some expert system applications may not reason well for others.

Conventional development tools are used to build only expert systems and support only one knowledge-processing activity of reasoning. This creates a problem for development of business applications because in business there is more than one management function that must be considered.

All of these problems must be solved in order to provide a smooth transition into the application of expert systems technology to business.

Research in Expert Systems

Interest in artificial intelligence is not limited to researchers in academia. Many large companies are involved in artificial intelligence research, and several smaller companies have been created to deal with artificial intelligence products (Keim and Jacobs, 1986).

A report by Michaelsen and Michie (1983) reveals that during the past year (1982), expert systems research in the United States has shifted to private companies where the latest developments are difficult to ascertain.

There is considerable industry speculation about what expert systems will be able to accomplish and the time frame required to create them. The time between researching expert systems in the labortory and actual implementation into industry is considerable. The time required to create systems varies greatly, depending upon the type of problem that must be solved, the level of performance achieved by the system, and the amount of knowledge needed to build the knowledge base. Winston and Prendergast (1984) suggest that developing a substantial expert system with real performance takes at least five man-years of effort, assuming the team already has some background in artificial-intelligence problem-solving techniques. However, they also feel that if the team is starting from scratch with this technology, then developing a high-performance expert system can take considerably longer.

Liebowitz (1988) states that the major areas of needed research include the following:

1. Knowledge acquisition/extration
2. Better understanding of analogical reasoning and learning
3. Developing expert systems that can learn from previous experiences.
4. Standard methodology of validation

Liebowitz (1988) also states that ancillary research issues pertaining to expert system development include these:

* Improving explanation capabilities
* Having better expert system architectures and inference procedures
* Incorporating the ability for expert systems to make assumptions and expectations
* Improving methods of handling uncertain, incomplete, and inconsistent information
* Developing better user interfaces
* Creating parallel processing approaches

If these areas of research are addressed, utilization of expert systems for business applications will increase.

Current Applications and the Role of Expert Systems in Business

There are many expert system applications that have been created and numerous more that are in the design stages of businesses. Townsend and Feucht (1986) report that certain

applications are more suitable for solutions with knowledge systems than others:

1. Knowledge systems should be used primarily when the data and knowledge are reliable and do not change with time.

2. The space (or domain) of possible solutions should be relatively small.

3. The problem solution should involve formal reasoning.

4. There should be at least one acknowledged expert, who should be able to explain his or her knowledge and the methods used to apply knowledge to the problem.

They also suggest the following types of tasks should not be done with expert systems:

Mathematical applications - These generally are solved using formulas and procedural analysis.

Perceptual problems - Perceptual problems are generally solved using numerical techniques.

Problems in which no knowledge exists - If no knowledge exists, it would be impossible to create the knowledge base.

The first uses of expert systems seldom addressed the areas of industry use, particularly, in management support. Early emphasis was with the use of expert systems in manufacturing, medical diagnosis, medicine, geology, engineering and chemical analysis. Today, research is concerned with business applications. According to Leigh (1986), the first requirement in dealing with expert systems in business is to establish a realistic perspective.

Holsapple (1987), reports that the application of this new, integrated approach to expert systems for management can change the very nature of decision-making processes,

managerial practices, and an organization itself. These systems are solving problems that exist in the various disciplines of management, including, but not limited to, operations research and management science, financial planning analysis, personal tax advising, applied economics, stocks, options trading, insurance underwriting, and sales order analysis. Other possible applications include recommending acquisition strategies, providing investment counseling, and generating project proposals. Most problem-solving tasks in organizations are possible applications, regardless of the level of responsibility.

Computer technology, one of the most important developments experienced by society has affected the life of almost every existing human. Marketed only three decades ago, the electronic computer has had a tremendous impact on society with virtually every aspect of business now utilizing the computer in some fashion (Aulgur, 1982). The use of management information systems, decision support systems, and integrated software applications makes it apparent how expert system technology naturally mixes well with business computing.

Academic Role in Expert Systems

Lampert (1985) reports that expert systems were born and nurtured in the esoteric realm of academe.

Industry dictates what colleges and universities must teach in the classroom. Responsibility rests with colleges

and universities to produce graduates who are prepared to work in industry. As the needs of industry change, so must the curriculum offerings in the programs at these institutions. Reservations have been voiced concerning the cooperation between industry and the academicians doing research in artificial-intelligence. Of great concern is the issue of whether or not enough manpower will be available to train the next generation of workers.

Winston and Prendergast (1984) feel that soon expert systems will be created in elementary courses in computing at the early undergraduate level.

Status of Qualified Personnel

Winston and Prendergast (1984) report that of approximately 2,500 people actively working on Artificial Intelligence in the United States, fewer than 250 are experienced and actively working in the area of expert systems.

There were about 400 knowledge engineers in 1983. Although the number will increase very rapidly, the shortage of knowledge engineers is not expected to be eased for several years (Lin, 1986).

Future Trends and Issues

The design, construction, and ongoing management of an effective infrastructure presents challenges to each of the traditional functional areas of management. Each area can

make important contributions to the realization of viable knowledge-based organizations. The focal point for study and research into these organizations will be a new area, referred to as knowledge management systems (KMS), which transcends the more narrow interest of fields such as MIS and DSS. Its mission involves the indentification and creation of concepts, methods, and tools for maximizing the global knowledge worker productivity in an organization (Holsapple and Whinston, 1987).

Expert systems that learn from their experiences, that acquire their knowledge bases directly, that make effective business decisions, that have improved explanation and inferencing capabilities, and that easily interact with each other are on the horizon (Liebowitz 1988).

Tomorrow's knowledge-based organizations using artificially intelligent application systems for decision support will play a prominent role in society.

Tomeski and Klahr (1986) believe that the one thing all artificial intelligence experts and specialists agree is that the future belongs to expert systems!

Summary and Critique

Expert systems are most often needed when the efficiency of an organization's experts is inadequate in areas that consume large amounts of time because of a high frequency of application (Michaelsen and Michie, 1986).

As the information age evolves, it becomes increasingly obvious that in any decision-making process, what we need is not just more information but more intelligent techniques to obtain better, more pertinent, and accurate information. With artificial intelligence techniques, information processing can be augmented with capabilities to deal with incompleteness, inconsistency, uncertainty, different beliefs, views, and attitudes (Cuadrado and Cuadrado, 1986).

Additional inquiry is needed to increase available knowledge of the current status and trends in the uses of expert systems applications in industry, as well as the future plans for implementing expert systems applications.

CHAPTER III

RESEARCH DESIGN AND PROCEDURES

The following steps were used in researching the problem, planning the study, conducting the survey of Fortune 500 businesses in the United States, and presenting the results of the study on utilization of expert systems applications in business:

1. Review of related literature
2. Development of the research questionnaire
3. Pretesting the research questionnaire (Pilot Study)
4. Preparation of the cover letters and follow-up letter
5. Selection of the population
6. Collection of the data
7. Analysis and interpretation of data
8. Presentation of conclusions and recommendations

This study was designed as a descriptive study in order to obtain data from businesses concerning their utilization of expert systems' applications. Data were obtained from respondents concerning the type and size of their business, whether or not they utilized any type of expert system application, what types of applications their business had, or if they intended to purchase expert system applications in the near future. Through the descriptive data obtained from

the returned questionnaires, it was possible to tabulate the number of firms by type and size which do and do not utilize expert systems. For businesses that utilize expert systems, the data indicate the type of computer hardware, and applications used by particular types and sizes of business, as well as the types of employees working with expert systems.

This chapter describes the research design by elaborating on each of the steps employed in completing the study.

Survey of Related Literature

The available professional publications and literature relating to expert systems applications were examined to determine if similar studies had been made and to review the literature concerning the use of expert systems in industry. Sources used included the Business Education Index (1985, 1986, 1987), the Index to Doctoral Dissertations in Business Education 1900-1975 (1975), 1975-1980 (1981), 1980-1985 (1986), Research: Process and Product (1977), Design and Conduct of Educational Surveys and Experiments (1977), Business Periodical Index (August 1983-April 1988), Educational Resources Information Center (ERIC), 1966-June 1987, an on-line search of the business database ABI Inform, 1971-May 1987, and the Dissertation Abstracts International Database, July 1980-December 1987, at the Oklahoma State

University Library, and numerous professional journals and computer magazines.

The review of literature was helpful and informative, even though there were no studies found, published at this time, which dealt primarily with the use of expert systems applications in industry.

Development of the Research Questionnaire

The research instrument designed to gather data for this study was an eight-page questionnaire. After thoroughly reviewing literature relating to questionnaire design, analysis of numerous sample questionnaires, and consultation with various faculty members in the College of Business Administration and the department of Applied Behavioral Sciences in the College of Education at Oklahoma State University, the completed questionnaire was printed.

The questionnaire went through numerous revisions by the researcher as it was reviewed and critiqued by faculty members at Oklahoma State University. This consultation and evaluation indicated a need for minor clarifications on specific items. Every effort was made to develop a questionnaire that was easy to follow and complete and that contained questions which were clearly stated and not ambiguous. It was designed to be completed by the respondent in approximately 15 minutes.

The final instrument was a printed eight-page, 8 1/2-by 11-inch questionnaire (see Appendix). It was printed on

canary yellow paper in an effort to obtain a higher response rate. To protect the anonyminity of the respondents, the questionnaire did not require a signature or name of the company. However, an identification number was used only for the purposes of the researcher in order to facilitate a follow-up mailing.

The questionnaire encompassed four sections, including the following:

I. Business Information

II. Personal Information

III. Expert Systems Applications Information

IV. Additional Comments/Optional

Section I of the questionnaire contained questions designed to obtain a profile of the company, including primary business purpose, annual gross revenue, number of employees, makes and models of computer equipment, expert systems development tools (shells), the quantity of each type of equipment currently utilized, geographic location of company, whether designated person is responsible for expert systems, and whether the firm utilized any expert systems, and if so, what types of applications.

Section II of the questionnaire sought data with respect to the respondent's sex, age, position, years in present position, highest educational level, and education or training in expert systems.

Section III of the questionnaire was designed to obtain the types of expert systems applications initially used in

the company, used currently in the company, and anticipated to be used in the company. It included the source of the expert systems' business applications used in the company, the amount of money spent on expert systems' development/maintenance, and the number of workers employed in the expert systems area now and in the future.

Section IV solicited additional optional comments considered relevant but not addressed in previous sections.

To facilitate ease of completion, thereby encouraging response, the survey instrument was designed in a straight-forward, easy-to-answer format. Related to the purpose of the study, the questions were formulated to be as clear, specific, and concise as possible. In developing the questionnaire for reliability and attractiveness, clear and complete directions were included, along with a title reflecting the purpose of the study, varying type style and size for headings, and professional quality reproduction.

Pretesting the Research Questionnaire (Pilot Study)

After careful consideration of the design of the questionnaire, a pilot study was mailed on November 1, 1987, to the following in order to pretest the questionnaire and cover letter:

1. Researchers's doctoral committee members.
2. One faculty member of Management Information Systems, Department of Management, College of

Business Administration at Oklahoma State University.

3. One instructor in Educational Research/Statistics in the Applied Behavioral Studies in Education at Oklahoma State University.
4. Five employees from five different computer-related companies using expert systems applications located in Oklahoma. These names were provided by Dr. In Hai Ro, Associate Professor in the Computer and Information Science Program, Division of Business, Langston University, Langston, Oklahoma. Dr. Ro has been employed for two and one-half years in expert systems-related work for the United States Geological Survey and was acquainted with each of the industry persons on the pilot study. These persons were chosen as they closely resembled the targeted population to be receiving the actual questionnaire.

The response rate to the pilot study was 92.0 percent. After the piloted questionnaires were returned, the questionnaire was again revised and critiqued by Oklahoma State University faculty members.

A letter thanking all pilot study respondents for their participation and assistance in revising the questionnaire was sent to respondents at Oklahoma State University and respondents in industry. A copy of the thank-you letter is included in the Appendix.

Preparation of the Cover Letters and Follow-up Letter

The cover letters were carefully constructed in order to encourage the businesses receiving it to participate in the study by completing and returning the questionnaire. The cover letters were written in the format and style of a business letter and were concise and explanatory. Both cover letters were reproduced on College of Business Administration, Oklahoma State University stationery and were co-signed by the dissertation advisor, Dr. Jeretta A. Horn. (See Appendix C for a copy of the cover letters.) The cover letters were addressed to the systems analyst with a request that the contents of the envelope be forwarded to the appropriate person, encouraging that individual to complete and return the questionnaire.

The follow-up letter was also written to be explanatory, to-the-point, and in a business format. It contained much encouragement for the businesses to complete and return the questionnaire as soon as possible and was written to be appealing to even the most disinterested individual in order to solicit a response. The follow-up letter was also reproduced on College of Business Administration, Oklahoma State University stationery, and was co-signed by the dissertation advisor, Dr. Jeretta A. Horn. (See Appendix for a copy of the follow-up letter.)

Selection of the Population

In the early planning stages of this study, a decision was made to survey the Fortune 500 companies. The population used for this study was selected from the April 27, 1987, edition of Fortune Magazine. The Fortune 500 companies are the biggest industrial corporations in the United States; and during 1987, they experienced record sales and earnings. Profits went from $64 billion to $91 billion.
This figure represents a 41% increase over the previous year (1986).

A study by Tootelian and Gaedeke (1987), a replication of a 1974 study that sought to determine corporate policies toward responding to academic research, what top corporate executives liked and disliked about such studies, and what factors influenced their decisions on whether to respond, sought to assess the continued viability of the Fortune 500 as a source of information for academic studies. This study received responses from 101 companies, providing a 20 percent response rate. It was revealed that while this response rate was somewhat low, it was not uncommon for mail surveys. This study also revealed that Fortune 500 companies may have increasingly adopted polices regarding whether to respond to academic mail surveys. While no massive shift away from responding was found, it seems likely that the policies will center on responding subject to time constraints or not responding at all. The greater number of surveys being directed to the chief executive officers, coupled with their

dislike for the time it takes to respond, supports this conclusion. The conclusion drawn from this study indicate that while the Fortune 500 corporations may not have reached the saturation point in terms of responding to academic mail surveys, they are surely still an endangered species.

The 1987 edition of The Corporate 1000 Directory (1986), was used to obtain the addresses of the businesses to be used in the population. This directory was designed principally to help identify and contact the executives who lead and manage large corporations in America. There are four indexes: an individual name index, a company and subsidiary index, a geographical index by state, and an index of companies by industry. The business activities of the 1000 companies are as follows: 595 manufacturing/industrial, 143 diversified services, 59 retailing, 56 utilities, 48 diversified financial, 45 transportation, 30 life insurances, and 24 banks.

The population's addresses were entered into a database file created by Mr. John Smith, Director of Unitized Data Systems, Langston University, Langston, Oklahoma. The program was run on a Digital Equipment Corporation (DEC) VAX 11/750, and printed on 3 1/2" by 15/16" pressure sensitive printout labels.

Collection of the Data

The original mailing was sent to the Fortune 500 companies in the United States and included a cover letter,

the research questionnaire, and an addressed postage-paid return envelope. Approximately five weeks after the original mailing was completed, a follow-up letter, a copy of the questionnaire, and an addressed postage-paid return envelope were sent to all nonrespondents.

The timetable for mailings of the original and follow-up materials was as follows:

1. Original mailing--February 1, 1988
   Date requested for return--March 1, 1988
2. Follow-up mailing--April 15, 1988
   Date requested for return--April 30, 1988

There were 134 return replies on this study instrument from the 477 companies contacted. This is a 26.8 percent response. The percentage of returns and nonreturns is reported in Table II.

TABLE II

DISTRIBUTION OF THE POPULATION BY RETURNS AND NONRETURNS TO THE STUDY INSTRUMENT

Category	Number	Percent Total (N = 500)
Total businesses in population	500	100.0
Total businesses thought to have been contacted	477	95.4
Total businesses with bad addresses not contacted	23	4.6
Total respondents from original mailing	81	16.2
Total respondents from follow-up mailing	53	10.6
Total respondents	134	26.8
Total usable returns	128	25.6
Total nonusable returns	6	1.2
Total nonrespondents	366	73.2

Analysis and Interpretation of the Data

After the questionnaires were returned, the responses were coded and entered into a data set. A statistical analysis program entitled "The Statistician," written by Quant Systems, Charleston, South Carolina, was used to tabulate the responses from each questionnaire and to reveal the frequencies and percentages of each response for each question on the questionnaire. The tabulation of the data collected is shown in table form in Chapter IV. The interpretation of the tabulated data resulted in the findings which are also reported in Chapter IV.

Presentation of Conclusions and Recommendations

On the basis of the findings reported in Chapter IV, conclusions and recommendations were made which are included in Chapter V.

Summary

This chapter has described the steps used in researching the problem, planning the study, conducting the survey of Fortune 500 businesses in the United States and presenting the results of the study. The questionnaire was administered through an original mailing to all Fortune 500 businesses, and follow-up mailings to all nonrespondents. Several steps were taken to increase the response rate: formulation of a good questionnaire, selection of an appropriate population,

development of an appealing cover letter, and pursuit of non-respondents. These steps have resulted in obtaining a higher response rate, thereby contributing to a more valid, reliable study.

CHAPTER IV

ANALYSIS AND INTERPRETATION OF THE DATA

The research questionnaire was sent to Fortune 500 companies selected from the April 27, 1987, edition of Fortune Magazine. The data gathered concerned the utilization of expert systems' applications in business. The findings resulted from a detailed analysis of responses to the questionnaire.

Method of Analyzing the Data

Section I of the questionnaire was designed to obtain a profile of the company. Specifically, the questions concerned the primary business purpose, annual gross revenue, number of employees, name of department, makes and models of computer equipment, expert systems' development tools (shells), the quantity of each type of equipment currently utilized, geographic location of company, and whether designated persons are responsible for expert systems development.

Section II of the questionnaire included statements concerning the respondent's gender, age, job title, years in present position, highest educational level, education or training in expert systems, any artificial intelligence/expert systems related courses completed and/or

required, college attended, graduation year and degree received.

Section III questions identified whether the firm utilized any expert systems applications, and if so, the types of expert systems applications and the number of years initially used in the company, currently used in the company, and anticipated to be used in the company. It included the source of the expert systems business applications used in the company, the amount of money spent on expert systems development and/or maintenance, and the number of workers employed in the expert systems area now and in the future.

Section IV solicited additional optional comments considered relevant but not addressed in previous sections.

The clarification of "other" responses was allowed in all sections of the questionnaire. The questionnaire is in Appendix B.

A microcomputer statistical analysis program, The Statistician, by Quant Systems, was utilized to tabulate the responses of each item included in the questionnaire. The results from each response to a question were tabulated according to frequency of occurrence, cumulative frequency, percentage, and cumulative percentage. The specific results of the findings may be seen in the various tables in the following discussion and in Appendix D.

Data Analysis

Responses were received from 134 of the companies contacted throughout the United States. Of these, 128 were used for analysis of the data. There were six questionnaires returned which were not usable because of corporate policies of not participating in research studies or surveys except when required by law.

A total of 23 questionnaires were returned to the researcher with indications from the United States Postal Service of:

* Insufficient addresses (9)
* Forwarding order expired (3)
* Returned for postage (2)
* Return to sender (9)

The analysis is divided into three sections: an analysis of the company profiles, an analysis of the types of expert systems business applications used by those firms using expert systems applications, and an analysis of the expert systems' employees.

The first section on the analysis of the company profiles is subdivided into six areas: primary business purpose, annual gross revenue, number of company employees, department names, geographic location of company, and whether designated persons are responsible for expert systems development. Each area was analyzed using frequencies and percentages.

The second section on the analysis of the types of expert systems business applications utilized is subdivided into nine areas: utilization of expert systems, status of consideration to utilize expert systems if the firm does not currently utilize any type of expert systems' applications, the types and numbers of expert systems' business applications used on the computer system initially, the types and numbers of applications used currently, and the applications considered for future use, the make and model of computers presently used for expert systems' development, expert systems development tools (shells), the source of expert systems business applications, and vendor name when applicable. Each area was analyzed using frequencies and percentages.

The third section on the analysis of the employees in the expert systems area is subdivided into four areas: the types of expert systems employees currently use, types of expert systems employees needed in the next five years, required completion of artificial intelligence/expert systems related courses, and types of expert systems education or training received. Each area was analyzed using frequencies and percentages to determine status and trends of employee positions in the expert systems area of companies.

Analysis of the Business Respondents

This section presents an analysis of the types of businesses that responded to the questionnaire as well as

their state affiliation. The questionnaire contained one question for each of the following areas: primary business purpose, annual gross revenue, number of employees in the firm, name of respondent's department, state location of firm, and whether designated persons were directly responsible for expert system development. See Appendix B for the complete questions.

Respondents were asked to indicate the primary business purpose of their firm, and a space was allowed to specify a response of "other." Table III represents the analysis of this question. The type of business indicated most often was manufacturing, with 97 respondents, or 75.78 percent, while 5 respondents, or 3.91 percent, indicated computer/electronics and printing/publishing respectively. There are 19 "other" responses listed in Table IV.

Table V contains an analysis of the annual gross revenue of the respondents. One-hundred twenty-three of the respondents, or 96.10 percent, indicated they work in companies with annual gross revenue exceeding $25 million. The second highest level of annual gross revenue reported was $5-$9.99 million with two respondents, or 1.56 percent. One respondent, or .78 percent, indicated annual gross revenue of $4-$4.99 million and less than $1 million respectively. Thus, the majority of respondents work in quite large businesses.

Table VI contains an analysis of the respondents by the number of employees in their firm. Seventy of the

respondents, or 54.69 percent, worked in companies with more than 10,000 employees. Thirteen respondents, or 10.16 percent, worked in companies with 9000 to 9999 employees, and ten respondents, or 7.81 percent, had between 4000 and 4999 employees in their companies. Fifty-eight respondents, or 45.31 percent, worked in companies with fewer than 10,000 employees. The large number of employees reported by the majority of respondents indicate relatively large businesses.

TABLE III

ANALYSIS OF THE TYPES OF BUSINESSES

TYPE OF BUSINESS	FREQ.	CUM. FREQ.	PERCENT	CUM. PERCENT
Manufacturing	97	97	75.78	75.78
Printing/Publishing	5	102	3.91	79.69
Computer Electronics	5	107	3.91	83.60
Financial Services	2	109	1.56	85.16
Retailing	-	-	-	-
Wholesaling	-	-	-	-
Insurance	-	-	-	-
Medical	-	-	-	-
Utilities	-	-	-	-
Consulting	-	-	-	-
Construction	-	-	-	-
Transportation	-	-	-	-
Legal	-	-	-	-
Other	19	128	14.84	100.00

TABLE IV

TYPES OF PRIMARY BUSINESS PURPOSES THAT WERE NOT LISTED ON THE QUESTIONNAIRE BUT SPECIFIED UNDER "OTHER"

PRIMARY BUSINESS PURPOSE	FREQUENCY
Agriculture	1
Oil, Chemicals	2
Petroleum	2
Mining	2
Agriculture/Food Process Packaging	1
Energy	1
Consumer Products and Personal Care	1
Pharmaceuticals	1
Business Equipment and Supplies	1
Agri-Business	1
Aerospace, Polymers	1
Motion Picture Exhibition	1
Food Services	1
Health Care	1
Oil and Gas	1
Natural Resources	1

TABLE V

ANALYSIS OF THE ANNUAL GROSS REVENUE

ANNUAL GROSS REVENUE	FREQ.	CUM. FREQ.	PERCENT	CUM. PERCENT
Less than $1 million	1	1	0.78	0.78
$1 - 1.99 million	-	-	-	-
$2 - 2.99 million	1	2	0.78	1.56
$3 - 3.99 million	-	-	-	-
$4 - 4.99 million	1	3	0.78	2.34
$5 - 9.99 million	2	5	1.56	3.90
$10 - 14.99 million	-	-	-	-
$15 - 19.99 million	-	-	-	-
$20 - 24.99 million	-	-	-	-
Over $25 million	123	128	96.10	100.00

TABLE VI

ANALYSIS OF THE NUMBER OF FIRM EMPLOYEES

NUMBER OF EMPLOYEES	FREQ.	CUM. FREQ.	PERCENT	CUM. PERCENT
Less than 1000	4	4	3.13	3.13
1000 - 1999	6	10	4.69	7.82
2000 - 2999	7	17	5.47	13.29
3000 - 3999	4	21	3.13	16.42
4000 - 4999	10	31	7.81	24.23
5000 - 5999	5	36	3.91	28.14
6000 - 6999	3	39	2.34	30.48
7000 - 7999	3	42	2.34	32.82
8000 - 8999	3	45	2.34	35.16
9000 - 9999	13	58	10.16	45.31
More than 10,000	70	128	54.69	100.00

An analysis of the respondents by state of residence is given in Table VII. There were a total of 36 states represented, with the majority of the respondents, 13, or 10.16 percent, from Illinois. The states of Ohio and Pennyslvania were the second highest with 12 respondents, or 9.38 percent each. Ten respondents, or 7.81 percent, represented Texas and nine respondents, or 7.03 percent, represented California and Connecticut each. Collectively, these six states represented over half of the respondents.

Respondents were requested to identify the department name that most closely approximated the name of their department. As presented in Table VIII, 15 of the respondents, or 11.72 percent, indicated that "Information Systems" was used as their departmental title, while 14 companies, or 10.94 percent, utilized the title "Management Information Systems." "Information Services" was the third most popular name as cited by 12 respondents, or 9.38 percent. "Data Processing" and "Corporate Information Systems" were utilized as the department name by ten, or 7.80 percent and seven, or 5.47 percent respectively of the institutions responding to this item. Department names listed by those who chose to specify are summarized in the table.

TABLE VII

ANALYSIS OF RESPONDENTS BY
STATE OF RESIDENCE

STATE OF RESIDENCE	FREQ.	CUM. FREQ.	PERCENT	CUM. PERCENT
Alabama	1	1	0.78	0.78
Arkansas	1	2	0.78	1.56
California	9	11	7.03	8.59
Colorado	1	12	0.78	9.37
Connecticut	9	21	7.03	16.40
Delaware	1	22	0.78	17.18
Florida	2	24	1.56	18.74
Georgia	3	27	2.34	21.08
Idaho	2	29	1.56	22.64
Illinois	13	42	10.16	32.80
Indiana	4	46	3.13	35.93
Iowa	2	48	1.56	37.49
Kansas	1	49	0.78	38.27
Louisiana	1	50	0.78	39.05
Maryland	2	52	1.56	40.61
Massachusetts	4	56	3.13	43.74
Michigan	6	62	4.69	48.43
Minnesota	6	68	4.69	53.12
Missouri	2	70	1.56	54.68
Nebraska	1	71	0.78	55.46
New Hampshire	1	72	0.78	56.24
New Jersey	5	77	3.91	60.15
New York	4	81	3.13	63.28
North Carolina	1	82	0.78	64.06
Ohio	12	94	9.38	73.44
Oklahoma	4	98	3.13	76.57
Oregan	1	99	0.78	77.35
Pennyslvania	12	111	9.38	86.73
South Carolina	1	112	0.78	87.51
Tennessee	1	113	0.78	88.29
Texas	10	123	7.81	96.10
Utah	1	124	0.78	96.88
Virginia	1	125	0.78	97.66
Washington	1	126	0.78	98.44
West Virginia	1	127	0.78	99.22
Wisconsin	1	128	0.78	100.00

TABLE VIII

ANALYSIS OF DEPARTMENT NAMES

DEPARTMENT NAME	FREQ.	CUM. FREQ.	PERCENT	CUM. PERCENT
Management Information Systems	14	14	10.94	10.94
Infomation Systems	15	29	11.72	22.66
Systems/Data Processing	2	31	1.57	24.23
Data Processing	10	41	7.80	32.03
Information Center	1	42	0.78	32.81
Corp. Information Systems	7	49	5.47	38.28
Information Processing	1	50	0.78	39.06
Systems Development/ Info Services	1	51	0.78	39.84
AI Group	1	52	0.78	40.62
Technology Systems	1	53	0.78	41.40
User Support/Training	1	54	0.78	42.18
Information Services	12	66	9.38	51.56
Management Information Services	3	69	2.34	53.90
Information Systems/ Data Processing	1	70	0.78	54.68
Corp. Systems/Programming	2	72	1.57	56.25
Manufacturing Services	1	73	0.78	57.03
Systems and Programming	2	75	1.57	58.60
Systems	1	76	0.78	59.38
Business Systems	2	78	1.57	60.95
Integration Technologies	1	79	0.78	61.73
End User Computing	2	81	1.57	63.30
Corp. Expert Systems	1	82	0.78	64.08

TABLE VIII (Continued)

DEPARTMENT NAME	FREQ.	CUM. FREQ.	PERCENT	CUM. PERCENT
Corp. Data Services	1	83	0.78	64.86
Market Research	1	84	0.78	65.64
Computer Systems	1	85	0.78	66.42
Information Systems/ Control	1	86	0.78	67.20
Decision Support Services	1	87	0.78	67.98
Computer Services	1	88	0.78	68.76
Corporate Systems	2	90	1.57	70.33
Corporate Management Systems	1	91	0.78	71.11
Client Services, Info Resources	1	92	0.78	71.89
Emerging Technologies	2	94	1.57	73.46
Corp. Human Resources	1	95	0.78	74.24
Corporate MIS	2	97	1.57	75.81
Info Services Research/ Development	1	98	0.78	76.59
Corp. Information Management	1	99	0.78	77.37
Corp. Information Services	1	100	0.78	78.15
MIS and Communications	1	101	0.78	78.93
Data Processing/Systems	1	102	0.78	79.71
Data Processing/ Communications	1	103	0.78	80.49
Corporate Applications	1	104	0.78	81.27
Management Systems	1	105	0.78	82.05
Advanced Business Systems	1	106	0.78	82.83
AI Center	1	107	0.78	83.61
User Computing	1	108	0.78	84.39

TABLE VIII (Continued)

DEPARTMENT NAME	FREQ.	CUM. FREQ.	PERCENT	CUM. PERCENT
MIS Systems Development	1	109	0.78	85.17
Computer Systems Department	1	110	0.78	85.95
Corp. Systems/Data Processing	2	112	1.57	87.52
Branch Office	1	113	0.78	88.30
Expert Systems	1	114	0.78	89.08
Data Services	1	115	0.78	89.86
Decision Analysis	1	116	0.78	90.64
Info Systems/Services	1	117	0.78	91.42
Corporate Information Center	1	118	0.78	92.20
Information Services Planning	1	119	0.78	92.98
ES Group	1	120	0.78	93.76
Customer Service Group Info Systems	1	121	0.78	94.54
Research and University Relations	1	122	0.78	95.32
Advanced Information Technology	1	123	0.78	96.10
Info Technology Department	1	124	0.78	96.88
Financial Reporting	1	125	0.78	97.66
Advanced Technology	1	126	0.78	98.44
Accounting	1	127	0.78	99.22
Corporate Business System	1	128	0.78	100.00

Table IX contains an analysis of the number of people presently employed in the department. Over one-fourth of the respondents, or 27.35 percent, indicated that the number of people in their department was over 50. In contrast, another one-fourth of the respondents, or 25.00 percent, indicated they employed 10 or fewer employees. The remaining 61 respondents, or 47.65 percent, employed between 11 and 50 employees.

Table X contains an analysis of designated persons directly responsible for expert systems' development. Thirty-two of the respondents, or 25.00 percent, answered 'yes' and 96 respondents, or 75.00 percent, answered 'no' to utilizing persons for development.

The 32 respondents who indicated that their company had a designated person were then asked to list the number of persons directly responsible for expert systems' development. The breakdown is shown in Table XI. The number of persons responsible for development tends to be rather small.
Two of the respondents, or 1.57 percent, indicated they utilized persons on a part-time basis only, which was not an option on the questionnaire. This response was written in by the respondents and was therefore coded and indicated as part of the statistical analysis for this item.
There was one respondent who did not indicate the number of designated person(s) responsible for development.

TABLE IX

ANALYSIS OF DEPARTMENT EMPLOYEES

NUMBER OF EMPLOYEES	FREQ.	CUM. FREQ.	PERCENT	CUM. PERCENT
1 - 10	32	32	25.00	25.00
11 - 20	19	51	14.84	39.84
21 - 30	17	68	13.28	53.12
31 - 40	10	78	7.81	60.93
41 - 50	15	93	11.72	72.65
Over 50	35	128	27.35	100.00

TABLE X

ANALYSIS OF DESIGNATED PERSONS DIRECTLY RESPONSIBLE FOR EXPERT SYSTEMS DEVELOPMENT

UTILIZATION OF DESIGNATED PERSONS	FREQ.	CUM. FREQ.	PERCENT	CUM. PERCENT
Does Not Utilize Designated Persons	96	96	75.00	75.00
Does Utilize Designated Persons	32	128	25.00	100.00

TABLE XI

NUMBER OF PEOPLE IN ORGANIZATION DIRECTLY RESPONSIBLE FOR EXPERT SYSTEMS DEVELOPMENT

NUMBER OF PEOPLE	FREQ.	CUM. FREQ.	PERCENT	CUM. PERCENT
0	96	96	75.59	75.59
1	11	107	8.66	84.25
2	9	116	7.09	91.34
3	3	119	2.36	93.70
6	2	121	1.57	95.27
7	1	122	0.79	96.06
15	1	123	0.79	96.85
30	1	124	0.79	97.64
400	1	125	0.79	98.43
Part-time	2	127	1.57	100.00
Did Not Respond	1	128	-	-

Respondents were also asked to identify the titles given to persons directly responsible for expert systems' development. The titles vary from organization to

organization. Table XII details the breakdown of these various titles. No titles were listed on the questionnaire. Twenty-seven respondents, or 21.09 percent, indicated a total of 30 different titles. Because some of the respondents had more than one designated person, there was more than one title listed. Two respondents, or 6.25 percent, had the title "Knowledge Engineer" and "Manager of Expert Systems". Twenty-eight of the respondents, or 87.50 percent, each indicated different titles. The majority of the respondents, 101, or 78.91 percent, indicated no designated person(s) directly responsible for expert systems' development.

Of the 101 respondents who indicated that their company did not have a designated person directly responsible for expert systems development, an analysis for the 'no' answer is shown in Table XIII. Because the respondent could list all that applied, some respondents had multiple responses to this item. Over one-half, or 65.49 percent, indicated they have no formal program in expert systems. Twenty-six of the respondents, or 23.01 percent, indicated that the expert systems development function is performed as part of other responsibilities and is not listed as a separate job function. Only four respondents, or 3.54 percent, indicated that consultants are utilized for expert systems development. Nine of the respondents indicated having no designated person directly responsible for expert systems development; however, they did not indicate a reason. One respondent did not respond to this item.

TABLE XII

TITLE OF PERSONS DIRECTLY RESPONSIBLE FOR EXPERT SYSTEMS DEVELOPMENT

TITLE	FREQ.	CUM. FREQ.	PERCENT	CUM. PERCENT
Project Manager	1	1	3.13	3.13
Area Manager	1	2	3.13	6.26
Director of AI	1	3	3.13	9.39
Knowledge Engineer	2	5	6.25	15.64
Manager, Technical Computer Support	1	6	3.13	18.77
Manager	1	7	3.13	21.90
Sr. Modeling Specialist	1	8	3.13	25.03
Sr. Programmer/Analyst	1	9	3.13	28.16
Associate Director/Corp. Info Resource Management	1	10	3.13	31.29
Manager - Expert Systems	2	12	6.25	37.54
Senior Consultant	1	13	3.13	40.67
Senior Systems Analyst	1	14	3.13	43.80
Manager, Decision Support Systems	1	15	3.13	46.93
Principal Mathmatician	1	16	3.13	50.06
Systems Analyst	1	17	3.13	53.19
Bus. Analyst Consultant	1	18	3.13	56.32
Manager, System Development Technologies	1	19	3.13	59.45

TABLE XII (Continued)

TITLE	FREQ.	CUM. FREQ.	PERCENT	CUM. PERCENT
Mgr. Knowledge Systems Research Engineering	1	20	3.13	62.58
Supervisor, Financial Systems	1	21	3.13	65.71
Supervisor, Human Resources	1	22	3.13	68.84
Supervisor, User Computing	1	23	3.13	71.97
Associate Research Consultant	1	24	3.13	75.10
Senior Systems Analyst	1	25	3.13	78.23
Manager, Systems and Programming	1	26	3.13	81.36
Programmer Analyst	1	27	3.13	84.49
Manager, Technical Applications	1	28	3.13	87.62
Senior Specialist	1	29	3.13	90.75
Expert Systems Supervisor	1	30	3.13	93.88
Research Scientist	1	31	3.13	97.01
Accounting Manager	1	32*	3.13	100.00

*multiple responses

TABLE XIII

ANALYSIS OF REASONS FOR COMPANIES NOT HAVING DESIGNATED PERSONS DIRECTLY RESPONSIBLE FOR EXPERT SYSTEMS DEVELOPMENT

REASONS	FREQ.	CUM.FREQ.	PERCENT	CUM. PERCENT
ES development is performed as part of other responsibilities and is not listed as a separate job function	26	26	23.01	23.01
No formal program in expert systems	74	100	65.49	88.50
Consultants are utilized for expert systems purposes	4	104	3.54	92.04
Other methods of expert systems development are utilized	-	-	-	-
Did not indicate reason(s)	9	113	7.96	100.00
Did not respond	1	114*	-	-

*multiple responses

Analysis of the Types of Expert Systems' Applications--Usage and Hardware

This section presents an analysis of the types of expert systems applications utilized by companies and the computer hardware in use by those firms that have expert systems. The questionnaire contained several questions for each of the following areas: money spent annually on expert systems' development and/or maintenance, status of expert systems' utilization in companies, the types of expert systems' business applications and the years initially used in companies, the types and longevity of business applications currently used, the types of business applications planned for future use, the make and model of computer hardware and the quantity of equipment pieces used presently for development, the development tools (shells) run on the hardware, the source of the expert systems business applications utilized in the company, and the vendor name used by respondents whose programs shells were developed by outside vendors. See appendix B for the complete questions.

Respondents were asked to indicate the amount of money spent annually on expert sytems development and/or maintenance. Table XIV contains an analysis of the responses. The majority of respondents, 104, or 83.87 percent, spent less than $100,000 on expert systems development and/or maintenance. Fifteen respondents, or 12.09 percent, spent between $100,000 and $499,999, while three respondents spent between $500,000 and $999,999. Only

two respondents spent over $1,000,000 on development and/or maintenance. Four respondents did not respond to this item.

Respondents were asked if they had been involved with expert systems development or maintenance. Thirty-eight of the respondents, or 30.65 percent, answered 'yes' and 86 answered 'no.' Table XV contains an analysis of the responses. There were four missing responses.

The respondents who replied 'yes' were then asked to specify the number of times they had been involved with expert systems development or maintenance. Table XVI contains the number of times specified and their frequency. Three respondents, or 2.46 percent, had been involved with development or maintenance over 25 times. The majority of respondents, 21, or 17.21 percent were involved less than ten times. Twelve respondents, or 9.84 percent were involved 10-14 times. Six respondents did not respond.

The respondents were also asked what types of development applications or maintenance applications they were involved with. Some of the 32 respondents reported multiple responses, indicating over 60 responses. The analysis of these applications is shown in Table XVII.

Table XVIII reflects the status of expert systems in the companies. Seventy percent of the respondents utilize or plan to implement expert systems within the next five years. related work. The largest number of respondents, 49, or 40.16 percent, indicated no expert systems related work

TABLE XIV

ANALYSIS OF MONEY SPENT ANNUALLY ON EXPERT SYSTEMS DEVELOPMENT AND/OR MAINTENANCE

AMOUNT OF MONEY	FREQ.	CUM. FREQ.	PERCENT	CUM. PERCENT
Less than $100,000	104	104	83.87	83.87
$100,000 - $499,999	15	119	12.09	95.96
$500,000 - $999,999	3	122	2.42	98.38
$1,000,000-4,999,999	1	123	0.81	99.19
$5,000,000-9,999,999	-	-	-	-
More than $10,000,000	1	124	0.81	100.00
Did not respond	4	128	-	-

TABLE XV

ANALYSIS OF INVOLVEMENT IN EXPERT SYSTEMS DEVELOPMENT OR MAINTENANCE

INVOLVEMENT	FREQ.	CUM. FREQ.	PERCENT	CUM. PERCENT
Yes	38	38	30.65	30.65
No	86	124	69.35	100.00
Did not respond	4	128	-	-

TABLE XVI

ANALYSIS OF TIMES INVOLVED WITH
EXPERT SYSTEMS DEVELOPMENT/MAINTENANCE

NUMBER OF TIMES	FREQ.	CUM. FREQ.	PERCENT	CUM. PERCENT
Over 25 times	3	3	2.46	2.46
21-25 times	-	-	-	-
15-20 times	-	-	-	-
10-14 times	12	15	9.84	12.30
Less than 10 times	21	36	17.21	29.51
Not involved	86	122	70.49	100.00
Did not respond	6	128	-	-

TABLE XVII

ANALYSIS OF DEVELOPMENT OR MAINTENANCE APPLICATIONS

APPLICATIONS	FREQ.	CUM. FREQ.	PERCENT	CUM. PERCENT
Robotics	1	1	1.61	1.61
Stereo Lithography	1	2	1.61	3.22
Credit Review	1	3	1.61	4.83
Oil Operations/Refining Exploration	3	6	4.83	9.66
Product Trouble Shooting	1	7	1.61	11.27
Diagnostic Planning	11	18	17.75	29.02
Structured Selection Problems	1	19	1.61	30.63
Manufacturing Process	1	20	1.61	32.24
Scheduling	2	22	3.24	35.48
Cust. Help Desk Support	1	23	1.61	37.09
Intelligent Procedure/ Policy Manual	1	24	1.61	38.70
Computer-aided Process Planning	2	26	3.24	41.94
Planning Models	1	27	1.61	43.55
Financial Analysis	2	29	3.24	46.79
Monitoring	1	30	1.61	48.40
Advising	1	31	1.61	50.01
Symbolics Workstation	1	32	1.61	51.62
Sales	1	33	1.61	53.23
Marketing	1	34	1.61	54.84
Product Design/Selection Systems	3	37	4.83	59.67
Tax Planning	1	38	1.61	61.28
Textile Fabric Design	1	39	1.61	62.89

TABLE XVII (Continued)

APPLICATIONS	FREQ.	CUM. FREQ.	PERCENT	CUM. PERCENT
Inventory Control	1	40	1.61	64.50
Order Entry/Probability	2	42	3.24	67.74
Project Estimating	1	43	1.61	69.35
Terminal Tracking	1	44	1.61	70.96
Personnel/Relocation/ Benefits Advisor	2	46	3.24	74.20
Option Compatibilities	1	47	1.61	75.81
Part Configuration	2	49	3.24	79.05
Machine Breakdown	1	50	1.61	80.66
Training/Education	3	53	4.83	85.49
Minor/Experimental	2	55	3.24	88.73
General PC Simplification	1	56	1.61	90.34
DOS User Aids	1	57	1.61	91.95
Electronic Catalog/ Dictionary	1	58	1.61	93.56
Communication	1	59	1.61	95.17
Chemical	1	60	1.61	96.78
Truck Loading Consultant	1	61	1.61	98.39
Appliance Repair	1	62*	1.61	100.00

*multiple responses

TABLE XVIII

ANALYSIS OF STATUS OF EXPERT SYSTEMS

STATUS	FREQ.	CUM. FREQ.	PERCENT	CUM. PERCENT
ES related work is utilized in the company	41	41	33.61	33.61
No ES related work exists; however, plan to implement some within the next five years	49	90	40.16	73.77
No ES related work exists, nor plan to implement such work within the next five years	32	122	26.23	100.00
Did not respond	6	128	-	-

exists; however, they plan to implement some within the next five years. Forty-one respondents, or 33.61 percent, indicated expert systems related work is utilized in the company. One-fourth of the respondents indicated no expert

systems related work exists, nor do they plan to implement such work within the next five years. Six respondents did not answer this item.

The researcher was interested in those applications which were put on the computer initially, those applications currently in use, and all anticipated future applications. However, some of the respondents did not respond to all three categories. Seven respondents indicated eleven applications as previously used (but not currently) utilized. These are reported in Table XIX. Ninety-six respondents, or 89.77 percent, indicated no applications were previously used. Twenty-five of the respondents did not answer this item.

Respondents were also asked to indicate the number of years these applications were utilized. Table XX contains an analysis of previously utilized applications. Nine respondents, or 81.82 percent, indicated two years of utilization. There was only one application, utilized 3-4 years and one application utilized 5-6 years. No applications were used over six years.

An analysis of current utilization of expert systems applications is contained in Table XXI. Respondents were asked if their company currently utilized any expert systems applications. Eighty-eight of the 123 respondents, or 71.54 percent, indicated 'no.' There were 35 respondents, or 28.46 percent, indicating a response of 'yes.' Five respondents did not respond to this item.

The respondents who answered 'no' were then asked if they were considering utilization of expert systems applications in the near future. An analysis of the

TABLE XIX

ANALYSIS OF PREVIOUSLY UTILIZED APPLICATIONS

TYPES OF APPLICATIONS	FREQ.	CUM. FREQ.	PERCENT	CUM. PERCENT
Diagnostics	1	1	0.93	0.93
Scheduling	1	2	0.93	1.86
Planning	1	3	0.93	2.79
Finance	1	4	0.93	3.72
Product Selection	1	5	0.93	4.65
Product Design	1	6	0.93	5.58
Chemical Analysis	1	7	0.93	6.51
Chemical Compounding	1	8	0.93	7.44
Information Expert	1	9	0.93	8.37
Palladian	1	10	0.93	9.30
Product Pricing	1	11	0.93	10.23
None	96	107	89.77	100.00
Did not respond	25	132*	-	-

*multiple responses

TABLE XX

ANALYSIS OF UTILIZATION OF PREVIOUSLY USED APPLICATIONS

YEARS OF UTILIZATION	FREQ.	CUM. FREQ.	PERCENT	CUM. PERCENT
Used 1-2 years	9	9	81.82	81.82
Used 3-4 years	1	10	9.09	90.91
Used 5-6 years	1	11	9.09	100.00
Used 7-8 years	-	-	-	-
Used 9 or more years	-	-	-	-

TABLE XXI

ANALYSIS OF CURRENT UTILIZATION OF APPLICATIONS

UTILIZATION OF APPLICATIONS	FREQ.	CUM. FREQ.	PERCENT	CUM. PERCENT
Yes	35	35	28.46	28.46
No	88	123	71.54	100.00
Did not respond	5	128	-	-

TABLE XXII

ANALYSIS OF COMPANIES CONSIDERING EXPERT SYSTEM UTILIZATION IN THE NEAR FUTURE

CONSIDERING UTILIZATION	FREQ.	CUM. FREQ.	PERCENT	CUM. PERCENT
Yes	26	26	36.62	36.62
No	45	71	63.38	100.00
Did not respond	57	128	-	-

responses is given in Table XXII. Twenty-six of the respondents, or 36.62 percent, answered 'yes' and 45 respondents, or 63.38 percent, answered 'no.'

Table XXIII contains an analysis of the types of currently utilized applications. Because respondents could list all applications that apply, some respondents had multiple responses. Respondents reported 62 different applications. Of these 62 responses, diagnostics was the most-often utilized application.

Table XXIV contains an analysis of currently utilized applications by the number of years utilized. The majority

of respondents, 43, or 71.67 percent, used them two years or less. Ten respondents, or 16.67 percent, utilized current applications 3-4 years, and five of the respondents, or 8.33 percent, had been using applications 7-8 years. Two respondents, or 3.33 percent, indicated nine or more years of utilization. Sixty-eight respondents did not currently use applications.

Respondents were asked to specify the types of expert systems' applications planned for future utilization. A total of 33 respondents indicated 76 responses, while only fifteen respondents chose not to respond. Table XXV contains the analysis of future applications as indicated by respondents. Respondents indicated that financial applications and scheduling applications, with seven respondents each, or 9.21 percent, will be of greatest concern in the future. Five respondents, or 6.57 percent, each indicated manufacturing applications and diagnostics as the next most important applications being planned for the future.

Table XXVI analyzes the make of computers presently used for expert systems development. Because the respondent could list all that applied, some respondents had multiple responses to this item. A total of 232 responses were given by 63 respondents. Sixty-five respondents did not indicate computer equipment utilized for expert systems' development. IBM tended to dominate the utilization with 129

TABLE XXIII

ANALYSIS OF CURRENTLY UTILIZED APPLICATIONS

TYPES OF APPLICATIONS	FREQ.	CUM. FREQ.	PERCENT	CUM. PERCENT
Credit Review	1	1	1.61	1.61
Hot Line (Product)	1	2	1.61	3.22
Pool Water Analysis	1	3	1.61	4.83
Customer Call Reports	1	4	1.61	6.44
TI PC Plus	1	5	1.61	8.05
Planning	1	6	1.61	9.66
Scheduling	1	7	1.61	11.27
Product Configuration	1	8	1.61	12.88
System Configuration	1	9	1.61	14.49
Procedure Manual	1	10	1.61	16.10
Diagnostics	11	21	17.80	33.90
Production Machinery Problem Diagnosing	1	22	1.61	35.51
Purchasing Systems	1	23	1.61	37.12
Order Entry	1	24	1.61	38.73
Inventory Control	1	25	1.61	40.34
Customer Support Help Desk/Help Desk Assistant	2	27	3.24	43.58
Intelligent Policy	1	28	1.61	45.19
Manufacturing Planning	1	29	1.61	46.80
Product Models	1	30	1.61	48.41

TABLE XXIII (Continued)

TYPE OF APPLICATION	FREQ.	CUM. FREQ.	PERCENT	CUM. PERCENT
Process Scheduling	1	31	1.61	50.02
Advising	1	32	1.61	51.63
Monitoring	1	33	1.61	53.24
Spice and Herb Buying	1	34	1.61	54.85
Market Analysis	1	35	1.61	56.46
Sales	1	36	1.61	58.07
Computer-aided Process Planning	1	37	1.61	59.68
Equipment Configuration	3	40	4.90	64.58
Packaging Verification	1	41	1.61	66.19
Automatic PC Configuration	1	42	1.61	67.80
Fabric Design	1	43	1.61	69.41
Database Reporting	1	44	1.61	71.02
Lighting Advisor	1	45	1.61	72.63
Terminal Tracking	1	46	1.61	74.24
Heavy Equipment Fault Diagnostics	1	47	1.61	75.85
Customer Profitability	1	48	1.61	77.46
Product Profitability	1	49	1.61	79.07
General Ledger	1	50	1.61	80.68
Pensions	1	51	1.61	82.29
Payroll	1	52	1.61	83.90
Fixed Assets	1	53	1.61	85.51
Pricing	1	54	1.61	87.12

TABLE XXIII (Continued)

TYPE OF APPLICATION	FREQ.	CUM. FREQ.	PERCENT	CUM. PERCENT
Selection	1	55	1.61	88.73
DOS User Aids	1	56	1.61	90.34
PC Simplification	1	57	1.61	91.95
Process Advisory Control	1	58	1.61	93.56
Lead Finding for Oil	1	59	1.61	95.17
Grinder Set-up Consultant	1	60	1.61	96.78
Preventive Maintenance	1	61	1.61	98.39
Truck Loading Consultant	1	62	1.61	100.00
Did not respond	8	70*	-	-

*multiple responses

TABLE XXIV

ANALYSIS OF UTILIZATION OF APPLICATIONS BY NUMBER OF YEARS

YEARS OF UTILIZATION	FREQ.	CUM. FREQ.	PERCENT	CUM. PERCENT
Used 1-2 years	43	43	71.67	71.67
Used 3-4 years	10	53	16.67	88.34
Used 5-6 years	-	-	-	-
Used 7-8 years	5	58	8.33	96.67
Used 9 or more years	2	60	3.33	100.00
Do not use	68	128	-	-

TABLE XXV

ANALYSIS OF FUTURE EXPERT SYSTEMS APPLICATIONS

TYPES OF APPLICATIONS	FREQ.	CUM. FREQ.	PERCENT	CUM. PERCENT
Debt Management	1	1	1.32	1.32
Manufacturing	5	6	6.57	7.89
Engineering	3	9	3.94	11.83
Exploration/Production	1	10	1.32	13.15
Financial	7	17	9.21	22.36
Defense	1	18	1.32	23.68
Learning/Education	1	19	1.32	25.00
Robotics	1	20	1.32	26.32
Industrial Automation	1	21	1.32	27.64
Maintenance	3	24	3.94	31.58
Human Resources	2	26	2.63	34.21
Production	2	28	2.63	36.84
Scheduling/Balancing	7	35	9.21	46.05
Planning	4	39	5.26	51.31
Modeling Tools for Business	1	40	1.32	52.63
Diagnostics	5	45	6.57	59.20
Trend/Analysis	3	48	3.94	63.14
Toxicology Advisor	1	49	1.32	64.46
Marketing Modeler	2	51	2.63	67.09
Pricing	2	53	2.63	69.72
Vendor Selection	1	54	1.32	71.04
Transportation Carrier Selection	1	55	1.32	72.36

TABLE XXV (Continued)

TYPES OF APPLICATIONS	FREQ.	CUM. FREQ.	PERCENT	CUM. PERCENT
Quality Management	1	56	1.32	73.68
Audit	1	57	1.32	75.00
Computer Technical Support	1	58	1.32	76.32
Configuration	1	59	1.32	77.64
Inventory Control	1	60	1.32	78.96
Order Entry	1	61	1.32	80.28
Products/Specification Advisor	1	62	1.32	81.60
Equipment (Conditions) Operator Advisor	1	63	1.32	82.92
Executive Inquiry	1	64	1.32	84.24
Sales Support	2	66	2.63	86.87
Customer Support Query	1	67	1.32	88.19
Backward Chaining	1	68	1.32	89.51
Help Desk	1	69	1.32	90.83
Software Development Assistant	1	70	1.32	92.15
Selection	1	71	1.32	93.47
CIM Programming	1	72	1.32	94.79
Automated Operations	1	73	1.32	96.11
IBM AS	1	74	1.32	97.43
Employee Benefits Advisor	1	75	1.32	98.75
Trading	1	76	1.32	100.00
No Response	15	91*	-	-

*multiple responses

TABLE XXVI

ANALYSIS OF THE MAKE OF COMPUTERS
USED FOR EXPERT SYSTEM DEVELOPMENT

COMPUTER MAKE	FREQ.	CUM. FREQ.	PERCENT	CUM. PERCENT
IBM	129	129	55.60	55.60
DEC	22	151	9.48	65.08
HBI	3	154	1.30	66.38
AMDAHL	4	158	1.72	68.10
BURROUGHS	3	161	1.30	69.40
UNISYS	8	169	3.45	72.85
HP	6	175	2.59	75.49
SPERRY	1	176	0.43	75.87
SYMBOLICS	4	180	1.72	77.59
NAS	2	182	0.86	78.45
HONEYWELL	2	184	0.86	79.31
CDC	2	186	0.86	80.17
UNIVAC	2	188	0.86	81.03
WANG	7	195	3.02	84.05
PERTEC	1	196	0.43	84.48
STRATUS	1	197	0.43	84.91
PRIME	1	198	0.43	85.34
DATA GENERAL	3	201	1.30	86.64
ATT	4	205	1.72	88.36
SUN	3	208	1.30	89.66
TI	2	210	0.86	90.52
COMPAQ	9	219	3.88	94.40
APPLE	5	224	2.16	96.56
WYSE	1	225	0.43	96.99
TOSHIBA	1	226	0.43	97.42
PC DESIGNS	1	227	0.43	97.85
NEC	2	229	0.86	98.71
TELEX	1	230	0.43	99.14
FIVE STAR	1	231	0.43	99.57
LEADING EDGE	1	232*	0.43	100.00

*multiple responses

TABLE XXVII

ANALYSIS OF THE MODEL OF COMPUTERS USED FOR EXPERT SYSTEMS DEVELOPMENT

COMPUTER MODEL*	FREQ.	CUM. FREQ.	PERCENT	CUM. PERCENT
IBM				
4341	48	48	20.70	20.70
3084	5	53	2.16	22.86
3081	6	59	2.59	25.45
370	2	61	0.86	26.31
3090	12	73	5.18	31.49
3083	6	79	2.59	34.08
4381	5	84	2.16	36.24
4361	2	86	0.86	37.10
4383	1	87	0.43	37.53
System 36	1	94	3.02	40.55
536	1	95	0.43	40.98
538	1	96	0.43	41.41
System 38	5	101	2.16	43.57
9370	1	102	0.43	44.00
P/S2	24	126	10.35	54.35
3270	1	127	0.43	54.78
5153	1	128	0.43	55.21
286	1	129	0.43	55.64
DEC				
8700	3	132	1.30	56.94
8300	3	135	1.30	58.24
785	4	139	1.72	59.96
780	4	143	1.72	61.68
750	2	145	0.86	62.54
8800	2	147	0.86	63.40
8350	3	150	1.30	64.70
73	1	151	0.43	65.13
COMPAQ				
286	7	158	3.02	68.15
386	2	160	0.86	69.01
UNISYS				
2930	1	161	0.43	69.44
V380	1	162	0.43	69.87
1100	1	163	0.43	70.30
5000	2	165	0.86	71.16
B26	1	166	0.43	71.59
B38	1	167	0.43	72.02
PW2500	1	168	0.43	72.45

TABLE XXVII (Continued)

COMPUTER MODEL*	FREQ.	CUM.FREQ.	PERCENT	CUM. PERCENT
WANG				
VS100	3	171	1.30	73.75
VS7310	1	172	0.43	74.18
PC280	3	175	1.30	75.48
HEWLETT PACKARD				
3000	4	179	1.72	77.20
1000	1	180	0.43	77.63
9000	1	181	0.43	78.06
APPLE				
MacIntosh	5	186	2.16	80.22
ATT	4	190	1.72	81.94
AMDAHL				
5860	4	194	1.72	83.66
HBI				
DPS8	1	195	0.43	84.09
DPS6	2	197	0.86	84.95
BURROUGHS				
B6810	1	198	0.43	85.38
A9	1	199	0.43	85.81
B6800	1	200	0.43	86.24
SYMBOLICS				
3670	2	202	0.86	87.10
3640	2	204	0.86	87.96
DATA GENERAL				
20000	2	206	0.86	88.82
Lap Top	1	207	0.43	89.25
SUN				
3/150	1	208	0.43	89.68
3/260	2	210	0.86	90.54
NAS				
9000	1	211	0.43	90.97
8083	1	212	0.43	91.40
HONEYWELL				
DPS90	1	213	0.43	91.83
DPS-6	1	214	0.43	92.26

TABLE XXVII (Continued)

COMPUTER MODEL*	FREQ.	CUM. FREQ.	PERCENT	CUM. PERCENT
CDC				
930	1	215	0.43	92.69
830	1	216	0.43	93.12
TEXAS INSTRUMENTS				
Professional	1	217	0.43	93.55
Explorer	1	218	0.43	93.98
NEC				
386	2	220	0.86	94.84
SPERRY				
1100/83	1	221	0.43	95.27
PERTEC				
XL40	1	222	0.43	95.70
TOSHIBA				
Lap Top	1	223	0.43	96.13
PC DESIGNS				
GV-386	1	224	0.43	96.56
UNIVAC				
1107	1	225	0.43	96.99
1192	1	226	0.43	97.42
TELEX				
1280	1	227	0.43	97.85
LEADING EDGE				
Model D	1	228	0.43	98.28
PRIME	1	229	0.43	98.71
STRATUS	1	230	0.43	99.14
WYSE	1	231	0.43	99.57
FIVE STAR	1	232	0.43	100.00

*includes pc, mini, mainframe

respondents, or 55.60 percent, indicating that their company utilized that particular make. Digital Equipment Company was utilized in 22 companies, or 9.48 percent. COMPAQ was used in nine companies, or 3.88 percent. UNISYS was used in eight companies, or 3.45 percent, while WANG was used in seven companies, or 3.02 percent. Hewlett Packard was used in six companies, or 2.59 percent. Respondents were asked to list the model of computer used in their company's development efforts. Table XXVII analyzes the different model of computers used for expert systems development.

Respondents were also asked to indicate the number of units of each computer utilized for expert systems' development. Table XXVIII analyzes the responses. Over half of the respondents, 135, or 58.19 percent, indicated utilizing 1-3 units, while one-fourth of the respondents, or 25.43 percent, utilized over 12 units.

Table XXIX provides the number of expert systems' development tools (shells) run by respondents. The majority of respondents utilizing development tools, 18, or 14.06 percent, used only one tool. The second highest number of tools utilized was two. There were nine respondents, or 7.03 percent, indicating this response. Six respondents, or 4.69 percent, used three tools, and five respondents, or 3.91 percent, used four tools. Two respondents, or 1.56 percent, both indicated using five and seven tools respectively. There was only one respondent, or .78 percent, indicating use of six development tools.

In Table XXX respondents indicated a total of 109 different tools were utilized for development. The most common tool used by respondents was Personal Consultant Plus (PC+). Eleven respondents, or 10.09 percent, used PC+. Ten respondents, or 9.17 percent, used Expert System Environment as the second most common tool. Eighteen respondents indicated a preference for Texas Instruments development tools more than any other manufacturer.

Respondents were asked to indicate the source of the expert systems' business applications utilized by checking all that apply. A total of 43 respondents indicated 66 responses for this item. Of those responding, half of them indicated programs were developed by in-house programming personnel. Nineteen of the respondents, or 28.79 percent, indicated program shells were developed by vendors. Thirteen respondents, or 19.70 percent, indicated programs were developed by programming consultants. The results are shown in Table XXXI.

Table XXXII provides information about the expert systems shells and the vendors (by the name of the manufacturer) utilized by respondents who indicated program shells developed by vendors. Ten respondents answered this item. Three respondents indicated utilizing the shell M.1 The manufacturer of M.1 is Teknowledge, Inc., of Palo Alto, California.

TABLE XXVIII

ANALYSIS OF NUMBER OF COMPUTERS UTILIZED FOR ES DEVELOPMENT

NUMBER OF UNITS	FREQ.	CUM. FREQ.	PERCENT	CUM. PERCENT
1 - 3	135	135	58.19	58.19
4 - 6	22	157	9.48	67.67
7 - 9	11	168	4.74	72.41
10 - 12	5	173	2.16	74.57
Over 12	59	232*	25.43	100.00

*multiple responses

TABLE XXIX

ANALYSIS OF THE NUMBER OF DEVELOPMENT TOOLS (SHELLS) UTILIZED

NUMBER OF TOOLS UTILIZED	FREQ.	CUM. FREQ.	PERCENT	CUM. PERCENT
0	85	85	66.41	66.41
1	18	103	14.06	80.47
2	9	112	7.03	87.50
3	6	118	4.69	92.19
4	5	123	3.91	96.10
5	2	125	1.56	97.66
6	1	126	0.78	98.44
7	2	128	1.56	100.00

TABLE XXX

ANALYSIS OF DEVELOPMENT TOOLS UTILIZED FOR EXPERT SYSTEM DEVELOPMENT

NAME OF TOOL	FREQ.	CUM. FREQ.	PERCENT	CUM PERCENT
Datacom/DB	1	1	0.92	0.92
Database III Plus	1	2	0.92	1.84
Dataquery	1	3	0.92	2.76
DMS-II	1	4	0.92	3.68
DISOSS	1	5	0.92	4.60
Ideal-4GL	1	6	0.92	5.52
Info Expert	1	7	0.92	6.44
Insight Plus	1	8	0.92	7.36
Insight II Plus	2	10	1.83	9.19
ICEE	1	11	0.92	10.11
IMS	1	12	0.92	11.03
IEW Workbench	1	13	0.92	11.95
Level 5	3	16	2.75	14.70
LISP	1	17	0.92	15.62
M.1	4	21	3.66	19.28
M1.A	1	22	0.92	20.20
AION	6	28	5.50	25.70
Application Expert	3	31	2.75	28.45
Art	1	32	0.92	29.37
XiPlus	2	34	1.83	31.20
Smalltalk V	1	35	0.92	32.12
S.1	1	36	0.92	33.04

TABLE XXX (Continued)

NAME OF TOOL	FREQ.	CUM. FREQ.	PERCENT	CUM. PERCENT
Nomad 2	1	37	0.92	33.96
NExpert	2	39	1.83	35.79
Natural Link	1	40	0.92	36.71
PC Easy Plus	2	42	1.83	38.54
PC Plus	11	53	10.09	48.63
PC Easy	3	56	2.75	51.38
Personal Consultant	2	58	1.83	53.21
PILOT	1	59	0.92	54.13
PACE	1	60	0.92	55.05
Powerhouse	1	61	0.92	55.97
KEE	7	68	6.42	62.39
Knowledge Pro	1	69	0.92	63.31
VPExpert	7	76	6.42	69.73
VSPC	1	77	0.92	70.65
Guru	1	78	0.92	71.57
EXSYS	2	80	1.83	73.40
ESE	10	90	9.17	82.57
ESS	1	91	0.92	83.48
Goldworks	3	94	2.75	86.23
TExpert	1	95	0.92	87.15
TSO	1	96	0.92	88.07
TURBO PROLOG	1	97	0.92	88.99
CMS	1	98	0.92	89.91
CICS	1	99	0.92	90.83

TABLE XXX (Continued)

NAME OF TOOLS	FREQ.	CUM. FREQ.	PERCENT	CUM. PERCENT
1st Class	4	103	3.66	94.49
OPS5	1	104	0.92	95.41
Wang Office	1	105	0.92	96.33
TIMM	1	106	0.92	97.25
Consultants Software	1	107	0.92	98.17
In-House	2	109*	1.83	100.00

*multiple responses

TABLE XXXI

ANALYSIS OF THE SOURCE OF EXPERT SYSTEMS BUSINESS APPLICATIONS

SOURCE	FREQ.	CUM. FREQ.	PERCENT	CUM. PERCENT
Programs developed by in-house programming personnel	34	34	51.51	51.51
Programs developed by programming consultants	13	47	19.70	71.21
Programs shells developed by vendors	19	66*	28.79	100.00
Other	-	-	-	-

*multiple responses

TABLE XXXII

ANALYSIS OF SHELL AND VENDOR UTILIZATION

SHELL/VENDOR	FREQ.	CUM. FREQ.	PERCENT	CUM. PERCENT
M.1, Teknowledge	3	3	15.80	15.80
AION, ADS	1	4	5.26	21.06
XiPlus, Expertech	1	5	5.26	26.32
AIM, Expertech	1	6	5.26	31.58
KEE, IntelliCorp	2	8	10.53	42.11
Guru, MDBS, Inc.	1	9	5.26	47.37
Level 5, IBI	2	11	10.53	57.90
Application Expert, Cullinet	1	12	15.26	63.16
Info Expert, MSA	1	13	5.26	68.42
PC Plus, TI	2	15	10.53	78.95
ESE, IBM	2	17	10.53	89.48
Insight 2+, Level 5 Corporation	1	18	5.26	94.74
Goldworks, Gold Hill	1	19*	5.26	100.00

*multiple responses

Legend: KEE (Knowledge Engineering Environment)

MDBS (Micro Database Systems)

MSA (Management Science America)

PC Plus (Personal Consultant Plus)

TI (Texas Instruments, Inc.)

ESE (Expert Systems Environment)

Analysis of Expert Systems' Employees

This section presents an analysis of the employees' backgrounds who work with expert systems. Items were included in the questionnaire concerning the current and future profile of these employees. The questionnaire contained several items for each of the following areas: the types of expert systems employees currently employed, including gender, age, title, years in position, educational level, and college/university attended, graduation year and degree received, type of expert systems education or training received, completion of artificial intelligence/expert systems related courses, and types of employees needed in the next five years. See Appendix B for complete questions.

Participants were requested to indicate gender. As presented in Table XXXIII, over 90 percent of the respondents were male. Ten respondents, or 8.00 percent, were female. Three respondents did not answer this item.

Table XXXIV summarizes the results concerning age of respondents. The majority of respondents, 54, were 40-49 years of age; and the second highest category was 30-39 years of age with 44 respondents. Four respondents did not answer this item.

Responses were received for all of the job titles of respondents. There were a total of 86 different titles indicated; however, there were seven respondents who did not answer this item. The job titles indicated most often were Systems Analyst, with six responses, Director of Information

TABLE XXXIII

ANALYSIS OF GENDER

GENDER	FREQ.	CUM. FREQ.	PERCENT	CUM. PERCENT
Male	115	115	92.00	92.00
Female	10	125	8.00	100.00
Did not respond	3	128	-	-

TABLE XXXIV

ANALYSIS OF AGE

AGE	FREQ.	CUM. FREQ.	PERCENT	CUM. PERCENT
20-29 years	10	10	8,07	8.07
30-39 years	44	54	35.48	43.55
40-49 years	54	108	43.55	87.10
50 and above	16	124	12.90	100.00
Did not respond	4	128	-	-

Systems, with five responses, and Project Manager, with four responses. The following six titles each received three responses: Systems/Programming Manager, Manager of Systems Development, Data Processing Manager, Manager of Business Systems, Senior Programmer/Analyst, and Director of Management Information Systems. Complete results are summarized in Table XXXV.

Over 70 percent of the respondents indicated being in job positions four years or less. Seventeen respondents, or 14.05 percent, indicated less than one year. Thirty-three respondents, or 27.27 percent, indicated 1-2 years, and thirty-nine respondents, or 32.23 percent, indicated 3-4 years. Table XXXVI shows an analysis of respondents' employment longevity.

Participants were requested to indicate their highest educational level. Table XXXVII shows the analysis of the 125 responses. Space was designated for "other" responses; however, no one utilized this category. Fifty-five of the respondents, or 44.00 percent, indicated an educational level of bachelor's degree. The second most common response was master's degree with 45 respondents, or 36.00 percent. Very few respondents with less than a college degree held positions in the expert systems area. Even fewer respondents held doctoral degrees.

Table XXXVIII shows an analysis of respondents educational or training areas in expert systems. Respondents were requested to check all that apply. There were 122

TABLE XXXV

ANALYSIS OF JOB TITLE

TITLE	FREQUENCY
Systems/Programming Manager	3
Associate Director	1
Manager, Systems Development	3
Director, Data Services	1
Manager, Technical Support	2
Manager, Market Research	1
Director, Systems & Data Processing	1
Director, Computer Systems	1
Data Processing Manager	3
Director, Information Systems & Controls	1
Project Manager	4
Manager, Decision Support	1
Systems Project Leader	1
Manager, Computer Services	1
Systems Development Manager	1
Manager, Information Services & Technology	1
Systems & Financial Analyst	1
Technical Systems Manager	1
Programmer/Engineer	2
Corporate Manager, Information Systems Consulting	1
Systems Analyst	7
Manager, Corporate Systems Development	1
Director of Artificial Intelligence	2
Information Resources Account Executive	1
Manager	1
Systems Consultant	1
Manager, User Support and Office Systems	1
Information Systems, Specialty Divisions	1
Manager of Manufacturing Systems	1
Director	1
Manager of Technical Services	1
Principal Mathematician	1
Manager, IS/DP Personnel Development	1

TABLE XXXV (Continued)

TITLE	FREQUENCY*
Database Administrator	2
Manager, Information Services	2
Manager, Knowledge-Based Systems	1
Manager, Corporate Systems & Programming	2
Information Systems Analyst	2
Director of Information Systems	5
Manager, Applications Development	1
System Architect	1
Manager, Corporate Management Info Systems	2
Coordinator	1
VP, Corporate Information Management	1
Emerging Technologies	1
Systems Technology	1
Manager of Operations & Technical Services	1
Manager, Business Systems	3
Technical Consultant	1
Manager, Integration Technologies	1
Office Automation Project Leader	1
Senior Programmer/Analyst	3
Manager Technical Planning and Support	1
Expert Systems Supervisor	1
Director Information Systems Planning	1
Business Systems Consultant/Analyst	1
Manager of Emerging Technology, MIS	2
Staff Specialist	1
Knowledge Engineer	1
Service Information Systems Manager	1
Corporate Information Systems Supervisor	1
Research Scientist II	1
Assistant Director Corporate Systems	1
Artificial Intelligence Supervisor	1
MIS Corporate Director	1
Accounting Manager	1
Advanced Business Systems Manager	1
Operations Research Analyst	1
Supervisor, Systems Planning	1

TABLE XXXV (Continued)

TITLE	FREQUENCY*
Applications Development Manager	1
Supervisor, User Computing	1
Financial Reporting Manager	1
Management Information Systems Director	3
Senior Project Analyst	1
Associate Research Consultant	1
Corporate Systems/Data Processing Manager	1
Advisory Marketing Representative	1
Manager of Operations Research	1
Manager, Expert Systems	1
Technical Analyst	1
Systems Q/A Manager	1
Systems and Programming Manager	1
Systems Manager	2
Decision Analysis Manager	1
Management Information Systems Manager - CPD	2
Lead Systems Analyst	1
Senior Specialist	1
Did not respond	7

*multiple responses

TABLE XXXVI

ANALYSIS OF YEARS IN POSITION

YEARS IN POSITION	FREQ.	CUM. FREQ.	PERCENT	CUM. PERCENT
Less than 1 year	17	17	14.05	14.05
1-2 years	33	50	27.27	41.32
3-4 years	39	89	32.23	73.55
5-6 years	12	101	9.91	83.46
7-10 years	10	111	8.27	91.73
More than 10 years	10*	121	8.27	100.00
Did not respond	7	128	-	-

*The ten respondents in the "more than 10 years" category listed the following years in position:

11-2	17-2
13-2	24
15	32

One respondent checked "more than 10 years" but did not provide a number.

TABLE XXXVII

ANALYSIS OF HIGHEST EDUCATIONAL LEVEL

LEVEL	FREQ.	CUM. FREQ.	PERCENT	CUM. PERCENT
High School Graduate	1	1	0.80	0.80
Some College Work	6	7	4.80	5.60
Associate Degree	3	10	2.40	8.00
Vocational/Trade School Certificate	6	16	4.80	12.80
Bachelor's Degree	55	71	44.00	56.80
Master's Degree	45	116	36.00	92.80
Doctoral Degree	9	125	7.20	100.00
Other	-	-	-	-
Did Not Respond	3	128	-	-

TABLE XXXVIII

ANALYSIS OF EDUCATIONAL OR TRAINING AREAS IN EXPERT SYSTEMS

AREAS	FREQ.	CUM. FREQ.	PERCENT	CUM. PERCENT
Regular College Courses or College Extension Courses	15	15	6.91	6.91
In-House Training Programs Presented by Company	16	31	7.37	14.28
Vendor-Sponsored Seminars	55	86	25.35	39.63
Seminars Offered by Other Private Companies and Presented by their Staff	25	111	11.52	51.15
Self-education	61	172	28.11	79.26
No Training/Education in Expert Systems	45	217	20.74	100.00
Did not respond	6	223*	-	-

*multiple responses

respondents who indicated a total of 217 responses. Sixty-one of the respondents, or 28.11 percent, indicated self-education as the most common response. Fifteen of the respondents, or 6.91 percent, reported regular college courses or college extension courses as the least common response. Vendor-sponsored seminars was the second highest response, being chosen 55 times, or 25.35 percent.

Respondents were requested to indicate whether or not they had completed an artificial intelligence/expert systems related course before entering their present job position. The results are summarized in Table XXXIX. There were only five respondents, or 4.00 percent, indicating 'yes.' An overwhelming majority of 120 respondents, or 96.00 percent, indicated no completion.

Those respondents indicating completion of an artificial intelligence/expert systems related course were also requested to specify the title of courses. Table XL summarizes seven responses, each with a frequency of one, received by the five respondents.

TABLE XXXIX

ANALYSIS OF ARTIFICIAL INTELLIGENCE/EXPERT SYSTEMS RELATED COURSES COMPLETED PRIOR TO PRESENT JOB POSITION

RESPONSE	FREQ.	CUM. FREQ.	PERCENT	CUM. PERCENT
Yes	5	5	4.00	4.00
No	120	125	96.00	100.00
Did Not Respond	3	128	-	-

Respondents' college graduation year is reported in Table XLI. The graduation years of 1980-1987 and 1975-1979 had the highest response with 25, and 1970-1974 was the second highest with 21 responses. These responses are approximately half of the responses received for this question.

Table XLII gives an analysis of respondents' degrees. Fifty-five respondents, or 50.46 percent, indicated bachelor degrees. Forty-five respondents, or 41.28 percent, indicated master degrees, and nine respondents, or 8.26 percent, indicated a doctors degree.

Table XLIII lists the colleges and universities attended by respondents. Five respondents indicated Ohio State University in Columbus, Ohio, as the university that awarded their degree. The following colleges/universities were each indicated by three respondents as the second highest

response: University of California/Berkeley, California, University of Texas, Austin, Texas, University of Minneapolis, Minneapolis, Minnesota, and Oklahoma State University, Stillwater, Oklahoma. A total of 113 responses were received for this item. Eleven respondents did not respond.

Respondents completing an artificial intelligence/expert systems related course before entering their present job position were asked to indicate whether the course was sufficient training to work with expert systems. An analysis of the responses is given in Table XLIV. Eight respondents, or 6.50 percent, indicated 'no.' Four respondents, or 3.25 percent, indicated 'yes.'

TABLE XL

ANALYSIS OF TITLES OF
ARTIFICIAL INTELLIGENCE/EXPERT SYSTEMS RELATED COURSES

TITLE OF COURSE	FREQ.	CUM. FREQ.	PERCENT	CUM. PERCENT
Business Applications of Expert Systems (Colloquium)	1	1	14.29	14.29
Building Expert Systems	1	2	14.29	28.58
Introduction to Artificial Intelligence	1	3	14.29	42.87
LISP	1	4	14.29	57.16
Natural Language	1	5	14.29	71.45
Expert Systems	1	6	14.29	85.74
Knowledge-Based Systems	1	7*	14.29	100.00

*multiple responses

TABLE XLI

ANALYSIS OF COLLEGE GRADUATION YEAR

GRADUATION YEAR	FREQ.	CUM. FREQ.	PERCENT	CUM. PERCENT
1980 - 1987	25	25	21.01	21.01
1975 - 1979	25	50	21.01	42.02
1970 - 1974	21	71	17.65	59.67
1965 - 1969	19	90	15.97	75.64
1960 - 1964	13	103	10.92	86.56
Prior to 1960	6*	109	5.04	91.60
Does not apply	10	119	8.40	100.00
Did not respond	9	128	-	-

*The six respondents in the "prior to 1960" category listed the following graduation years:

1950
1959
1956

Three respondents checked "prior to 1960" but did not provide a number.

TABLE XLII

ANALYSIS OF TYPE OF DEGREE

DEGREE	FREQ.	CUM. FREQ.	PERCENT	CUM. PERCENT
Bachelor's	55	55	50.46	50.46
Masters	45	100	41.28	91.74
Doctors	9	109	8.26	100.00
Did not respond	19	128	-	-

TABLE XLIII

ANALYSIS OF COLLEGE/UNIVERSITY ATTENDED

COLLEGE	FREQUENCY
Western Illinois University Macomb, IL	1
Belleville Area College Belleville, IL	1
University of Nebraska Lincoln, NE	2
Claremont Claremont, CA	1
Weber State Ogden, UT	1
Boston College Newton, MA	1
University of California/Berkeley Berkeley, CA	3
University of Pittsburgh Pittsburg, PA	2
John Hopkins Baltimore, MD	1
University of Cincinnati Cincinnati, OH	1
University of California/Los Angeles Los Angeles, CA	1
University of Bridgeport Brideport, CT	1
University of Iowa Iowa City, IA	1
Mankato State University Mankato, MN	2
University of Texas Austin, TX	3

TABLE XLIII (Continued)

COLLEGE	FREQUENCY
University of Mississippi Oxford, MS	1
San Jose State San Jose, CA	1
California State University Los Angeles, CA	1
Ohio State University Columbus, OH	5
Iowa State University Ames, IA	2
Indiana University (NW) Gary, IN	1
University of Dayton Dayton, OH	1
University of Wisconsin Madison, WI	2
Towson State University Baltimore, MD	1
Pace University New York, NY	1
University of Houston Houston, TX	2
Stanford University Palo Alto, CA	2
Lake Forest School of Management Lake Forest, IL	1
University of Connecticut Storrs, CT	1
University of Pennsylvania Philadelphia, PA	1
Carnegie Mellon University Pittsburgh, PA	1

TABLE XLIII (Continued)

COLLEGE	FREQUENCY
North Carolina University Raleigh, NC	1
University of Minnesota Duluth, MN	1
Michigan State University East Lansing, MI	2
Mississippi State University Starkville, MS	1
Vanderbilt University Nashville, TN	1
Southern Illinois University Carbondale, IL	1
Abilene Christian University Abilene, TX	2
Ball State Muncie, IN	1
Central Connecticut State University New Britain, CT	1
Wisconsin State University Whitewater, WI	1
University of Minnesota Minneapolis, MN	3
Kutztown State University Kutztown, PA	1
Mapua Institute of Technology Manila, Philippines	1
Georgia Tech Atlanta, GA	1
Purdue University Lafayette, IN	1
Virginia Polytechnic Institute & State Univ Blacksburg, VA	2

TABLE XLIII (Continued)

COLLEGE	FREQUENCY
Oklahoma State University Stillwater, OK	3
University of Wisconsin/Whitewater Whitewater, WI	1
LaRoche College Pittsburgh, PA	1
University of Kentucky Lexington, KY	2
Duquesne University Pittsburg, PA	1
Adelphi Garden City, NY	1
Yale University New Haven, CT	1
Kent State University Kent, OH	1
Harvard University Cambridge, MA	1
Boston University Boston, MA	1
Illinois Institute of Technology Chicago, IL	2
LaSalle College Philadelphia, PA	1
Northwestern University Evanston, IL	2
New York University New York, NY	2
University of Chicago Chicago, IL	1
University of Michigan Ann Arbor, MI	1

TABLE XLIII (Continued)

COLLEGE	FREQUENCY
University of Northern Iowa Cedar Falls, IA	1
Cleveland State University Cleveland, OH	1
Westminister College New Wilmington, PA	1
University of Washington Seattle, WA	1
New Hampshire College Manchester, NH	1
Bentley College Waltham, MA	1
University of Tennessee Chattanooga, TN	1
Central Michigan University Mt. Pleasant, MI	1
Bowling Green State University Bowling Green, OH	1
Dallas Baptist University Dallas, TX	1
Rhode Island College Providence, RI	1
Harper Community College Palatine, IL	1
University of New Mexico Albuquerque, NM	1
University of Southern California Los Angeles, CA	1
Texas A & M College Station, TX	1

TABLE XLIII (Continued)

COLLEGE	FREQUENCY
Malone College Canton, OH	1
West Virginia University Morgantown, WV	1
Western Michigan University Kalamazoo, MI	1
The Citadel Charleston, SC	1
St. Thomas Miami, FL	1
Northern Illinois University Dekalb, IL	1
Temple University Philadelphia, PA	1
Hope College Holland, MI	1
University of Oklahoma Norman, OK	1

TABLE XLIV

ANALYSIS OF COURSES SUFFICIENT ENOUGH FOR EXPERT SYSTEMS JOB TRAINING

RESPONSE	FREQ.	CUM. FREQ.	PERCENT	CUM. PERCENT
Yes	4	4	3.25	3.25
No	8	12	6.50	9.75
Did not apply	111	123	90.25	100.00
Did not respond	5	128	-	-

The respondents were asked if the college attended required completion of an artificial intelligence/expert systems related course. Table XLV shows the analysis of the responses. Respondents indicated only four 'yes' responses, or 3.25 percent. There were 119, or 96.75 percent, 'no' responses.

Respondents indicating required completion of courses were asked to indicate title of courses. Five responses were indicated by four respondents. Table XLVI summarizes the responses.

Respondents were asked if their background in expert systems would be adequate for modifying or describing needed collegiate business courses. Table XLVII contains an analysis of the responses. The majority of the respondents, 94, or 77.05 percent, indicated 'no.' while 28 respondents, or 22.95 percent, indicated 'yes.' Six respondents did not respond to this item.

TABLE XLV

ANALYSIS OF THE NUMBER OF REQUIRED ARTIFICIAL INTELLIGENCE/EXPERT SYSTEMS RELATED COLLEGE COURSES

RESPONSE	FREQ.	CUM. FREQ.	PERCENT	CUM. PERCENT
No	119	119	96.75	96.75
Yes	4	123	3.25	100.00
Did not respond	5	128	-	-

TABLE XLVI

ANALYSIS OF REQUIRED ARTIFICIAL INTELLIGENCE/ EXPERT SYSTEMS RELATED COURSE TITLES

COURSE TITLE	FREQ.	CUM. FREQ.	PERCENT	CUM. PERCENT
LISP Programming	1	1	0.81	0.81
Logic	1	2	0.81	1.62
Decision Support Systems	1	3	0.81	2.43
Statistics	1	4	0.81	3.24
Introduction to Computer Programming	1	5	0.81	4.05
Did not apply	118	123	95.95	100.00
Did not respond	5	128	-	-

TABLE XLVII

ANALYSIS OF RESPONDENTS' BACKGROUND IN EXPERT SYSTEMS FOR MODIFYING COLLEGIATE BUSINESS COURSES

RESPONSE	FREQ.	CUM. FREQ.	PERCENT	CUM. PERCENT
Yes	28	28	22.95	22.95
No	94	122	77.05	100.00
Did not respond	6	128	-	-

TABLE XLVIII

ANALYSIS OF ARTIFICIAL INTELLIGENCE/EXPERT SYSTEMS RELATED COURSE REQUIREMENT IN MIS BUSINESS PROGRAMS

RESPONSE	FREQ.	CUM. FREQ.	PERCENT	CUM. PERCENT
Yes	99	99	81.82	81.82
No	22	121	18.18	100.00
Did not respond	7	128	-	-

Respondents were also asked if artificial intelligence/expert systems' related courses should be required in Management Information Systems business programs. Table XLVIII contains an analysis of the responses. The majority of respondents, 81.82 percent, felt courses should be required. Twenty-two respondents, or 18.18 percent, indicated 'no.'

Table XLIX analyzes respondents' anticipation of employing additional workers in the expert systems area within the next five years. Fifty-two respondents, or 55.32 percent, indicated 'yes,' and 44.68 percent, or 42 respondents, indicated 'no.' Thirty-four respondents did not answer this item.

Respondents were asked if they hired employees in the expert systems area within the last five years. The responses were 18, or 19.35 percent with 'yes' and 75 respondents, or 80.65 percent with 'no'. There were 35 respondents who did not respond to this item. Table L contains an analysis of the results.

Table LI summarizes the number of employeees hired in the expert systems area within the last five years. Respondents hired from two to forty employees; however, 70 percent of the companies responding hired from two to four employees.

Respondents were asked to indicate current openings for an expert systems' position. As shown in Table LII, 89.25

percent of the respondents indicated no current openings for an expert systems position. However, 10 respondents, or 10.75 percent, indicated current openings.

Table LIII summarizes the number of current openings for an expert systems position.

Table LIV shows an analysis of the number of employees currently working in the expert systems area. Responses indicate a total of 48 employees currently working in the expert systems area.

TABLE XLIX

ANALYSIS OF ADDITIONAL WORKERS

RESPONSE	FREQ.	CUM. FREQ.	PERCENT	CUM. PERCENT
Yes	52	52	55.32	55.32
No	42	94	44.68	100.00
Did not respond	34	128	-	-

TABLE L

ANALYSIS OF EXPERT SYSTEMS EMPLOYEES HIRED WITHIN THE LAST FIVE YEARS

RESPONSE	FREQ.	CUM. FREQ.	PERCENT	CUM. PERCENT
Yes	18	18	19.35	19.35
No	75	93	80.65	100.00
Did not respond	35	128	-	-

TABLE LI

ANALYSIS OF NUMBER OF EMPLOYEES HIRED
WITHIN THE LAST FIVE YEARS

NUMBER OF EMPLOYEES	FREQ.	CUM. FREQ.	PERCENT	CUM. PERCENT
2	4	4	23.53	23.53
3	5	9	29.42	52.95
4	3	12	17.65	70.60
5	1	13	5.88	76.48
7	1	14	5.88	82.36
8	1	15	5.88	88.24
22	1	16	5.88	94.12
40	1	17	5.88	100.00

TABLE LII

ANALYSIS OF CURRENT OPENINGS
FOR POSITIONS IN EXPERT SYSTEMS

RESPONSE	FREQ.	CUM. FREQ.	PERCENT	CUM. PERCENT
Yes	10	10	10.75	10.75
No	83	93	89.25	100.00
Did not respond	35	128	-	-

TABLE LIII

ANALYSIS OF NUMBER OF CURRENT OPENINGS
FOR POSITIONS IN EXPERT SYSTEMS

NUMBER OF OPENINGS	FREQ.	CUM. FREQ.	PERCENT	CUM. PERCENT
2	1	1	10.00	10.00
3	6	7	60.00	70.00
4	1	8	10.00	80.00
5	1	9	10.00	90.00
6	1	10	10.00	100.00

TABLE LIV

ANALYSIS OF NUMBER OF EMPLOYEES
CURRENTLY WORKING IN EXPERT SYSTEMS

NUMBER OF EMPLOYEES	FREQ.	CUM. FREQ.	PERCENT	CUM. PERCENT
1	18	18	37.50	37.50
2	7	25	14.58	52.08
3	9	34	18.75	70.83
4	2	36	4.17	75.00
5	4	40	8.33	83.33
Other	8*	48	16.67	100.00
Did not respond	35	83	-	-

*The eight respondents in the "other" category listed the following number of employees: 6 (3), 7, 10, 15, 300

One respondent indicated one part-time employee.

Summary

This chapter has presented an analysis of the responses received from the research questionnaire. The responses were tabulated and reported using frequencies, cumulative frequencies, and percentages. The results were summarized and presented through the discussion and tables within this chapter. The conclusions and recommendations are presented in Chapter V.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Society has moved from the information age to the knowledge age. This knowledge must be permanently stored for the future. Computer programs, or expert systems, are being built as the knowledge base for this new technology. Expert systems is gaining interest not only in academia, but also in industry and government, even though research is still needed to improve what has already been implemented. This growing technology has created a tremendous demand for competent knowledge engineering personnel, as well as for competent expert systems instructors. It is imperative that a serious look be taken at the current curriculum offerings in the Management Information Systems business programs.

The purpose of this study was to provide information about the extent to which expert systems business applications are being used by companies, the types of applications being used, and the types of the expert systems employees utilized within these companies. This was accomplished through an interpretative analysis of data obtained from research questionnaires that were mailed to Fortune 500 companies The data on the returned questionnaires were interpreted

and analyzed to determine the utilization of expert systems by revealing the uniformity and diversification among the various companies.

Results of the Study

The results of the study are summarized in three sections according to (1) the type of business respondents, (2) the types of expert systems business applications used by those firms using expert systems applications, and (3) the expert systems' employee.

The Type of Business Respondents

The majority of respondents were manufacturing businesses. The other respondents came from a number of different types of businesses, including printing and publishing, computer electronics, financial services, oil and gas, agriculture, mining, petroleum, energy, consumer products, pharmaceuticals, business equipment and supplies, food services, health care, and motion picture exhibition.

Ninety-six percent of the respondents had over $25 million in annual gross revenue. Approximately four percent of the respondents had less than $10 million in annual gross revenue, indicating that the majority of respondents would be considered relatively large businesses.

Fifty-four percent of the respondents also reported more than 10,000 employees. This would indicate that the majority of respondents were also large businesses because of the large numbers of employees.

The majority of respondents indicated employment in departments entitled Information Systems and Management Information Systems, with 11.72 percent and 10.94 percent respectively.

A total of 36 states were represented in this study. The majority of the respondents were from Illinois, Ohio, Pennsylvania, Texas, California, and Connecticut. Collectively, these states represented over half of the respondents.

Only 25 percent of the companies utilized designated persons who were directly responsible for expert systems' development, while 75.00 percent of the respondents did not. However, of these who indicated having no one directly responsible for development, 23.01 percent indicated the expert systems development function is performed as part of other responsibilities and is not listed as a separate job function. There was 3.54 percent who indicated consultants were utilized.

The Type of Expert Systems Business Applications

Even though respondents indicated employment in relatively large businesses, according to annual gross revenue and number of company employees, the majority of

companies spent less than $100,000 on expert systems' development and maintenance.

Thirty-eight of the respondents, or 30.65 percent, were involved with expert systems development or maintenance, the majority of which had only been involved less than ten times. The kinds of applications that respondents were involved in varied greatly. Some common applications involved oil operations and refining exploration, product design and selection of systems, and education and training.

Currently, low numbers of respondents are utilizing expert systems applications. Seventy percent utilize, or plan to implement, expert systems related work within the next five years. Forty percent of the respondents indicated no expert systems related work exists, but they plan to implement some within the next five years. Thiry-three percent indicated expert systems related work is utilized in the company, and one-fourth of the respondents indicated no expert systems related work exists, nor do they plan to implement such work within the next five years.

Expert systems' applications that were previously utilized by respondents included diagnostics, scheduling, planning, finance, product selection and design, chemical analysis and compounding, information expert, palladian, and product pricing. The majority of these applications were used two years or less.

Twenty-eight percent of the respondents currently utilize expert systems applications. While 71.54 percent of the respondents do not, 36.62 percent of them are considering utilization in the near future.

Respondents indicated currently utilizing 62 different applications, with diagnostics as the most often utilized application. Equipment configuration and help desk applications were also common among users. The majority of respondents have also used these applications only two years or less.

The most significant future applications planned by respondents were financial and scheduling applications. Manufacturing and diagnostic applications were also indicated as important applications to be considered for the future.

The computer used most often by respondents was IBM. Other manufacturers commonly used included Digital Equipment Company, COMPAQ, UNISYS, WANG, and Hewlett Packard. Over half of the respondents indicated using 1-3 of these units most often.

The majority of respondents utilizing development tools used only one tool, the most common tool being Personal Consultant Plus. The majority of respondents indicated a preference for Texas Instrument development tools.

Respondents were asked to indicate the source of the applications utilized. Fifty-one percent indicated

using programs developed by in-house programming personnel.

Expert Systems' Employees

The majority of the respondents were male, between the ages of 40-49 years of age, and who had worked as Systems Analysts or Information Systems Directors for four years or less. These respondents have bachelor's degrees, most having completed college during the periods of 1980-1987 and 1975-1979 respectively. The employees most often acquired their expert systems training through self-education. Five respondents completed a required artificial intelligence/expert systems related course before entering their present job position, the majority of whom felt it was not sufficient training. As a result, an overwhelming number of respondents felt artificial intelligence/expert systems' related courses should be required in Management Information Systems business programs.

Fifty-five percent of the respondents anticipate employing additional workers in the expert systems area within the next five years. A total of 117 employees were hired within the last five years, and 10 respondents indicated current openings. Respondents indicated a total of 48 employees were currently working in the expert systems area.

Conclusions and Recommendations

The following conclusions and recommendations are based on the results of the descriptive analysis of the utilization of expert systems in industry as reported on the returned questionnaires and also on the review of the related literature.

1. There is considerable difference of opinion regarding the utilization of expert systems in various types of industry.

2. There is considerable difference of opinion regarding the required expert systems skills of existing employees in various types of industry.

3. It may be concluded that expert system employees will have to be better trained in meeting the demands of technology, information and people in order to perform their jobs more effectively in the future.

4. There is considerable difference of opinion regarding the current expert systems applications in various types of industry.

5. Programs must be designed to give business students a broad-based background with a high emphasis on expert system development in the business environment.

Recommendations

Based on an analysis of the responses given by the companies surveyed, the researcher believes that certain

recommendations can be offered. The following recommendations are made as a result of studying the data collected.

1. It is recommended that expert systems' related courses be developed and implemented in management information systems business programs to meet the increasing demands that modern technology has created.

2. Studies should be done in the future to obtain information concerning expert systems curricula requirements in American Assembly of Collegiate Schools of Business (AACSB) institutions.

3. Studies of all sizes of business are needed to determine their expert systems' utilization, types of business applications, and the need for qualified expert systems employees.

4. Studies are needed to obtain information regarding the skills needed by graduates of business programs in order to be successfully employed in business.

5. Methodology of teaching expert systems courses should be addressed in further research to determine the best methods to instill the knowledge needed by future employees working with expert systems.

6. Studies similar to this one should be made in the future in order to assess continually the impact of expert systems in large business.

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APPENDIXES

APPENDIX A

PILOT QUESTIONNAIRE, PILOT COVER LETTER, PILOT THANK-YOU LETTER

Dear

Enclosed you will find a questionnaire and cover letter which I have developed for my doctoral dissertation research at Oklahoma State University. The questionnaire deals with the utilization of expert systems in industry and their related applications.

The target group for this study will be 500 Fortune 1000 companies throughout the United States. These companies will be randomly selected.

I would appreciate it very much if you would please assist me in my attempt to make certain that the cover letter and questionnaire are clear as to purpose and desired response. Please mark your suggestions or changes directly on the cover letter and questionnaire, particularly questions which you feel may be misleading or difficult to answer. Your suggestions will be seriously considered before mailing out the questionnaire.

Thank you very much for taking time from your busy schedule to assist me in my research efforts. A stamped, self-addressed envelope is enclosed for returning the cover letter and questionnaire on or before November 30, 1987. If you have any questions, please call me at (405)843-0815.

Cordially,

Connie A. Wilson

Enclosures

Dear

SUBJECT: EXPERT SYSTEMS APPLICATIONS SURVEY OF FORTUNE 1000 BUSINESSES

During the last few years, as you know, the development and utilization of expert systems applications in businesses have increased considerably. I am writing to request your assistance in a national survey of Fortune 1000 businesses. It is the purpose of this study to collect data which will provide information and facts stating the extent to which expert systems applications are being used and its impact on future curriculum development of artificial intelligence instruction in information processing curricula.

Your business has been selected at random from the "Corporate 1000" Directory
to be a part of my research study. Would you please take a few minutes of your valuable time to complete the enclosed questionnaire? If you cannot participate in this study, please forward the enclosed questionnaire along with this letter to the appropriate professional, encouraging that individual to complete and return the questionnaire. If possible the questionnaire should be returned on or before January 1, 1988. An addressed, postage-paid envelope is enclosed for convenience in returning the questionnaire.

Thank you very much for being a part of this study, and providing your professional expertise, thereby contributing to this study. Please indicate if you wish to have an abstract of the completed research.

Cordially,

Connie A. Wilson
Doctoral Student

Jeretta Horn
Doctoral Dissertation Advisor

Enclosures

QUESTIONNAIRE ON EXPERT SYSTEMS USAGE

This questionnaire is a survey of selected businesses to determine the extent of the use of expert systems applications in industry and to determine the knowledge and skills needed by employees who work with expert systems.

Please complete the questionnaire by checking (✓) the appropriate response and filling in the blanks when necessary. Your participation in this survey is greatly appreciated. Thank you.

****

I. BUSINESS INFORMATION

1. What is the primary business purpose of your firm?

_____ retailing
_____ wholesaling
_____ printing/publishing
_____ insurance
_____ medical
_____ utilities
_____ manufacturing
_____ construction
_____ transportation
_____ financial services
_____ legal
_____ other, please indicate:
_____

2. According to the most recently completed year for which data is available, what is your firm's annual gross revenue?

_____ less than $1 million
_____ $1 - 1.99 million
_____ $2 - 2.99 million
_____ $3 - 3.99 million
_____ $4 - 4.99 million
_____ $ 5 - 9.99 million
_____ $10 - 14.99 million
_____ $15 - 19.99 million
_____ $20 - 24.99 million
_____ over $25 million

3. What is the number of employees number of employees in your firm?

_____ less than 1000 employees
_____ 1000-1999 employees
_____ 2000-2999 employees
_____ 3000-3999 employees
_____ 4000-4999 employees
_____ 5000-5999 employees
_____ 6000-6999 employees
_____ 7000-7999 employees
_____ 8000-8999 employees
_____ 9000-9999 employees
_____ more than 10,000 employees

4. How many people are presently employed in your department?

_____ 1-10
_____ 11-20
_____ 21-30
_____ 31-40
_____ 41-50
_____ over 50 (please specify)

5. What is the name of your department?

_____

6. In what state is your company located?

_____

7. What make and model of computer(s) do you presently use for ES development? (Please specify all makes and models used if your organization utilizes more than one).

Name	Make	Model Number	Number of Units 1-3	4-6	7-9	10-12	over 12
MAINFRAMES:							
MINIS:							
MICROS:							
OTHERS, please indicate:							

8. Does your company have a designated person(s) directly reponsible for expert systems development? (Please check one)

_____ yes

If yes, how many? _____

If yes, title of person(s) directly responsible

_____

_____ no

If no, please check all that apply:

_____ Expert systems development is performed as part of other responsibilities and NOT listed as a separate job function.

_____ We have no formal program in expert systems.

_____ Consultants are utilized for expert systems purposes.

_____ Other methods of expert systems development are utilized. Please specify below.

II. PERSONAL INFORMATION

1. What is your exact job title?

_____

2. How long have you been in the position identified in item 1 above?

_____ less than 1 year
_____ 1 - 2 years
_____ 3 - 4 years
_____ 5 - 6 years
_____ 7 - 10 years
_____ more than 10 years

3. Please indicate your highest educational level.

_____ high school graduate
_____ some college work
_____ associate degree
_____ vocational/trade school certificate
_____ bachelor's degree
_____ master's degree
_____ doctoral degree
_____ other, please specify: _____

4. Please indicate if you have utilized any of the following educational or training areas in expert systems. Please check all that apply).

_____ regular college courses or college extension courses
_____ in-house training programs presented by your company
_____ vendor-sponsored seminars
_____ seminars offered by other private companies and presented by their staff
_____ self-education (i.e. independent reading and study)
_____ no training/education in expert systems

5. Did you complete an artificial intelligence/expert systems-related course(s) before entering your present job position?

_____ yes
_____ no

If yes, please specify title of course(s):
(1) _____
(2) _____
(3) _____

6. Please indicate when you graduated from college.

_____ 1980 - 1987
_____ 1975 - 1979
_____ 1970 - 1974
_____ 1965 - 1969
_____ 1960 - 1964
_____ prior to 1960. Please specify: _____
_____ does not apply

What college/university did you attend?

Name _____
City _____ State _____

7. Did the college you attended require completion of an artificial intelligence/expert systems-related course?

_____ yes
_____ no

If yes, please indicate which course(s).
(1) _____
(2) _____
(3) _____

8. If you answered yes to question 7, do you feel that the course(s) was sufficient training in order for you to work with expert systems on your present job?

_____ yes
_____ no

9. Have you been involved with expert systems development or maintenance?

_____ yes
_____ no

If yes, please specify the number of times.
_____ over 25, please specify: _____
_____ 21 - 25
_____ 15 - 20
_____ 10 - 14
_____ less than 10, please specify: _____

If yes, with what types of applications were you involved? Please specify.

10. Do you feel that your background in expert systems would be adequate for modifying or describing needed collegiate business courses?

_____ yes
_____ no

11. Do you feel an artificial intelligence/expert systems-related course(s) should be required in Management Information Systems business programs?

_____ yes
_____ no

12. What is your gender?

_____ male

_____ female

13. What is your age?

_____ 20 - 29 years
_____ 30 - 39 years
_____ 40 - 49 years
_____ 50 and above

III. EXPERT SYSTEMS APPLICATIONS INFORMATION

1. Does your company currently utilize any expert systems applications?

_____ yes If yes, please continue with the next question.

_____ no If no, is your company considering utilizing expert systems application in the near future?

_____ yes _____ no (GO TO QUESTION #7)

2. Please specify the types of expert systems application(s) not currently being utilized in your company and the number of years utilized.

		Number of years utilized				
		1-2	3-4	5-6	7-8	9 or more
(1)	_____					
(2)	_____					
(3)	_____					
(4)	_____					

3. Please specify the types of expert systems application(s) currently being utilized in your company and the number of years utilized.

		Number of years utilized				
		1-2	3-4	5-6	7-8	9 or more
(1)	_____					
(2)	_____					
(3)	_____					
(4)	_____					

4. Please specify the types of expert systems application(s) planned for future utilization in your company.

(1) _____
(2) _____
(3) _____
(4) _____

5. How much money is spent annually on expert systems development and/or maintenance?

_____ less than $100,000
_____ $100,000-$499,000
_____ $500,000-$999,999
_____ $1,000,000-$4,999,999
_____ $5,000,000-$9,999,999
_____ more than $10,000,000

6. What is the source of the expert systems business applications utilized in your company? (Check all that apply)

_____ programs developed by in-house programming personnel
_____ programs developed by programming consultants
_____ program shells developed by vendors
Please specify shell and vendor:_____
_____
_____ other, please specify: _____
_____

7. Please check the following statement which most accurately reflects the status of expert systems at your company.

_____ expert systems-related work is utilized in the company.
_____ no expert systems-related work exists, however, we plan to implement one within the next five years.
_____ no expert systems-related work exists, nor do we plan to implement such work within the next five years. PLEASE GO TO SECTION IV ON PAGE 9.

8. Do you anticipate employing additional workers within the next five years in the expert systems area?

_____ yes
_____ no

9. Have you hired employees in the expert systems area within the last five years?

_____ yes
_____ no

10. Do you currently have an opening for a position working with expert systems?

_____ yes
_____ no

11. Please indicate the number of employees currently working in the expert systems area?

_____ 1
_____ 2
_____ 3
_____ 4
_____ 5
_____ other, please specify: _____

IV. ADDITIONAL COMMENTS/OPTIONAL

1. Please make any additional comments you consider relevant.

If you would you like a summary of the questionnaire responses, please complete the information below.

Name _____

Department _____

Name of Company _____

Company Address _____

_____

(City) (State) (Zip)

****

Thank you for your participation in this survey. We appreciate your taking the time to fill out this questionnaire.

Please return the completed questionnaire in the enclosed, stamped envelope to:

Connie A. Wilson
39 1/2 Northeast 63 Street
Oklahoma City, OK 73105

on or before _____ .

Dear

Thank you very much for taking the time to fill out my pilot questionnaire on the topic of expert systems applications. Your assistance was helpful in refining the questionnaire and cover letter. The complete questionnaire is ready to mail, and I am confident it is going to yield positive results.

If you would like a summary of the responses, please complete the information below and return it to me in the envelope provided.

Cordially,

Connie A. Wilson
Doctoral Student

Name _____

Department _____

Name of Company _____

Company Address _____

_____

(City (State) (Zip)

APPENDIX B

FINAL QUESTIONNAIRE

QUESTIONNAIRE ON EXPERT SYSTEMS USAGE

This questionnaire is a survey of selected businesses to determine the extent of the use of expert systems applications in industry and to determine the knowledge and skills needed by employees who work with expert systems.

Please complete the questionnaire by checking (√) the appropriate response and filling in the blanks when necessary. Your participation in this survey is greatly appreciated. Thank you.

.....

I. BUSINESS INFORMATION

1. What is the primary business purpose of your firm?

_____ retailing
_____ wholesaling
_____ printing/publishing
_____ insurance
_____ medical
_____ utilities
_____ computer/electronics
_____ consulting
_____ manufacturing
_____ construction
_____ transportation
_____ financial services
_____ legal
_____ other, please indicate
_____
_____

2. According to the most recently completed year for which data are available, what is your firm's annual gross revenue?

_____ less than $1 million
_____ $1 - 1.99 million
_____ $2 - 2.99 million
_____ $3 - 3.99 million
_____ $4 - 4.99 million
_____ $5 - 9.99 million
_____ $10 - 14.99 million
_____ $15 - 19.99 million
_____ $20 - 24.99 million
_____ over $25 million

3. Please indicate the number of employees in your firm.

_____ less than 1000 employees
_____ 1000 - 1999 employees
_____ 2000 - 2999 employees
_____ 3000 - 3999 employees
_____ 4000 - 4999 employees
_____ 5000 - 5999 employees
_____ 6000 - 6999 employees
_____ 7000 - 7999 employees
_____ 8000 - 8999 employees
_____ 9000 - 9999 employees
_____ more than 10,000 employees, please specify _____

4. How many people are presently employed in your department?

_____ 1 - 10
_____ 11 - 20
_____ 21 - 30
_____ 31 - 40
_____ 41 - 50
_____ over 50, please specify:
_____

5. Please indicate the name of your department.

_____

6. In what state is your company located?

_____

7A. What **make** and **model** of computer(s) do you presently use for ES development? (Please specify all makes and models used if your organization utilizes more than one.)

Name	Make	Model Number	Number of units				
			1-3	4-6	7-9	10-12	over 12
Mainframes:							
Minis:							
Micros:							
Others, please indicate:							

7B. What expert systems development tools (shells) do you run on the hardware listed above?

8. Does your company have a designated person(s) directly responsible for expert systems development? (Please check one)

_____ Yes

If yes, how many? _____
If yes, title of person(s) directly responsible

_____

_____ No

If no, please check all that apply:

_____ Expert systems development is performed as part of other responsibilities and **NOT** listed as a separate job function.
_____ We have no formal program in expert systems.
_____ Consultants are utilized for expert systems purposes.
_____ Other methods of expert systems development are utilized. Please specify below.

II. PERSONAL INFORMATION

1. What is your gender?

_____ Male
_____ Female

2. What is your age:

_____ 20 - 29 years
_____ 30 - 39 years
_____ 40 - 49 years
_____ 50 and above

3. Please specify your exact job title.

_____

4. How long have you been in the position identified in item 1 above?

_____ less than 1 year
_____ 1 - 2 years
_____ 3 - 4 years
_____ 5 - 6 years
_____ 7 - 10 years
_____ more than 10 years, please specify:
_____

5. Please indicate your **highest** educational level.

_____ high school graduate
_____ some college work
_____ associate degree
_____ vocational/trade school certificate
_____ bachelor's degree
_____ master's degree
_____ doctoral degree
_____ other, please specify: _____

6. Please indicate if you have utilized any of the following educational or training areas in expert systems. (Please check all that apply.)

_____ regular college courses or college extension courses
_____ in-house training programs presented by your company
_____ vendor-sponsored seminars
_____ seminars offered by other private companies and presented by their staff
_____ self-education (i.e. independent reading and study)
_____ no training/education in expert systems

7. Did you complete an artificial intelligence/expert systems related course(s) before entering your present job position?

_____ Yes
_____ No

If yes, please specify title of course(s):
(1) _____
(2) _____
(3) _____

8. Please indicate when you graduated from college.

_____	1980 - 1987	Bachelors _____	Masters _____	Doctors _____
_____	1975 - 1979	Bachelors _____	Masters _____	Doctors _____
_____	1970 - 1974	Bachelors _____	Masters _____	Doctors _____
_____	1965 - 1969	Bachelors _____	Masters _____	Doctors _____
_____	1960 - 1964	Bachelors _____	Masters _____	Doctors _____
_____	prior to 1960.	Please specify: _____		
_____	does not apply			

What college/university did you attend?

Name _____
City _____ State _____

9. Did the college you attended require completion of an artificial intelligence/expert systems related course?

_____ Yes
_____ No

If yes, please indicate title(s) of course(s).

(1) _____
(2) _____
(3) _____

10. If you answered yes to question 7, do you believe that the course(s) was (were) sufficient training for you to work with expert systems on your present job?

_____ Yes
_____ No

11. Have you been involved with expert systems development or maintenance?

_____ Yes
_____ No

If yes, please specify the number of times.
_____ over 25, please specify: _____
_____ 21 - 25
_____ 15 - 20
_____ 10 - 14
_____ less than 10, please specify: _____

If yes, with what types of applications were you involved? Please specify.

_____

12. Do you believe your background in expert systems would be adequate for modifying or describing needed collegiate business courses?

_____ Yes
_____ No

13. Do you believe an artificial intelligence/expert systems related course(s) should be required in Management Information Systems business programs?

_____ Yes
_____ No

III. EXPERT SYSTEMS APPLICATIONS INFORMATION

1. Does your company currently utilize any expert systems applications?

_____ Yes If yes, please continue with the next question.
_____ No If no, is your company considering utilizing expert systems application in the near future?

_____ Yes _____ No (GO TO QUESTION #7)

2. Please specify the types of expert systems application(s) previously used (but not currently) in your company and the number of years utilized.

	Number of Years Utilized				
	1-2	3-4	5-6	7-8	9 or more
(1) _____					
(2) _____					
(3) _____					
(4) _____					

3. Please specify the types of expert systems application(s) currently being utilized in your company and the number of years utilized.

	Number of Years Utilized				
	1-2	3-4	5-6	7-8	9 or more
(1) _____					
(2) _____					
(3) _____					
(4) _____					

4. Please specify the types of expert systems application(s) planned for future utilization in your company.

(1) _____
(2) _____
(3) _____
(4) _____

5. How much money is spent annually on expert systems development and/or maintenance?

_____ less than $100,000
_____ $100,000 - $499,999
_____ $500,000 - $999,999
_____ $1,000,000 - $4,999,999
_____ $5,000,000 - $9,999,999
_____ more than $10,000,000

6. What is the source of the expert systems business applications utilized in your company? (Check all that apply.)

_____ programs developed by in-house programming personnel
_____ programs developed by programming consultants
_____ program shells developed by vendors
Please specify shell and vendor: _____
_____
_____ other, please specify: _____
_____

7. Please check the following statement which most accurately reflects the status of expert systems at your company.

_____ expert systems related work is utilized in the company
_____ no expert systems related work exists; however, we plan to implement some within the next five years
_____ no expert systems related work exists, nor do we plan to implement such work within the next five years. PLEASE GO TO SECTION IV ON PAGE 7.

8. Do you anticipate employing additional workers in the expert systems area within the next five years?

_____ Yes
_____ No

9. Have you hired employees in the expert systems area within the last five years?

_____ Yes, please specify how many _____
_____ No

10. Do you currently have an opening for a position working with expert systems?

_____ Yes, please specify how many _____
_____ No

11. Please indicate the number of employees currently working in the expert systems area.

_____ 1
_____ 2
_____ 3
_____ 4
_____ 5
_____ other, please specify: _____

IV. ADDITIONAL COMMENTS/OPTIONAL

1. Please make any additional comments you consider relevant.

If you would like a summary of the questionnaire responses, please complete the information below.

Name _____

Department _____

Name of Company _____

Company Address _____

_____

(city) (state) (zip)

.....

Thank you for your participation in this survey. We appreciate your taking the time to fill out this questionnaire.

Please return the completed questionnaire in the enclosed, stamped envelope to:

Connie A. Wilson
39 1/2 Northeast 63 Street
Oklahoma City, OK 73105

on or before

April 30 **1988**

APPENDIX C

CORRESPONDENCE TO BUSINESSES--COVER LETTER

FOLLOW-UP LETTER

OSU

Oklahoma State University

COLLEGE OF BUSINESS ADMINISTRATION

STILLWATER, OKLAHOMA 74078-0555
BUSINESS 201
405-624-5064

February 1, 1988

Dear Systems Analyst:

SUBJECT: EXPERT SYSTEMS APPLICATIONS SURVEY OF FORTUNE 500 BUSINESSES

During the last few years, as you know, the development and utilization of expert systems applications in businesses has increased considerably. I am writing to request your assistance in a national survey of Fortune 500 businesses. It is the purpose of this study to collect data which will provide information and facts stating the extent to which expert systems applications are being used and their impact on future curriculum development in the information systems area.

Your business has been selected from the April 27, 1987 edition of Fortune Magazine to be a part of this research study. Would you please take a few minutes of your valuable time to complete the enclosed questionnaire? If you cannot participate in this study, please forward the enclosed questionnaire along with this letter to the appropriate professional, encouraging that individual to complete and return the questionnaire. Your data will be dealt with confidentially, with every effort being made to avoid disclosure of who you are. If possible the questionnaire should be returned on or before March 1, 1988. A self-addressed, postage-paid envelope is enclosed for convenience in returning the questionnaire.

Thank you very much for being a part of this study by providing your professional expertise. Please indicate if you wish to have a summary of the research findings.

Cordially,

Connie A. Wilson

Connie A. Wilson
Doctoral Student

Jeretta Horn

Jeretta Horn
Doctoral Dissertation Advisor

Enclosures

CENTENNIAL
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Celebrating the Past . . . Preparing for the Future

OSU

Oklahoma State University

COLLEGE OF BUSINESS ADMINISTRATION

STILLWATER, OKLAHOMA 74078-0555
BUSINESS 201
405-624-5064

April 15, 1988

Dear Systems Analyst:

SUBJECT: FOLLOW-UP ON EXPERT SYSTEMS APPLICATIONS SURVEY OF FORTUNE 500 BUSINESSES

Recently you received a questionnaire requesting responses concerning your company's expert systems utilization. This is a national survey of the Fortune 500 businesses, and the information provided by the questionnaires will be of great value in completing my dissertation at Oklahoma State University. At the time this letter was mailed, a response had not been received from your business. If the questionnaire has since been completed and returned, I sincerely thank you.

Would you participate in this project by completing the enclosed questionnaire? If you cannot participate in this study, would you forward the questionnaire along with this letter to the appropriate professional, encouraging that individual to complete and return the questionnaire before April 30? Your data will be dealt with confidentially, with every effort being made to avoid disclosure of who you are. A self-addressed, postage-paid envelope is enclosed for convenience in returning the questionnaire.

Your participation in this study will contribute greatly to the effectiveness and validity of my research, and is greatly appreciated. Please indicate if you wish to have a summary of the research findings.

Cordially,

Connie A. Wilson
Doctoral Student

Jeretta Horn
Doctoral Dissertation Advisor

Enclosures

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APPENDIX D

ADDITIONAL COMMENTS/OPTIONAL

Additional Comments/Optional

In section IV of the questionnaire, respondents were provided space at the end of the questionnaire to include any additional comments considered relevant. Some of the comments were:

"////////// ///// newspaper realized the value of expert systems but feels the technology is not advanced enough to be practical. Studies have been done by //////// at the ///// to simulate a pressman's job and have indicated that it would be too costly, too unreliable and too slow to use an expert system in that area. An actual expert system was developed but was too costly and slow to be implemented. Expert systems have been evaluated in the display ad make-up area and, again, they are too slow to be of value. The problem is the sheer volume of work they would have to perform and the limited time window to perform that work (press deadlines). We use IBM mainframes 390 150E computers, Vax clusters, Tandem non-stop, and many IBM, Macintosh, and clone PC's".

"In process of transferring AI from emerging technologies group to rest of systems. We have both a knowledge-engineering group (our AI experts) and also have a few normal programmers using our PC shell. We plan on getting mainframe rule-based products when they have matured a bit (1989). We plan on using KEE on 386's, workstations, and IBM mainframes. I see a need for AI programmers, knowledge engineers, and AI expert consultants who will support the programmers and knowledge engineers".

"Our company is being reorganized as a result of a merger. Expert systems have been investigated but are not now being planned".

"At this point I would not hire individuals for the sole purpose of developing expert systems. As requirements for expert systems arise, I would train specifically for the project. Requirements for these systems are increasing, but they are still a trickle".

"Our expert systems development efforts have been placed 'on hold' within the past year as a result of a LBO of the corporation. Anticipate renewed activity during 1989".

"I believe that expert systems will become more relevant to us in the future".

"We are only 2 months into our Application Expert project".

"Would consider college background in ES an added plus on job candidates - primary emphasis is on mainframe, online COBOL experience, but micro, mini, and new technology exposure becoming increasingly important".

"We are a corporate headquarters with a very small staff and are only involved with financial consolidation. It is my experience, however, that expert systems or AI are not widely used in manufacturing companies, at least not in the Pittsburgh area".

"We're just beginning to go online".

"My experience with ES development was in my previous job. Development tools were IBM PC/AT's using MProlog, Turbo Prolog, and Insight 2+. I plan to initiate ES development in my current position as opportunities arise".

"There are several projects planned which might benefit from the availability of an expert system. Expert systems (IBM mainframe) were evaluated and a decision postponed until later in the projects due to the rapid change taking place in this area currently".

"There are areas within this company where use of an expert system would be productive, but at the moment there are no clear cut plans to implement such a system. As AI and ES use becomes more mainstream, I am sure that we will give a serious look at possible applications".

"An expert system product is in-house. Some experimental work is in progress but no functioning applications are in place or planned at this time".

"We have only just begun! I consider expert systems just one of many MIS approaches to helping clients make better decisions. Rather than hiring 'x' people to write them then, I feel it's important that every systems analyst be educated on their capabilities and suitability for different types of applications. Only then can she/he identify what applications should be attacked from an ES viewpoint. We need to be a good resource that can pick from a whole bag of tools".

"We currently do not plan on expert systems but in reference to the 5-year period I believe something will be used doing this time frame".

VITA

Connie A. Wilson

Candidate for the Degree of

Doctor of Education

Thesis: UTILIZATION OF EXPERT SYSTEMS IN SELECTED INDUSTRIES

Major Field: Business Education

Biographical:

Personal Data: Born in Okmulgee, Oklahoma, July 19, 1952, the daughter of Milton and Vera I. Biglow.

Education: Graduated from Okmulgee High School, Okmulgee, Oklahoma, in May, 1970; received Bachelor of Science degree in Education from Northeastern State College, Tahlequah, Oklahoma, in 1973; received Master of Science degree in Education from Northeastern Oklahoma State University, Tahlequah, Oklahoma, in 1975; completed requirements for the Doctor of Education degree at Oklahoma State University in December, 1988.

Professional Experience: Business Education Instructor, Tulsa Public Schools, Tulsa, Oklahoma, 1973-1978; evening instructor, Division of Business, Tulsa Junior College, Tulsa, Oklahoma, 1977-1978; business education instructor, Millwood Public Schools, Oklahoma City, Oklahoma, 1978-1981; Radio Communications Representative, Motorola Communications & Electronics, Inc., Oklahoma City, Oklahoma, 1981-1982; business education instructor, Oklahoma City Public Schools, Oklahoma City, Oklahoma, 1983-1984; Assistant Professor, Division of Business, Langston University, Langston, Oklahoma, 1984 to present.

Professional Organizations: Delta Phi Epsilon, National Business Education Association, Oklahoma Business Education Association, International Association of Black Business Educators, Alpha Kappa Alpha Sorority, Phi Beta Lambda, Higher Education Alumni Council of Oklahoma, Oklahoma Alliance of Black School Educators.