CEC Theses and Dissertations

College of Engineering and Computing

2009

A Comparison of the Rule and Case-based Reasoning Approaches for the Automation of Help-desk Operations at the Tier-two Level

Michael Forrester Bryant

Nova Southeastern University, dr_bryant@cox.net

This document is a product of extensive research conducted at the Nova Southeastern University College of Engineering and Computing. For more information on research and degree programs at the NSU College of Engineering and Computing, please click here.

Follow this and additional works at: http://nsuworks.nova.edu/gscis_etd

Part of the Computer Sciences Commons

Share Feedback About This Item

A Comparison of the Rule and Case-based Reasoning Approaches for the Automation of
Help-desk Operations at the Tier-two Level

by

Michael Forrester Bryant

A dissertation submitted in partial fulfillment of the requirements
for the degree of Doctor of Philosophy
in
Computer Information Systems

Graduate School of Computer and Information Sciences
Nova Southeastern University

2009

We hereby certify that this dissertation, submitted by Michael Forrester Bryant, conforms to acceptable standards and is fully adequate in scope and quality to fulfill the dissertation requirements for the degree of Doctor of Philosophy.

_____   _____
Sumitra Mukherjee, Ph.D.   Date
Chairperson of Dissertation Committee

_____   _____
Maxine S. Cohen, Ph.D.   Date
Dissertation Committee Member

_____   _____
William L. Hafner, Ph.D.   Date
Dissertation Committee Member

Approved:

_____   _____
Edward Lieblien, Ph.D.   Date
Dean, Graduate School of Computer and Information Sciences

Graduate School of Computer and Information Sciences
Nova Southeastern University

2009

An Abstract of a Dissertation Submitted to Nova Southeastern University in
Partial Fulfillment of the Requirements for the Degree of Doctor of Philosophy

A Comparison of the Rule and Case-based Reasoning Approaches for the
Automation of Help-desk Operations at the Tier-two Level

by
Michael Forrester Bryant

April 2009

This exploratory study investigates the hypothesis that case-based reasoning (CBR)
systems have advantages over rule-based reasoning (RBR) systems in providing
automated support for Tier-2 help desk operations. The literature suggests that rule-
based systems are best suited for problem solving when the system being analyzed is a
single-purpose, specialized system and the rules for solving the problems are clear and do
not change with high frequency. Case-based systems, because of their ability to offer
alternative solutions for a given problem, give help-desk technicians more flexibility.
Specifically, this dissertation aims to answer the following questions:

1. Which paradigm, rule-based or case-based reasoning, results in more precise solutions
to problems when compared to the solutions derived from system manuals?

2. Which paradigm, rule-based or case-based reasoning, is more convenient to maintain
in terms of knowledge modification (i.e. addition, deletion, or modification of
rules/cases)?

3. Which paradigm, rule-based or case-based reasoning, enables help-desk technicians to
solve problems in shorter time, and therefore at lower cost?

This is an exploratory study based on data collected from field experiments. RBR and
CBR based prototypes were set up to support Tier-2 help desk operations. Trained help
desk operators used the system to solve a set of benchmark problems. Data collected
from this exercise was analyzed to answer the three research questions.

This exploratory study supported the hypothesis that the case-based paradigm is better
suited for use in help desk environments at the Tier-2 level than is the rule-based
paradigm. The case-based paradigm, because of its ability to offer alternative solutions
for a given problem, gave the help-desk technician flexibility in applying a solution.
Alternatively, the rule-based paradigm provided a solution if, and only if, a rule existed
for a solution meeting the exact problem specifications. Further, in the absence of a rule,
problem research time, using the rule-based paradigm, extended the time required to
formulate a solution thereby increasing the cost.

This research provided sufficient information to show that the help-desk knowledge based system utilizing the case-based shell provided better overall solutions to problems than did the rule-based shell.

Acknowledgements

I consider it a privilege to have completed this dissertation under the guidance of three of the finest individuals and scholars that I have ever had the pleasure of working with.

First, I want to offer my sincere thanks to Dr. Sumitra Mukherjee, my committee chairman and professor, who literally taught me the meaning of good research through his wisdom in my research area, his feedback on each iteration of my research, and advice on other topics that I believed to be important.

Dr. Maxine Cohen, one of my professors and committee members, who always helped improve the content of my dissertation with her input and suggestions.

Dr. William Hafner, one of my committee members, who always gave excellent advice for necessary changes in my dissertation.

Mrs. Tam Bryant, my loving wife, who put up with all of my long hours working on this dissertation and still managed to give me her love and encouragement. She truly understands how much I love academia and teaching at the university level.

I would like to thank Mr. Mark Langley and Mr. Jay Dalby of Casebank Technologies who were kind enough to provide a copy of their Spotlight case-based shell for my use in this research. Further, I want to offer my appreciation to Mr. Matt Bodenner of Exsys Corporation who provided me with extended rights to use their rule-based CORVID shell.

Finally, I want to express my gratitude to Dean Edward Lieblein, Dr. Eric Ackerman, and the entire faculty and staff who have made my studies and research at Nova Southeastern University one of the best experiences of my life.

Thank You!

Table of Contents

List of Tables

Tables

List of Figures

Figures

Appendixes

Chapter 1

Introduction

Introduction

This purpose of this exploratory study was to demonstrate the importance of the use of a knowledge-based system to provide problem solutions typically found in an Information Technology (IT) help-desk environment. Specifically, the relative merits of rule-based and case-based approaches to support help desk operations at the Tier-2 level were investigated.

Problem Statement and Goal

Sweat (2001) states that help desks are designed to address many different problems and often for different reasons or causes. Some problems still require manual intervention, but many can be solved automatically. An operational reality at some help desks, the high turnover of staff and enormous time and cost of training new technical support representatives, results in a significant productivity problem and often low-quality advice. Additionally, most help desks face a number of complicating factors including a wide range of products, the systems they support, frequent changes and additions and complex problems, and interaction with various field units. These make the job difficult even for well-trained, experienced personnel.

Some of the typical help desk problems, such as call and problem tracking are best dealt with by the utilization of either conventional information systems technology or one of the many problem-tracking software packages currently available (Gonzalez, Giachetti, and Ramirez, 2005). However, Gonzalez et al. continue, many of the difficulties that help desk operations face are inherently knowledge problems. As an

example, a new technical support technician cannot use the information available to him

or her in manuals, notebooks, databases and meetings without extensive training. Even

experienced and talented technical support personnel have trouble integrating their

knowledge gained on the job and from the systems department into addressing customer

problems as they arrive while answering phone calls.
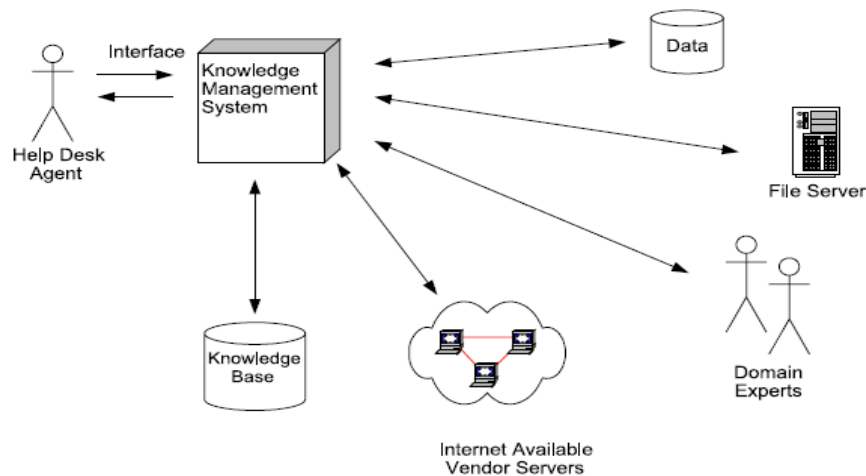
Figure 1. Knowledge management-centric help desk

Note: From Knowledge management centric help desk: specification and performance

evaluation, Gonzalez, Giachetti, and Ramirez, 2005, Decision Support Systems, 40:2, p. 393.

Copyright Elsevier Publishing. Reprinted with permission.

Similarly, Gonzalez, Giachetti, and Ramirez (2005) found that these same

technical support personnel find that troubleshooting guidance is sometimes needed to

keep up with new products, releases and repair procedures. Moreover, even if a help

desk operation is working well now, it will have problems. Some of these problems, such

as key personnel leaving the organization, or new or additional systems getting installed,

can be solved by the use of a knowledge management-centric (KM) help desk system

(Figure 1).

Additionally, Gonzalez, Giachetti, and Ramirez (2005) state that the results of their experiments using a knowledge-centric help desk system found that (Figure 2) "The experimental results indicate the knowledge management-centric approach would significantly reduce the time to resolve problems and improve the throughput of the help desk."
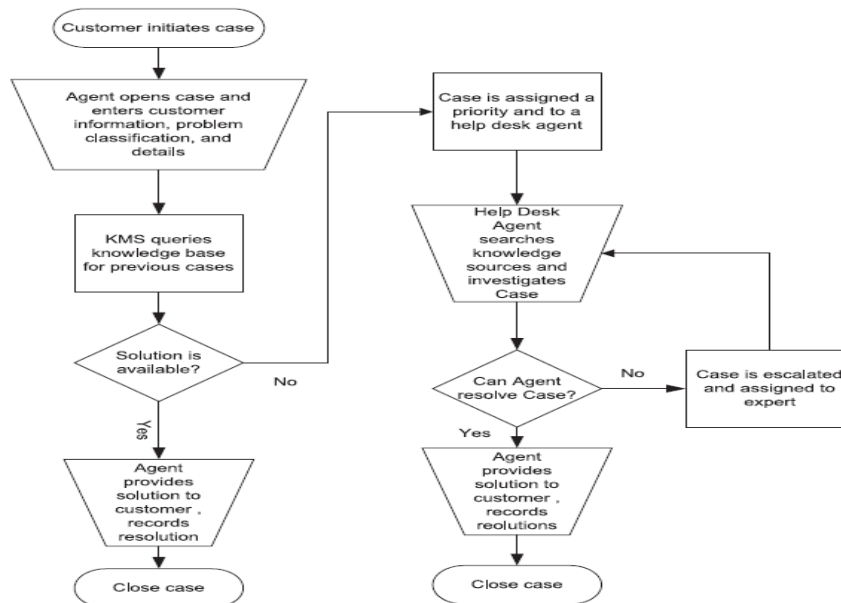
Figure 2. KM-centric help desk resolution process

Note: From Knowledge management centric help desk: specification and performance evaluation, Gonzalez, Giachetti, and Ramirez, 2005, Decision Support Systems, 40:2, p. 393. Copyright Elsevier Publishing. Reprinted with permission.

The implementation of a knowledge management centric system at the organizations IT help desk can realize many benefits. The productivity and collaboration skills of the help desk technicians will be enhanced along with the sharing of their respective knowledge. These enhancements will, in a majority of cases, lead to increased

customer satisfaction in terms of the speed and accuracy of system problem solutions (Farver, Joslin, and LaBounty, 2001).

Definitions of the Problem Resolution Tiers of the IT Help Desk

The help desk industry divides support into three tiers (or levels) – Tier-1, Tier-2, and Tier-3. The work breakdown for each of the three levels is as follows:

1. **Tier-1 Support:** Tier-1 provides basic application software and/or hardware support for the initial customer contact.

2. **Tier-2 Support:** Tier-2, or middle tier, provides more complex support and/or subject matter expertise on application software and/or hardware and is usually an escalation of a call from Tier-1.

3. **Tier-3 Support:** The Tier-3 Level provides support on complex hardware and network operating system software and usually involves certified systems engineers. Call lengths on Tier-3 vary widely depending upon the type of incident.

The cost of the initial call to the Tier-1 technicians is approximately $50; however, the solution cost in the Tier-2 grows to $200 and to $800 in Tier-3. This cost alone has caused most organizations to use some type of knowledge based system (KBS) to solve the more difficult problems thus avoiding the higher upper tier costs (Delic and Hoelimer 2000). The use of a KBS to solve the more difficult problems will also ensure that the cost at the lower tiers is maintained at the lowest rate possible.

The goal of this exploratory study was to investigate the relative merits of rule-based and case-based approaches to support help desk operations at the Tier-2 level. The questions that were answered as a result of this study are as follows:

1. Which paradigm, rule-based or case-based reasoning, resulted in more precise solutions to problems when compared to the solutions derived from system manuals?

2. Which paradigm, rule-based or case-based reasoning, is more convenient to maintain in terms of knowledge modification (i.e. addition, deletion, or modification of rules/cases)?

3. Which paradigm, rule-based or case-based reasoning, enabled help-desk technicians to solve problems in shorter time, and therefore at lower cost?

This exploratory study contrasted and compared the case and rule-based paradigms when used as help-desk decision support systems for solving Tier-2 problems based on the outcomes of the above three questions. This was accomplished by the development of two prototypes, one rule-based and one case-based. These shells were populated with problem and solution data categorized by problem type. Randomly selected problems were then selected and entered into each of the prototypes. The solutions returned by each of the prototypes were compared to determine which solution was the most accurate when compared to system maintenance manuals. The difficulty of maintenance for each of the prototypes was then determined. Each maintenance item was evaluated by one of the help desk technicians as to the length of time taken to perform the maintenance item and the difficulty, based on the intuitiveness of each of the systems. Maintenance of these systems is defined as the addition of new cases or rules, the

deletion of cases or rules and the reclassification of cases. Finally, the time required to implement the proposed solutions was evaluated. This exploratory study emphasized the conjectures that rule-based systems are better suited for problem solving when the system being analyzed is a single-purpose, specialized system and the rules for solving the problems are clear and do not change with high frequency.

The hypothesis of this study is that the case-based paradigm is better suited for use in the Tier-2 computer workstation (workstation hardware/software problems) help desk environment than is the rule-based paradigm. The case-based paradigm, because of its ability to offer alternative solutions for a given problem, gives the help-desk technician flexibility when applying a solution. Alternatively, the rule-based paradigm provided a solution if, and only if, a rule existed for a solution meeting the exact problem specifications. Further, in the absence of a rule, problem research time, using the rule-based paradigm, extended the time required to formulate a solution thereby increasing the cost.

Relevance and Significance

Help desks in organizations are very important to the day-to-day business of the organization. Over the last 10 to 15 years, the model of the help desk has changed from being a basic IT Help Desk that solves user's problems into a more process-oriented support center. The help desk has emerged as a very important part of an organization and has been recognized as a place where organizations can gain competitive advantage (Kane, 2001).

Kane (2001) further states that knowledge bases and web support services are popular in large first line (Tier-1) support environments where the nature of support

requests is homogeneous and predictable. Not only are these knowledge bases useful for first line support but they increase the overall knowledge and learning in the organization.

The use of a knowledge-based system which implements the case-based reasoning paradigm has many benefits. Inasmuch as case-based reasoning employs solution reuse as a main premise it can help reduce the amount of time that agents spend on service calls. This "knowledge reuse" also increases the productivity of the help-desk technician who has answered the same questions for customers in the past and will certainly give new technicians a head start in answering these and similar questions (Doctor, 2003). Delic and Hoelimer (2000) further emphasize this stating that help-desk operations at all three tiers are frequently supported by some sort of knowledge-based system.

The major knowledge-centric techniques utilized in help-desk automation are case and rule-based reasoning, and combinations of these two paradigms. Both of these paradigms are based primarily on the cognitive processes employed by human thought. There are many studies that investigate applications of both the rule-based expert system and the case-based knowledge-base system. This exploratory study shows the types of applications in which each of the paradigms is best suited. A survey of the research pertaining to both paradigms has presented a very convincing argument for each of their cases; however, case-based reasoning presents the stronger case in the domain of automating help-desk operations (Doctor, 2003; Delic and Hoelimer, 2000; Kane 2001).

Barriers and Issues

There have been many studies as to the merits of case and rule-based reasoning and text-based retrieval systems; however, there have only been a few relevant studies that have made actual comparisons between them. The research indicated that

knowledge retrieval systems can be valuable assets to the information technology help desk (Kriegsman and Barletta, 1993; Delic and Hoelimer, 2000). This exploratory study performed comparisons that compared the accuracy of retrieved solutions, the difficulty of maintenance encountered, and the time in minutes that a call takes using each of the knowledge retrieval systems, case and rule-based shell applications coupled with any manual research that may have been required. A review of the literature within the help desk domain revealed that an actual comparison of the rule-based versus the case-based paradigms did not appear to have taken place.

The outcome of this exploratory study depended on the two environments that were set up to develop, test, and maintain the case and rule-based systems. The rule-based system, Exsys'® CORVID™, and the case-based system, Casebank Spotlight® , version 3.26 were installed and maintained on a stand-alone Microsoft® XP Professional® desktop. The CORVID™ and Casebank Spotlight® software were designed to run in this environment, and no significant problems arose that could have caused delays or other software problems during the development and test phases of this exploratory study. There were no significant retrieval time differences between the rule and case-based implementations, however, when an event occurred where the specific rule is absent in the rule-based model, problem research time was extended and caused the solution period to be longer than that of the case-based system.

Validity and Uniqueness of the Data

To ensure content validity is maintained, the data transcribed from the text sources were validated by researching a minimum of two help desks from the commercial

and governmental environments. This ensured that the problems entered into the case and rule-based servers were actual problems encountered by the researched help desks.

Summary

The need for the information technology help desk has become critical over the past several years. With the growth of technology within the business and government entities, a simple help desk manned with technicians and reference manuals will no longer satisfy the need. The use of the knowledge base for solving problems has grown to where they provide answers to users problems without human intervention. Because the problems submitted to the help desk are very broad based, from printer to specific software problems, the case-based knowledge system is better suited to provide solutions.

Chapter 2

Review of the Literature

Introduction

This chapter examines the methods that the Information Systems (IS) help-desks use to solve software and hardware problems encountered by various workforces using the personal computer as their primary data retrieval tool. This chapter also examines the evolution that has taken place from using only the help-desk technicians and their ability to solve hardware and software problems, to the use of various types of knowledge bases for faster, cheaper, and more efficient problem solving. The methodologies used for these knowledge based systems include the rule-based expert system and case-based knowledge management systems. The literature seems to suggest that the case-based knowledge management system is better suited for the IT help-desk than the rule-based expert system.

The Information Technology (IT) Help Desk

The past two decades have shown exponential advancement in the technology of information systems available to the business and government sectors of countries throughout the world. This technological growth created the need to move away from the vast libraries of three-ring binders on system problems and solutions to a methodology that allows the help desk technician to provide problem solutions in minutes versus hours.

Graham and Hart (2000) in their report of successes and failures of developing a University-wide centralized IT help desk at the University of Pittsburgh, show the value that is added to the help desk by the implementation of a knowledge management system to replace antiquated manual methods. Prior to the implementation of the knowledge-

centric system, help desk technicians at the University of Pittsburgh, were expected to review resolved problems in various databases, and be able to resolve future problems based on the information contained in the solution fields of the these databases. The database contained approximately 150,000 trouble calls at any given time making it practically impossible for the technicians to be able to review and retain this knowledge to solve future problems.

Graham and Hart (2000) continue that the university developed a knowledge-centric help desk system by combining two off-the-shelf software packages. The first was a ticket processing package for logging and storing the actual trouble ticket. The second package provided a framework for the creation of a knowledge base organizing it into logical categories using a decision tree format.

Graham and Hart (2000) conclude by stating the benefits derived by the university due to the implementation of the knowledge-centric system. "The benefits include:

1. Improved consistency and accuracy of responses to Help Desk calls.

2. Improved quality of support by reducing the amount of time required to research problems.

3. Reduced average call length.

4. Delivery of tools for end-users to search the knowledge base and resolve problems independently.

5. Reduced training costs for new Help Desk Analysts."

Last (2003) discusses the merits of building your own help desk software as opposed to purchasing an off-the-shelf version. Last's conclusion is that with the growth of information technology and the demands already placed on various in-house

programming staffs that the best way is to purchase an available software package for use on the help desk.

Halverson, Erickson, and Ackerman (2004) examine the concept used at a large corporation which employed the concept of using the Question and Answer (Q&A) paradigm where they store the question (problem) and the answer (solution) in a Q&A knowledge-base. The implementation of this Q&A system allowed both in-house and on-line customers access to query the knowledge-base.

The increase in service calls from 4,076 in 2000 to 22,126 in 2005 at the University of Rochester prompted them to design a help desk system which would allow them to handle the increase in calls. The designers at the University of Rochester developed a help desk system, called System Reference (SysRef), using several off-the-shelf search engines and help desk packages. The designers used Intuit Corporations "Track-it" for logging trouble calls. Coveo Search, which is similar to searching on Google or Yahoo, is utilized as their primary search engine. They then stored the data using Microsoft SQLServer 2000 as the database system to store all of the help desk data. The University of Rochester states that because the SysRef database has substantially addressed the immediate needs of their changing IT environment that they are "…looking forward to a period of infrastructure strengthening which will then poise the application for future growth while retaining the original concepts of using existing data whenever possible and not 're-inventing the wheel'" (Padeletti, Coltrane, and Kline, 2005).

The research indicates that the IT help desk is moving rapidly from the massive numbers of three-ring binders to some type of knowledge-based system. This movement confirms in part the thesis of this exploratory study that a knowledge-base is becoming a

critical part of the IT help desk. An important question that remains to be investigated is the relative merits of CBR and RBR for this task.

Expert Systems Defined

Jackson (1999) states that expert systems are computer programs that are derived from Artificial Intelligence (AI). The goal of AI is to understand intelligence by building computer programs, or shells, that exhibit intelligent behavior. AI is further concerned with the concepts and methods of symbolic inference, or reasoning, and how that knowledge will be used to make those inferences will be represented inside the machine.

Jackson (1999) further states that an expert system can completely fulfill the knowledge gap within a domain or it may act as an assistant to aid a domain expert in solving complex problems. Typically, expert systems are utilized in a diverse range of knowledge domains, such as internal medicine, organic chemistry, and business applications such as the IT help desk. Expert system tasks include data interpretation, diagnostics such as machine failure, analysis of complex chemical compounds, computer systems configuration, and for use in robotics.

Conventional computer programs can be written to supply some of the requisite domain knowledge required by an individual. However, there are major differences in the way expert systems can be distinguished from these conventional application programs.

First, the expert system "simulates human reasoning" about a given problem domain but does not simulate the domain itself. Second, the expert system performs "reasoning over representations" of human knowledge while maintaining the ability to do numerical calculations and/or data retrieval. Third, conventional programs solve

problems using strict algorithmic methodology while the expert system uses "heuristic or approximate methods" that do not guarantee that the answer will be absolutely correct and will succeed. These "heuristic or approximate methods" are better known as rules of thumb (Jackson, 1999).

Jackson (1999) continues that there is a difference between other types of artificial intelligence programs and the expert system. First, the expert system deals with problems that require a great deal of human expertise. Other AI programs deal mainly with abstract mathematical problems and are, for the most part, considered research vehicles. Secondly, the expert system, because it is attempting to solve problems dealing with human expertise, must exhibit a high degree of performance in terms of speed and reliability in order to maintain its usefulness. This is because these problems dealing with human expertise, for example solving problems related to computer performance, require solutions in a short time frame due of the volume of problems encountered in any one day. The AI programs are just that, programs, being used as research vehicles. Finally, Jackson suggests that an expert system must be "capable of explaining and justifying solutions or recommendations" to give the user confidence that the answer retrieved from the expert system is, in fact, correct.

Englemore and Feigenbaum (1993) state that AI is concerned with the concepts and methods of symbolic inference, or reasoning, by a computer, and how this knowledge will be used to represent these inferences within the computer system itself. Englemore and Feigenbaum continue that every expert system consists of two principal parts: the knowledge base; and the reasoning, or inference engine.

Luger and Stubblefield (2002) state that the knowledge base of an expert system contains both factual and heuristic knowledge. Factual knowledge is that knowledge of the task domain that is widely shared and, usually found in books and journals. Further, this factual knowledge is commonly agreed upon by experts in a particular domain.

Heuristic knowledge is the less rigorous, more experiential, more judgmental knowledge of performance. It is the knowledge that humans possess that underlies our ability to formulate "good guesses". The formalization and organization of the knowledge is known as knowledge representation.

The exploratory study in this dissertation deals with two of the most important paradigms utilized in expert systems. These paradigms are rule and case-based reasoning.

Current Uses and Advances in Expert Systems and Knowledge Acquisition using Rule-based Reasoning (RBR)

Rule-based knowledge representation is one of the most widely used types (Englemore and Feigenbaum, 1993). But what exactly is Rule-based Reasoning? Crossman et al. (1995) state by breaking this down into its individual parts, rules are knowledge representations about which "patterns of information experts use to make decisions and what are the decisions that follow." Rule-based reasoning offers a set of rules that chain to a given conclusion. The most popular way to represent this knowledge is by using the "if-then" rule. Crossman et al. state that this rule can be represented in the logical relation "p→q". In this relation, "p" represents a condition or set of conditions and "q" represents a conclusion or set of conclusions. This relation/conclusion set is, according to Ignizio (1991), the most common set utilized by expert systems, and

especially in rule-based expert systems. This inference strategy is better known as "modus ponens" which means that if A infers B and A is true, then B is true.

Crossman et al. (1995) further state that many different algorithms have been developed to support the basic premise of rule-based reasoning. There are varying differences in these approaches and are all in the domain of knowledge engineering. One example given by Crossman et al. is that "forward chaining rules facilitate programming synthesis, while backward chaining rules are more suited for analysis or search."

If the type of reasoning involved in the domain of interest involves the use of flow diagrams or trees, then the use of rules is the best way to proceed. These rules do not, however; represent the facts or data themselves; rather they represent the reasoning about the facts or data. Rule-based systems use an inference engine which is an algorithm that governs what the rules can do, when they will be activated or triggered, and what priority is given to each for execution. Rules in the rule-based system can also entertain certain forms of uncertain reasoning, e.g., the adding or subtracting of confidence levels while evaluating a hypothesis or providing an alternative mechanism to handle other lines of reasoning (Crossman et al., 1995).

Rule-based and other expert systems tools are more commonly known as shells. The biggest advantage that rule-based systems offer is they allow the user to look at the rules in a near-natural language format and provide an explanation as to why an explanation was made.

Luger and Stubblefield (2002) state that the first attempt at building an expert system using the rule-based paradigm, is unlikely to be very successful. The primary

reason for this is because the domain expert finds it very difficult to express tacit knowledge in terms that can be used to solve the specific problem.

Finally, Luger and Stubblefield (2002) conclude that the most widely used knowledge representation scheme for expert systems is rule-based. Normally, the rules themselves will not hold certain conclusions but there will be some degree of certainty that the conclusion will hold if the conditions hold. There are statistical techniques which are used to determine these certainties. Rule-based systems, whether or not they possess certainties, are usually easily modifiable. These certainties make it relatively simple to provide helpful traces of the system's reasoning. These traces can be used in providing explanations of what it is doing.

It is noteworthy to mention that rule-based reasoning is used in the help desk environment primarily as an enhancement to case-based technology (Luger and Stubblefield, 2002).

Current Uses and Advances in Expert Systems and Knowledge Acquisition using Case-based Reasoning (CBR)

Case-based reasoning (CBR) is an Artificial Intelligence (AI) paradigm for problem solving and knowledge reuse that uses previous similar examples to solve the current problem. Further, CBR draws its ability to search its memory for solutions and acquire new ones without necessarily understanding the underlying principles of its domain (Kolodner, 1993).

In order, however, to explain how CBR works, one must first understand the meaning of case. Watson (2002, p. 27) defines case as:

Cases are records of experiences that contain knowledge, which can be both explicit and tacit. For example, they can be cases in the legal sense; they can be case histories of patients in the medical sense, details of bank loans, or descriptions of equipment troubleshooting situations.

Watson continues by describing what comprises a legal case, a medical case history, a bank loan and the troubleshooting record. First, he states the description is made up of "the legal problem, the patient's symptoms, the details of the loan, and the equipment's problem". He concludes by stating that the outcome or solution of each of these descriptions is comprised of "the verdict or ruling, the treatment, the outcome of the loan, and the technical fix".

Kolodner (1993) states that a case can further be described as an account of an event, a story, or some record that typically comprises the problem that describes the state of the world when the case occurred and the solution that states the derived solution to that problem. This means that CBR derives solutions from previous cases only and acquires new cases to improve and evolve its decision-making abilities.

Further, the representation of a case has various forms, such as an example or even a story, as long as it can be recognized by a reasoner in a specific domain. Semantically, a case represents both a specific piece of knowledge and its context, under which the case will be retrieved to construct a solution for a new problem. This means that we can view case-based reasoning as a process of remembering a set of previous cases and making decisions based on the comparison between them and new situations.

Kolodner (1993) continues by discussing the advantages and disadvantages of using CBR in knowledge development. Kolodner asserts that CBR allows the reasoner to propose solutions to problems quickly, avoiding the time necessary to derive those answers from scratch. As an example, a doctor remembering an old diagnosis or treatment experiences this benefit. The case-based reasoner, as with any other reasoner, has to evaluate proposed solutions; getting a head start on solving problems because it can generate proposals easily. This was certainly brought to light during an evaluation of a CBR application called CASEY (Kolodner's first CBR application), which showed a speedup of two orders of magnitude when a problem had been seen in the past.

CBR allows a reasoner to propose solutions in domains that are not completely understood by the reasoner. Many domains are impossible to understand completely, often because much depends on unpredictable human behavior. CBR allows assumptions and predictions to be made based on what worked in the past without having a complete understanding of the problem or issue.

CBR gives a reasoner a means of evaluating solutions when no algorithmic method is available for evaluation. Using cases, in this instance, is particularly helpful when there are many unknowns, making any other type of evaluation impossible or at least difficult. Solutions are evaluated in the context of previous similar situations. Again, the reasoner does its evaluation based on what worked in the past (Kolodner, 1993).

The CBR problem solving methodology equates with the manner in which humans solve problems where there is a situation when an individual encounters a new situation or problem, that person will often refer to a past experience of a similar problem

(Pal and Shiu, 2004). Pal and Shiu continue that the concept of CBR is very appealing

due to the fact that it is very similar to the human problem solving behavior and as such

will relieve the task of in-depth analysis of the problem domain where history is

available. Finally, Pal and Shiu conclude that the use of this method leads to the

advantage that CBR can be based on "shallow knowledge" and does not require the

knowledge engineering effort required by rule-based systems.

Bergmann et al. (2003, p. 16) state that "Compared to expert systems, case-based

decision support systems do not rely on rules that are supplied by a specialist".

Bergmann et al. believe that CBR is more of a "natural approach" whereby the help-desk

technician (or other specialist) never has to supply diagnostic rules or to define formal

specifications of any of the decision processes utilized to determine a solution to a

problem. The CBR decision support system has the ability to acquire and maintain

knowledge inasmuch as the system has the ability to learn new cases.

Pal and Shiu (2004) state that the process of CBR can be abstracted as a cycle

which consists of four basic steps (Figure 1, The CBR Cycle): (1) Case Retrieval to find

the most similar case that will address the new problem, (2) Case Reuse to utilize the

retrieved case to solve the problem, (3) Case Revision or adapting to modify the retrieved

case with the hope that it will fit the new problem, and (4) Case Retention to maintain the

revised case as a new case in the case-base after it has been confirmed or validated.

Other research has concluded that the four basic steps in the CBR cycle should actually

be a six step process by adding the Restore and Review phases.
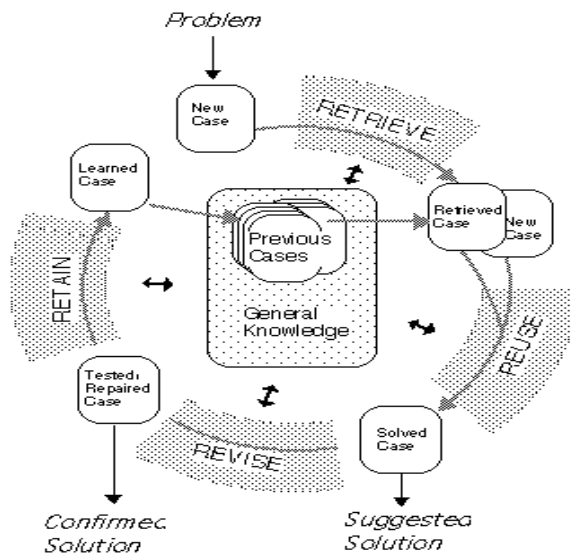
Figure 3. The CBR Cycle

Note: From Foundational issues, methodological variations, and system approaches, Aamodt and Plaza, 1994, Artificial Intelligence Communications, 7:1, p. 8. Copyright IOS Press. Reprinted with permission.

Göker and Roth-Berghofer (1999) believe that the steps in the CBR cycle are contained within two general cycles; the Application Cycle and the Maintenance Cycle. The Application Cycle, which contains the Retrieve, Reuse, and Revise steps, is performed whenever a user or the help-desk technician solves a problem with the case-based help-desk support system. If the solution that is generated during the Reuse cycle is not correct and it cannot be repaired, the help-desk technician must generate a new solution. This new solution is put into play during the ReCyle phase. All of the new solutions generated in this manner are stored in a buffer and made available to the help-desk technicians as unconfirmed cases. These unconfirmed cases are then sent to the Maintenance Cycle to be processed and included in the case-base. The Maintenance Cycle, which contains the Retain and Refine steps is executed less frequently. Normally,

the maintenance phase is conducted at specific intervals to update the case-base with the unconfirmed case(s) contained in the ReCycle phase buffer. There are two additional steps that Göker and Roth-Berghofer have added to the generally accepted four-phase CBR cycle. These are the ReCycle and Refine steps. The ReCycle step is used as an intersection between the Application and Maintenance Cycles and contains the unconfirmed cases sent by the Application Cycle. The unconfirmed cases retrieved from the ReCycle buffer are placed in the Refine step where they are repaired and written to the case-base. The primary mission of the Refine step is to ensure that the case-base is accurate. There are five checks that Göker and Roth-Berghofer (1999, p. 144) state that must take place before the case can be added to the case-base. These are:

"1. Whether it is a viable alternative that does not yet exist in the case base,

2. Whether it subsumes or can be subsumed by an existing case,

3. Whether it can be combined with another case to form a new one,

4. Whether the new case would cause an inconsistency, and

5. Whether there is a newer case already available in the case base."

Roth-Berghofer and Iglezakis (2001) also believe that the six-step CBR cycle is the correct method and that the two phases, Maintenance and Application, best describe the correct CBR process of retrieving solutions and insuring that they are accurate and then storing them in the case-base. Figure 4 shows how the Maintenance and Application phases interact.
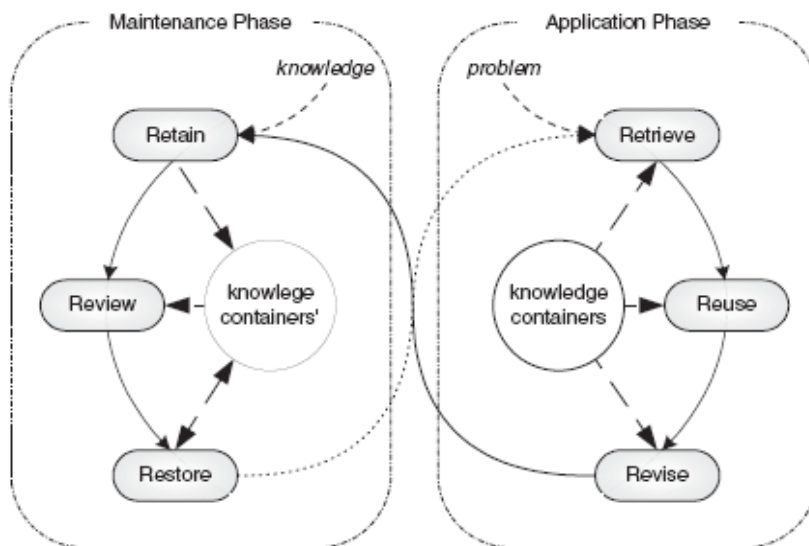
Figure 4. The six RE cycle

Note: From Six Steps in Case-Based Reasoning: Towards a maintenance methodology for case-based reasoning systems, Roth-Berghofer and Iglezakis, 2001, Proceedings of the 9th German Workshop on Case-Based Reasoning (GWCBR). Copyright Shaker Verlag. Reprinted with permission.
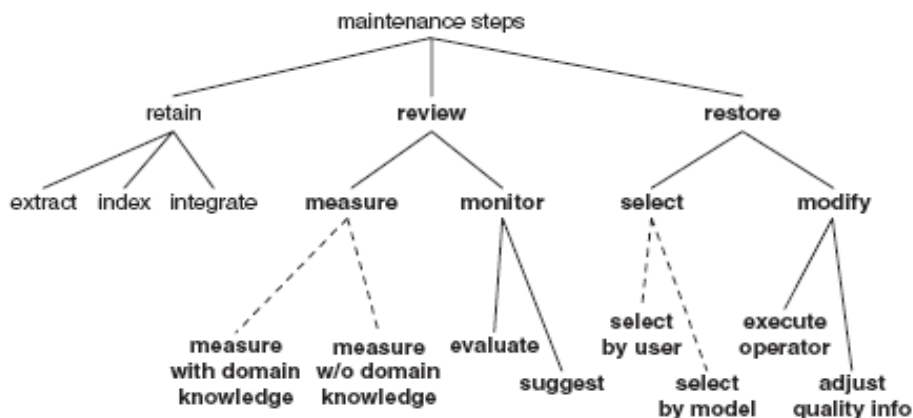
Figure 5. Decomposition of Maintenance

Note: From Six Steps in Case-Based Reasoning: Towards a maintenance methodology for case-based reasoning systems, Roth-Berghofer and Iglezakis, 2001, Proceedings of the 9th German

Workshop on Case-Based Reasoning (GWCBR). Copyright Shaker Verlag. Reprinted with permission.

Roth-Berghofer and Iglezakis (2001) also give a detailed decomposition of the tasks and methods that are utilized in the Maintenance Phase (Figure 5). The Retain step of the maintenance phase is used to add the adapted case to the case-base. Prior to adding these adapted cases to the case-base, they should be marked as unconfirmed (Göker and Roth-Berghofer, 1999). The technician will then have a choice between confirmed and unconfirmed cases giving the technician a chance to evaluate the unconfirmed cases to determine whether or not they should be entered into the case-base. The retain step is further utilized to allow the modification of the similarity measures by realigning the index structure.

The Review step contains steps required to measure and monitor tasks. Figure 5 shows the maintenance phase with three subservient levels. The solid lines show the subtasks and the dotted lines show the alternative methods.

Further, Roth-Berghofer and Iglezakis (2001) state that it is necessary to evaluate the current state of the knowledge containers to determine the quality of the resident cases. Roth-Berghofer and Iglezakis identified syntactical (no reliance on domain knowledge) measures such as correctness, consistency, uniqueness, minimality and incoherence to determine this quality. The Monitoring phase looks at statistics such as case-base growth and duplication of solutions.

The Restore step is described by the second level tasks select and modify. These sub-steps select the appropriate modify operators and utilizes them to change the cases in the case-base.

Watson (2002, p. 16) also submits that there are six versus four steps in the CBR

cycle. Watson identifies these "six-REs" of the CBR cycle as:

"1. Retrieve knowledge that matches the knowledge requirement.

2. Reuse a selection of the knowledge retrieved.

3. Revise or adapt that knowledge in light of its use if necessary.

4. Review the new knowledge to see if it is worth retaining.

5. Retain the new knowledge if indicated by step 4.

6. Refine the knowledge in the knowledge memory as necessary."

Figure 6 shows how the six steps of the CBR cycle can be mapped to the activities

required by a KM cycle.
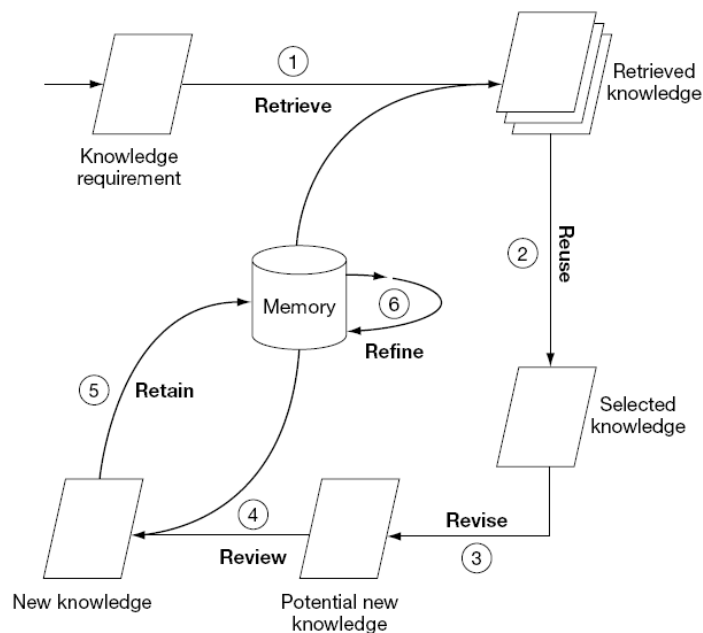
Figure 6. The CBR Cycle

Note: From Applying Knowledge Management: Techniques for Enterprise Systems, Watson, I.,

2002, p. 17, Copyright Elsevier Science & Technology Books, December 2002. Reprinted with

permission.

Watson's (2002, p. 17) description of the activities that take place during the CBR cycle for the most part, parallel the activities stated by Göker and Roth-Berghofer (1999), albeit semantics. Watson describes the activities which take place during the CBR cycle outlined in Figure 4. Watson states:

"1. The processes of retrieval, reuse, and revision support the acquisition of knowledge.

2. The processes of review and refinement support the analysis of knowledge.

3. The memory itself (along with retrieval and refinement) supports the preservation of knowledge.

4. Finally, retrieval, reuse, and revision support the use of knowledge."

Brief discussions of the four major elements that define case-based reasoning (case representation, case indexing, case retrieval, and case adaptation) follow.

Case Representation

According to Main, Dillon, and Shiu (2001) it makes no difference what a case actually represents, however, the features, or composition of each case, has requirements that need to be represented in some format. One of the most significant advantages that case-based reasoning has is its flexibility in this regard. Depending on the types of features that have to be represented, an appropriate implementation platform can be chosen. These implementation platforms range from simple Boolean, numeric and textual data to binary files, time dependent data, and relationships between data. CBR can be made to reason with all of them.

In addition to case representation, Pal and Shiu (2004) state that regardless of the format chosen to represent cases, the structure of the cases themselves must be set up in

such a way that it will facilitate the retrieval of the appropriate case when the case base is queried. Pal and Shiu continue that there are a number of ways the memory model for a particular form of case representation will depend. Accordingly, Pal and Shiu list six factors pertaining to the memory model. These memory model factors are 1) how the case representation is actually defined within the case-base, 2) What is the CBR system being used for?, 3) How many cases can conceivably be stored in the case base, 4) When the case-base is being searched, how many of the case features are being utilized during case matching, 5) Is it possible, because of case similarity, to group sets of cases into natural groupings? 6) In terms of the domain knowledge, how easy or difficult is it to determine case similarity?

In any event, cases are assumed to have two components, problem specifications and solutions and the representation used may be anything from a simple flat data structure to a complex object hierarchy.

As it applies to these structures, Main, Dillon, and Shiu (2001, p. 9) adds that there are two primary structures that can be applied to case bases; one is a flat case base where indices are chosen to represent important parts of the case base and during the retrieval process utilizes the comparison of current case features and the features of each case in the case base. The second structure is a hierarchical structure where cases are stored in groups (much like the help desk scenario where the cases are stored by problem area) which reduce the number of cases that must be accessed during each search.

Watson (2002, p. 27) believes that there are two distinctive types of case-bases, homogenous and heterogeneous. Watson describes these as:

In homogenous case bases all cases share the same data or record structure; that is, cases have the same attributes but varying values. In heterogeneous case bases, cases have varied record structures; that is, cases may have different attributes and varying values.

Case Indexing

According to Pal and Shiu (2004) case indexing refers to the methodology for assigning an index to a case which will enable the future retrieval and comparison of selected cases. Selecting the correct index is very important inasmuch as it guides the pointer to select the right case at the right time. This is important because the index assigned to a case will determine the context in which it will be retrieved in the future. Pal and Shiu offer several suggestions for choosing indices. First, the indexes should be tied to the important features of a case, for example, in the help-desk case-base category is a feature that would need to be indexed. This means that if the category of "main board" came up the system would go directly to that category and search for solutions. Secondly, the abstraction level of the indices should be such that cases would only be retrieved from the indexed category. If the abstraction level was too abstract, cases could be retrieved in circumstances outside their domain. This would, of course, cause an inordinate amount of processing time thereby slowing case retrieval time.

CBR Retrieval Methods

Pal and Shiu (2004, p. 15) state that: "Case retrieval is the process of finding, within the case base, those cases that are the closest to the current case." The question arises during case-base development as to how cases are to be retrieved. The developer must design a case retrieval method that will determine if a case is appropriate for

retrieval and, further, how the case-base is to be searched. Selection criteria are necessary to decide which case is the closest match to the request and therefore the "best" one to retrieve.

Case retrieval depends on the actual processes involved in retrieving a case from the case-base along with the memory model and indexing procedures used. The retrieval methods used by case-base developers in their designs depend on the size and content of the case-base. These methods range from the use of the nearest neighbor algorithm up to and including the use of intelligent agents. Pal and Shiu (2004) state that the nearest neighbor, inductive, knowledge-guided, and validated retrieval approaches are the most common, traditional methods used in case retrieval.

Pal and Shiu (2004) continue that before a retrieval method is selected several factors need to be taken into account. These factors include first, how many cases are to be searched, second, how much domain knowledge is available, third, how hard is it to determine the weightings of the individual features of the cases, and fourth, should all of the cases be indexed by the same features or do each of the cases have features that may vary in importance even though they are part of the same category.

After case retrieval has been accomplished, a determination normally needs to be made as to whether or not the retrieved case closely emulates the problem case or should the various search parameters be modified and the search conducted again. Adaptation or changing the search criteria can offer a considerable time savings for retrieval as opposed to searching the case-base again without modifying the search criteria. To make this determination for the correct analysis method, Pal and Shiu (2004) believe that the following points should be considered: 1) how much time and resources are required for

adaptation, 2) the number of cases in the case-base, or how likely is it that there is a closer case, 3) the time and resources that are required for each search, and, 4) how much of the case-base has already been searched in previous passes.

Case Adaptation Methodology

Pal and Shiu (2004) state that translating a retrieved solution into a solution that solves the current problem is called case adaptation. This is the most important step in the CBR process due to the fact that it adds a degree of intelligence to simple pattern matching. Pal and Shiu further believe that there are a number of approaches that can be taken to carry out case adaptation. First, the solution returned by the system can be used to solve the problem without any modification or if the solution is not usable in its present format simple modifications can be employed to make it exact. In the second approach, the first process could be rerun with or without modification when the steps in the first solution were not fully satisfactory in the current approach. The third approach states that a solution could be derived from multiple solutions being returned or several alternative cases could be presented one of which could be the exact solution.

Adaptation can and usually does use various techniques, which include the use of rules, or the application of further case-based reasoning based on the more detailed aspects of the case. Pal and Shiu (2004) suggest that when deciding on which strategy to use for case adaptation it is helpful to consider that as an average of all queries and retrievals how close will the case solution be to the problem presented? In general, will there be differences in the characteristics of the cases and if so, how many? Finally, are there known rules that can be applied to the query to have it return the correct solution?

As an after adaptation task, the developer should check to ensure that the adapted solution allows for the differences between the current problem and the retrieved case. That is to say that the adaptation has addressed the differences between the adapted solution and the current problem. At this point the developed solution should be ready for testing and/or use in the applicable domain.

Maintenance

Roth-Berghofer (2003) describes the maintenance phase in a CBR system in the same terms as any other software system (See Figure 7). The control loop, consisting of the defect/repair cycle, is essential in the maintenance of any system. Inasmuch as knowledge-based systems are software systems, they have no parts to wear out, rather, environment changes, e.g. software upgrades, and patches, etc. are of primary concern when a failure is encountered thus creating a faulty system.
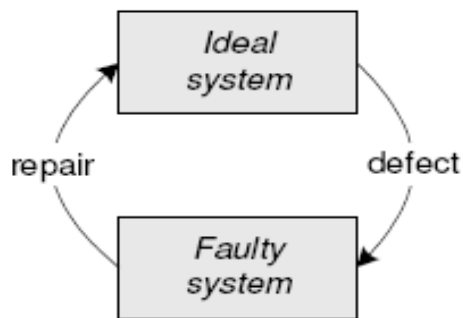
Figure 7. The control loop of system maintenance

Note: From Developing maintainable Case-Based Reasoning Systems: Applying SIAM to empolis orenge, Roth-Berghofer, T., p. 2, Reprinted with permission.

Roth-Berghofer (2003) continues that some methodology must be in place that facilitates discovery of changes to the case-base. The changes that take place in the case-base that can create problems must be the first to be corrected or adjusted. When these

changes are noticed, the technician can then bring the system back to the desired

functional state.

Roth-Berghofer (2003) shows, in Figure 8, one of the possible "sequences of CBR

system states, where defects and repairs are following each other." The methodology is

based on having a certain level of system performance and when the system drops below

that level of performance, repairs are made until the system is back to the desired level of

performance. The importance of case-based maintenance was recognized when

researchers and developers discovered that case retention and the encoding methodology

of these cases were just a part of case-based development (Lopez de Mantaras et al.
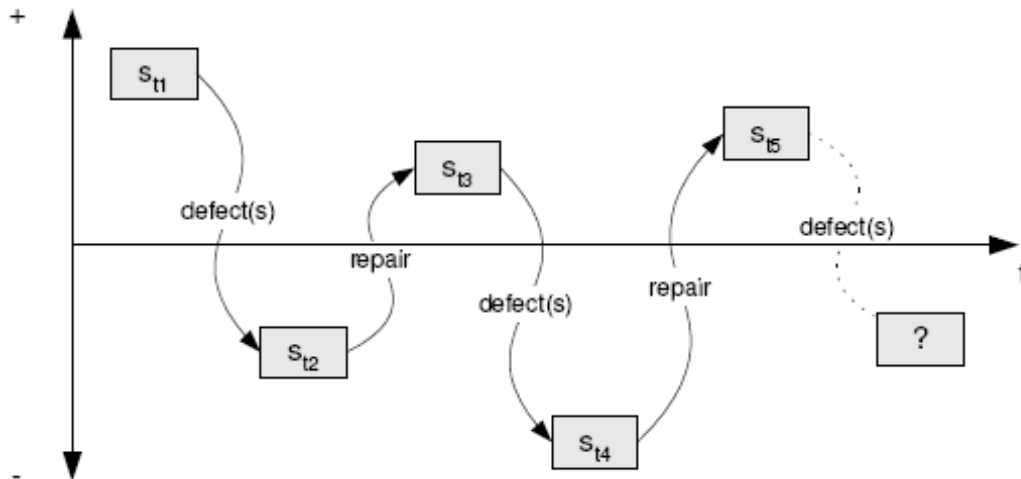
2005).

Figure 8. The changing quality level (+/-) of a system over time

Note: From Developing maintainable Case-Based Reasoning Systems: Applying SIAM to

empolis orenge, Roth-Berghofer, T., p. 2, Reprinted with permission.

Lopez de Mantaras et al. (2005) continue that during the development cycle of the

case-base, understanding the issues that could lead to maintenance problems should be

brought to light to ensure that maintenance problems during the production mode of the case-base will be kept at a minimum. The issues that should be focused on are the categorization of the case-base maintenance policies, how these policies decide when to activate a maintenance operation, the types of available maintenance operations and how each of these maintenance operations are activated.

The case-base maintenance policies do not necessarily focus on just the case-base, they can look at the case indices, the individual cases, and the methodology by which cases are adapted. Lopez de Mantaras et al. (2005), believe that the purpose of adding the review and restore phase to the CBR process was to enhance the development of the maintenance cycle of the case-base.

Lopez de Mantaras et al. (2005) have modified the Roth-Berghofer and Iglezakis version of the six-stage CBR Model (Figure 4) with a centralized Knowledge Container shared by the Maintenance and Application phases of case-based development and maintenance (Figure 9).
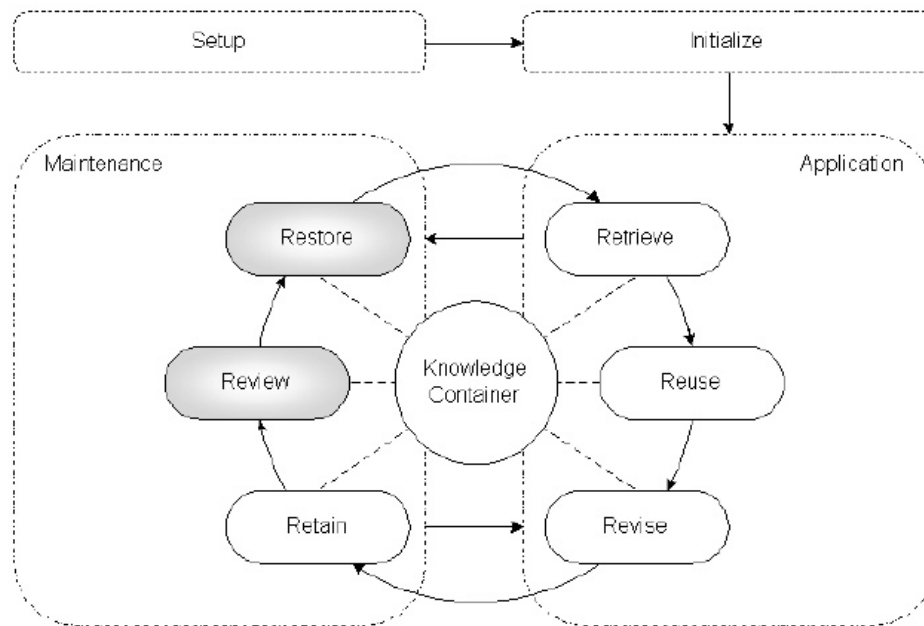
Figure 9. An extension of the classical four-state CBR model to emphasize the importance of maintenance

Note: From, Retrieval, reuse, revision, and retention in case-based reasoning, Lopez de Mantaras et al., 2005, Knowledge Engineering Review, Vol. 00:0, 1 – 2, 2005. Copyright Cambridge University Press. Reprinted with permission.

Summary

The use of a knowledge management-centric system in an Information Technology Help-Desk environment can solve such problems as key personnel leaving the organization, new or additional systems getting installed, or loss of other solution based media (Gonzalez, Giachetti, and Ramirez, 2005).

Watson (2002) states that "CBR is ideally suited to the creation of knowledge management systems." Watson believes that the activities in the CBR cycle have a close match with those process requirement activities in the knowledge management cycle.

The literature confirms, in part, first, that case-based reasoning utilized as the solution engine in a knowledge management system for an information technology help-desk, because of the diversity of equipment, solves many of the more difficult problems encountered by technicians, and finally, that the rule-based system lends itself more towards system specificity. For example, a single equipment type, e.g. HP Laser Jet Printers, Model 2100, is primarily what rule-based systems are being used for.

Chapter 3

Methodology

Introduction

This is an exploratory (non experimental) study based on data collected from field experiments provided by professional help desk technicians. RBR and CBR based prototypes were set up to support Tier-2 help desk operations. Professional help desk technicians used the systems to solve a set of benchmark problems. Data collected from this exercise was analyzed to answer each of the exploratory study questions. These questions are:

1. Which paradigm, rule-based or case-based reasoning, results in more precise solutions to problems when compared to the solutions derived from system manuals?

2. Which paradigm, rule-based or case-based reasoning, is more convenient to maintain in terms of knowledge modification (i.e. addition, deletion, or modification of rules/cases)?

3. Which paradigm, rule-based or case-based reasoning, enables help-desk technicians to solve problems in shorter time, and therefore at lower cost?

Measures used to evaluate the knowledge-based methods

The answer to the first exploratory study question was determined by evaluating each of the systems for their effectiveness, that is, the accuracy of the returned solutions as they compare to the documented solutions found in system manuals. The help-desk technicians assigned a numeric value one to seven (1 – 7) to each of the returned solutions to indicate how well the solutions matched the solutions found in the systems manuals.   These values are defined as; 1 – Strongly Disagree (that the solutions did not

match) and 7 – Strongly Agree (that the solutions matched). The assigned numbers for the 20 different problems in each of the systems were averaged. The averages were then compared and the system with the higher average was the system demonstrating the more accurate response to the help desk problems.

Difficulty of the maintenance of the rule and case-bases (exploratory study question two) was evaluated next by the complexity of making changes based on the returned solutions, for example, adding a rule where one did not exist, modifying cases where the returned solution was not accurate when compared to documented problems and solutions, and deleting inappropriate rules and cases. The second section of the questionnaire was developed, using a Likert scale, and distributed to the help-desk technicians to evaluate the convenience of maintaining the rule and case-based systems. The help-desk technicians noted the difficulty of each of the maintenance items in terms of ease of maintenance on a scale of one to seven (1 – 7), with 1 being Strongly Disagree (the maintenance procedures were very difficult) and 7 being Strongly Agree (the maintenance procedures were very simple) At the conclusion of the maintenance period, the questionnaire scores were compared with the lowest score being the most difficult to maintain and the higher score representing little or no difficulty encountered during maintenance.

The exploratory study presented in this paper then evaluated the third question by comparing the time in minutes, that a call takes using manual methods (no solution returned by either of the knowledge based systems), the time taken to retrieve a solution from the Exsys'® CORVID™ rule-based system and any research required to complete the solution, and, the time taken to retrieve a solution from the Casebank Spotlight®

case-based system and any research required to complete the solution. The help-desk

technicians tracked the time required for each of the systems to return a solution, and the

time for any additional research for solving the problem. The times were then recorded

by category along with the cost of the call based on current Tier-2 help desk costs (the

dollar value of the time required to implement the solution based on the average dollars

per hour for Tier-2 level help desk support).

After evaluating each of these areas, it was determined which paradigm (case or

rule-based) should be used in a help-desk environment to solve problems arising at the

Tier-2 level.

Prototype Building and Development

A detailed account of the development effort required in each of each of the

expert system shells was developed. This included a description of how knowledge bases

are created, and how problems, questions, and answers are formulated within each of the

shells. Further, in order to provide a better understanding of the two candidate expert

system tools, Exsys® CORVID™ (Appendix B) and Casebank Spotlight® (Appendix

C), and how close a fit each of them are to the Rule-based and Case-based paradigms,

respectively, a feature comparison walkthrough preceded each of the actual

implementations.

The second step dealt with storing each of the solutions in the case/rule-base in

one or more of the problem categories (Audio, Data Recovery, Floppy Disk/Drives, Hard

Disk/Drives, Keyboard, Mouse, Network, Optical Drives, Power Supply, Printer,

Random Access Memory (RAM), Startup, System, USB, Video, and Windows). The

rule-base was populated with the same set of solutions; however, creating rules in the rule-base did not require entry by category.

Building the Rule-Based and Case-Base System Prototypes

A rule-based prototype was developed using the rule-base shell Exsys'® CORVID™. The rule-based system, Exsys'® CORVID™, Version 4.0.3, was developed using a stand-alone system running Microsoft® XP Professional®.

The case-based prototype was developed using the case-based system Casebank Spotlight®. Like the rule-based system, Casebank Spotlight® was developed using a stand-alone system running the Microsoft® XP Professional® operating system. During the build of these shells, any problems encountered during their population were documented.

Benchmark Problems Used to Compare Rule-Based Reasoning and Case-Based Reasoning

The problems and solutions which were entered into the rule and case-bases were retrieved from Scott Mueller's Upgrading and repairing PCs, 16th Edition and verified using three of the other troubleshooting guides, (Bigelow, 2001; Mueller, 2005; Laporte, 2006; and Minasi, 2005). One hundred (100) solutions from the 16 problem categories of Audio, Data Recovery, Floppy Disk/Drives, Hard Disk/Drives, Keyboard, Mouse, Network, Optical Drives, Power Supply, Printer, Random Access Memory (RAM), Startup, System, USB, Video, and Windows were selected from Scott Mueller's Upgrading and repairing PCs, 16th Edition reference manual. Each of the 100 selected solutions were inserted into the rule and case-bases.

The primary troubleshooting guide used for the retrieval of problems and solutions to be utilized in this exploratory study was the "Upgrading and Repairing PCs, 16th Edition" (Mueller, 2005). This manual, as well as the other three, were selected because of their wide industry use and acceptance within the help-desk organizations of government and industry. Further, the 100 solutions found in the primary reference guide were compared to the same problems and solutions in the other three reference guides. The same problems and solutions were found in the other three reference guides and were found to be essentially the same. The comparison was made to ensure the selected problems and solutions were accurate.

The primary troubleshooting guide contained a total of 256 problems and solutions considered to be Tier-2 problems and solutions. Of the 256 problems in the 16 categories selected, 100 problems and solutions were randomly selected to be inserted in the rule and case-based systems. Of the same 256 problems in the 16 categories selected, 20 problems were randomly selected for test entry by the help desk technicians.

The PC Hardware and Software related Problems

One hundred problems and solutions were considered adequate inasmuch as they covered the majority of the problem types encountered by middle tier (Tier-2) help desk technicians. There were 100 PC hardware/software-related problems/solutions entered into the CORVID™ rule-based and Casebank Spotlight® case-based systems.

A complete problem/solution guide based on the 100 hardware/software problems itemized on the next several pages, was developed to determine the accuracy of the returned solutions. The 100 PC hardware/software related problems entered into the CORVID™ rule-based and Casebank Spotlight® case-base system are as follows:

AUDIO

1. Symptom: "sound card doesn't sound quite right"

2. Symptom: "Cannot hear any sounds at all"

3. "Can hear sound through only one speaker"

4. "Volume is low"

5. "Computer will not start after installing sound card"

6. "Cannot use onboard audio"

BIOS

7. "Cannot install Flash BIOS update"

8. "BIOS update fails"

CD-ROM

9. "Cannot boot from CD-ROM drive"

DATA RECOVERY

10. "Cannot retrieve a particular file stored on a system running Windows NT/2000/XP"

11. "Cannot locate files on a FAT disk after it was formatted"

FLOPPY DRIVE

12. "Disks placed on top of a TV or monitor has data errors when read"

13. "Contents of all floppy disks viewed appear to be duplicates of the first disk, although the contents of each disk are different"

HARD DISK

14. "Cannot access full capacity of hard drive over 8.4GB"

15. "Cannot use drive capacity beyond 528MB"

16. "Large number of files ending in .CHK are found in root directory of drive"

HARD DRIVE

17. "UDMA/66 or UDMA/100 drive runs at UDMA/33 on systems that support UDMA/66 or UDMA/100"

18. The error message "Immediately back up your data and replace your hard disk drive. A failure may be imminent." is seen

19. "Windows 98 FDISK misidentifies the capacity of a drive over 64GB"

20. "Invalid Drive Specification error"

21. "Invalid Media Type error"

IDE HARD DRIVE

22. "Cannot detect drive with BIOS setup program"

23. "Cannot detect either drive on cable with BIOS setup program"

24. "Drive does not perform reliably"

IRQ

25. "Conflicts between PCI devices"

26. "Conflicts between COM ports"

KEYBOARD

27. "Num Lock stays off when starting system"

28. "Intermittent keyboard failures"

29. "Wireless keyboard does not work at some angles relative to the computer

30. "Wireless keyboard does not work at long distances (such as with a Media Center PC and big-screen display"

31. "Wireless keyboard stops working after the computer is moved"

32. "Standard keys on keyboard work, but not multimedia or internet keys"

MODEM

33. "Modem works correctly with internet access, but computer-to-computer terminal emulation produces garbage screens"

34. "Modem drops calls unexpectedly"

MOUSE

35. "Mouse doesn't work"

36. "Cannot use PS/2 mouse"

37. "Mouse pointer jerks on screen"

38. "Wireless mouse doesn't work at some angles relative to the computer"

39. "Wireless mouse stops working after the computer is moved"

40. "Mouse works for basic operations, but extra buttons or scroll does not work"

41. "Mouse works in Windows but not when booted to DOS"

NETWORK

42. System locks up after installing network card"

43. "Duplicate computer ID error"

44. "Cannot connect to other computers on network after installing a new custom-built cable"

45. "Network changes made but do not work"

46. "One user can not access network, but others can"

47. "Cannot connect to other users on network, although card diagnostics check out"

48. "Distant computer works with 10BASE-T network but not with Fast Ethernet"

49. "Users cannot share printers or folders with others"

50. "IP Address Conflict error"

51. "Need to create a NetBEUI network using Windows XP"

OPTICAL DRIVES

52. "Drive slows down when reading CD with a small paper label attached to the label side"

53. "Cannot read CD-R or CD-RW disc on a CD-ROM drive, but only on a CD-R/CD-RW drive"

54. "Drive runs very slowly or has read errors"

55. "Cannot write to CD-RW or DVD-RW 1x media"

56. "CD-RW or rewriteable DVD drive writes to some types of media more slowly than others"

57. "Cannot create writeable DVD"

58. "Cannot boot from bootable CD"

59. "Cannot read CD-RW media on MultiRead CD-ROM drive"

60. "Cannot read CD-RW media on an older drive"

61. "Cannot install new drive firmware"

POWER MANAGEMENT

62. "System cannot use power management features"

63. "Cannot use ACPI power management"

PRINTER

64. "The printer prints gibberish"

PROCESSOR

65. "Improper CPU identification during POST"

66. "Cannot install newer processors"

STARTUP

67. "System will not start, no error messages on screen"

68. "System won't start, various error messages indicating system cannot boot"

69. "System beeps several times, does not start properly"

70. "System displays error message when turned on; doesn't start properly"

71. "Invalid drive specification error"

SYSTEM

72. "System unstable when overclocking"

73. "System is dead, no beeps, no cursor, no fan"

74. "System is dead, no beeps, or locks up before POST begins"

75. "System beeps on startup, fan is running, no cursor onscreen. Locks up

   during or shortly after POST"

76. "System powers up, fan is running, but no beep or cursor"

77. "System locks up after running for a time"

78. "System locks up when office equipment such as copiers or microwave
    ovens nearby are operated"

79. "Memory address conflict between devices"

80. "Intermittent lockups, memory and drive glitches"

81. "System frequently locks up"

82. "Hardware and software bugs"

83. "Slow system performance"

TAPE DRIVES

84. "Cannot run tape backup or restore; bad block errors during restore"

VIDEO

85. "Onscreen icons too small at high resolutions"

86. "Slow video performance with any card type"

87. "Slow video performance with any card type"

88. "Garbage appears on the video screen for no apparent reason"

89. "Frequent screen lockups or invalid page fault errors"

USB

90. "Cannot use USB keyboard and mouse outside of Windows"

91. "Cannot use USB devices"

92. "USB 2.0 ports aren't supporting USB 2.0 devices at top speed"

WINDOWS

93. "Operating system will not boot"

94. "Virus warning triggered when trying to upgrade Windows"

95. "The PC starts in Safe mode [Windows 9x/Me]

96. "Problems with operating system During the POST"

97. "File system problems with Windows 9x/ME or DOS"

98. "File system problems with Windows 2000/XP"

99. "System running Windows NT 4.0 cannot access a drive prepared with Windows 2000 or Windows XP".

WIRELESS NETWORK

100. "Wi-Fi 5GHz band device cannot connect to other Wi-Fi devices"

Data Subjects

Help-desk technicians from industry and government served as the data subjects by entering 20 randomly selected problems into each of the two prototype systems. Further, each of these technicians performed required maintenance on each of the systems by adding rules or cases as required where a solution cannot otherwise be attained.

Professional help-desk technicians working at the Tier-2 level were chosen because of their expertise in solving day to day Tier-2 hardware and software problems both in the government and private sectors. These technicians have no experience in using an expert system for problem resolution so there was no bias toward one platform (rule or case-based) or the other. The technicians were able to make the requisite determinations as to ease of use, ease of maintenance, and time required to retrieve a proper solution without bias.

Training

Each of the technicians were trained on the operation of each of the systems. The technicians received training as a group for each of the systems. This was to ensure that the technicians received identical training to reduce any bias from the training method. All of the training was performed on a single stand-alone Windows XP Professional workstation containing both the Casebank Spotlight® case-based system and the Exsys Corvid rule-based system. The group was trained first on the Exsys Corvid system and then on the Casebank Spotlight® system. Questions were answered during the training to ensure the technicians understood the functionality of each of the systems.

Each of the technicians received the identical training which allowed them to modify each of the systems (enter cases/rules), maintain each of the systems (modify cases/rules), and enter problems into each system and retrieve and evaluate the returned solutions. There was no bias based on problem understanding, inasmuch as all of the problems to be used in this exploratory study are common to a Tier-2 level help desk technician.

Resource Requirements

The rule-based system, Exsys'® CORVID™, and the case-based shell Casebank Spotlight® were installed and maintained on a stand-alone Microsoft® XP Professional® desktop. Because the CORVID™ and Casebank Spotlight® software is designed to run in this environment, no problems arose that caused delays or other software problems during the development and test phases of this exploratory study. All of the hardware and software required for this exploratory study project was obtained and set up for use.

Data Collection and Analysis

One of the data collection methodologies used in this exploratory study is the group-administered questionnaire. This methodology brought the respondents (help desk technicians) together and asked them to respond to a structured sequence of questions based on their use of the two system shells. This methodology was utilized to ensure all of the respondents completed the questionnaire. Further, this methodology allowed the respondents to ask questions pertaining to the questionnaire to clarify their meaning.

First, the questionnaires were handed out to each of the help desk technicians for their evaluation of each of the systems for their effectiveness, that is, the accuracy of the

returned solutions as they compare to the documented solutions found in system manuals. The help-desk technicians assigned one of the following numeric values to each of the returned solutions to indicate how well the solutions matched the solutions found in the systems manuals. These values are defined as; 1 – Strongly Disagree (solutions were not a match to system manual solutions) and 7 – Strongly Agree (solution was an exact match to a system manual solution). The results derived from 20 total problems in each of the systems were averaged. The averages were then compared and the system with the highest average was the system demonstrating the more accurate response to the help desk problems.

Next, the maintenance section of the questionnaire was handed out to each of the help desk technicians for their evaluation of the difficulty of maintenance of the rule and case-bases. The values are defined as; 1 – Strongly Disagree; and 7 – Strongly Agree. The technicians were asked to perform five maintenance tasks on each of the systems, for example, adding a rule where one did not exist, modifying cases where the returned solution was not accurate, and deleting inappropriate rules and cases. The help-desk technicians noted the ease of each of the maintenance items on a scale of one to seven, as noted above. At the conclusion of the maintenance period, the questionnaire scores were compared with the lowest score being the most difficult to maintain and the high score, the easier the maintenance was to perform.

Finally, the time taken, in minutes, to perform the task of entering problem data, the systems returning a possible solution, and any manual information retrieval was noted. The cost of the actual repair was not calculated inasmuch as it would be the same regardless of the system providing the solution. The cost of the repair process was then

attained by multiplying the time in minutes times the cost for one minute of Tier-2 help desk technician wages (hourly rate divided by 60). The rates were obtained from the most recent Help Desk Institute wage report for all levels of help desk technicians. This process was performed on the CORVID™ rule-based system and the Casebank Spotlight® case-based system.

Summary

The culmination of this exploratory study was to test the hypothesis that the case-based knowledge-based system is a better alternative to help desk knowledge based systems than is the rule-based expert system. The review of the literature pertaining to knowledge-based systems tends to agree with this perspective.

This exploratory study's objectives were as follows:

1. The two prototype knowledge based systems were built and delivered to the help desk technicians for testing.

2. The technicians were given a demonstration of each of the systems to ensure they understood how each of the user interfaces work, get their evaluation of each of the systems for their effectiveness, that is, the accuracy of the returned solutions as they compare to the documented solutions found in system manuals, prepare their evaluation of the difficulty of maintenance of the rule and case-bases, and finally, the time taken, in minutes, to perform the task of entering problem data, the systems returning a possible solution, and any manual information retrieval that was noted.

Chapter 4
Results

Introduction

The purpose of this exploratory study was to better understand the differences between the rule and case-based paradigms as they relate to the information technology help desk environment, and, further, to determine which paradigm would better serve the Tier-2 help desk technician in his/her daily problem analysis. Specifically, this exploratory study was conducted to answer the following questions:

1. Which paradigm, rule-based or case-based reasoning, resulted in more precise solutions to problems when compared to the solutions derived from system manuals?

2. Which paradigm, rule-based or case-based reasoning, is more convenient to maintain in terms of knowledge modification (i.e. addition, deletion, or modification of rules/cases)?

3. Which paradigm, rule-based or case-based reasoning, enables help-desk technicians to solve problems in shorter time, and therefore at lower cost?

Two expert system shells, one employing case-based reasoning and the other rule-based reasoning, representing two of the major paradigms in knowledge representation and retrieval, were used in this study of help desk problem resolution retrieval. This chapter presents the comparative analysis of these two knowledge-based shells based on a survey of current Tier-2 help desk technicians with at least two years of relevant experience. Each technician was asked to use a rule-based system and a case-based system to solve 20 randomly selected benchmark test problems.

Upon completion of their assigned task a questionnaire was presented to the help desk technicians which solicited their input in four specific areas:

The first area had one question: whether the test problems were relevant to Tier-2 help desk operations. The second area asked eight questions pertaining to the value of the case and rule based systems when employed in an expert system to help solve daily Tier-2 help desk problems. The third area asked ten questions pertaining to the ease/difficulty of the maintenance of the case/rule based systems. The fourth area asked each of the respondents to enter the time in minutes that was required for them to enter each of the problems and the associated time taken to retrieve solutions from each of the expert systems. These questions and their responses are discussed later in this chapter.

This chapter begins with a description of the hardware and software utilized to host the two knowledge-based systems and concludes with an analysis and breakdown of the questionnaire completed by each of the help desk technicians.

Hardware

The hardware utilized for the development and testing of the two knowledge systems was a Hewlett-Packard (HP) desktop system with the following features: The CPU was an AMD Athlon™ 64 Processor 3300+, 2.41 GHz, sixty-four bit microprocessor running with 2 MB of processor cache. The system had 2 GB of system memory and a 150 Gigabyte hard disk drive. This development and test platform was chosen because of its speed and ability to host both of the AI shells.

Software

The operating system software consists of Microsoft® Windows XP Professional. The software for the development of the two knowledge bases was the rule-based shell

Exsys® CORVID and the case-based shell Casebank Spotlight®. The Spotlight® system

utilized an Oracle 10g database management system for its knowledge base repository.

Training

Even though the technicians were very familiar with the hardware/software

platform being utilized to host the two knowledge-based systems, it was thought prudent

to give them training on the specific system for which they would be receiving their

knowledge base utilization training. At the end of the training session all subjects felt

comfortable using the systems.

The second stage of the training was to introduce the technicians to the Exsys'®

CORVID™ rule-based and Casebank Spotlight® case-based systems. This introduction

included a group presentation and individual hands-on training relating to bringing the

system up, how to find the various classes of problems/solutions (Audio, BIOS, Hard

Disk, etc.), the execution of each of the solution screens, and finding a solution via the

question dropdowns presented to them by each of the systems. After each of the

technicians had worked their way through to a problem solution on each of the systems,

they had a good understanding of the mechanics of each of the systems and how to

retrieve solutions.

The third stage showed the technicians, as a group, and then individual hands-on,

how to perform limited maintenance on each of the systems via creating a new rule/case

leading to a problem solution, changing an existing rule/case, and deleting a rule/case that

was no longer required in the system. The technicians had problems with understanding

how to create/delete rules and cases in each of the systems. The technicians seemed to

have more of a problem with the case-based maintenance cycle, as shown in the Findings section below, than that of the rule based system.

The majority of the experienced technicians had various levels of programming experience prior to their transition to a Tier-2 level help desk. Because of the similarities between programming and rule-based development, these technicians found writing or modifying the rules in Exsys'® CORVID™ of little or no consequence. The logic of the Casebank Spotlight® case-based system, however, was completely new to them and subsequently required more training time for them to learn and understand the case-based maintenance cycle.

After completion of the training, the technicians were able to perform all necessary steps to execute and perform basic maintenance on each of the systems, albeit limited. The total time utilized for this training was two days.

Analysis and Findings

The 20 problems to be entered by each of the help desk technicians were randomly selected from the 226 problems contained in "Upgrading and Repairing PCs, 16th Edition" (Mueller, 2005).   Table 1 identifies the selected problems.

Table 1. List of Randomly Selected Problems

Random Number	Problem Title
5	Audio – Game port on sound card conflicts with other game port in system
16	CD ROM – Can't boot from CD-ROM drive
26	Floppy Drive – Disk access light stays on continuously after system is started
36	Hard Drive – UDMA/66 or UDMA/100 drive runs at UDMA/33 on systems that support UDMA/66 or UDMA/100
41	Hard Drive – Can't boot from SCSI Hard Drive
64	Modem – Modem works correctly with Internet access, but computer-to-computer terminal emulation produces garbage screens.
67	Modem – Can't dial with analog modem
76	Mouse – Wireless mouse doesn't work at some angles relative to the computer
100	Optical Drives – Can't read CD-RW media on MultiRead CD-ROM drive
103	Optical Drives – Can't write to CD-RW or DVD-RW 1x media
113	Optical Drives – Can't burn a CD-R disk while performing other tasks
121	Optical Drives – Can't create writeable DVD
129	Optical Drives – Can't boot from bootable CD
165	System – System is dead, no beeps, or locks up before POST begins.
174	System – System lock up after running for a time
175	System – System locks up when office equipment such as copiers or microwave ovens nearby are operated.
191	USB – USB 2.0 ports aren't supporting USB 2.0 devices at top speed
197	Video – Can't use AGP card as primary video
216	Windows – Operating system will not boot
221	Windows – The PC starts in Safe mode (Windows 9x, Windows Me).

Eight of the 20 randomly selected problems (5, 26, 41, 67, 113, 121, 129, and 197) listed in Table 1 were not previously entered into either of the knowledge bases.

The motivation here was that if the technicians were to enter such a problem, e.g. problem number 113 (Optical Drives – Can't burn a CD-R disk while performing other tasks) they would determine that when querying the CORVID rule-based system they would be unable to find the problem inasmuch as no rule existed for the formulation of its solution, necessitating manual research. On the other hand, although the specific problem was not entered into the Spotlight case-based system, the category of "Optical Drives" would be there and they would be able to query the case-base to attain a "close" match or at least a starting point for problem solution. The technicians were not aware of this fact during the course of this exploratory study.

The following four subsections recapitulate the questions in each of the four major areas and present the results obtained. Unless otherwise stated, the responses to all questions were rated on a scale from one to seven, (1 - Strongly Disagree; 2 –Disagree; 3 – Moderately disagree; 4 – Neither agree nor disagree; 5 – Moderately agree; 6 –Agree; 7 – Strongly Agree), seven being the most positive.

Section One

The question asked in this section asked for a determination of the validity (the respondent agreed/disagreed) of the twenty problems entered into both the CORVID and Spotlight systems as being within the scope of the daily problems received at the Tier-2 level of the IT Help Desk.

Section One Responses and Findings

The respondents rated all of the 20 problems to be within the scope of a Tier-2 environment. As shown in Table 2, twenty percent of the respondents strongly agreed, forty percent agreed, and the remaining forty percent moderately agreed. The mean score, based on the responses from this question, was 5.8, with a standard deviation of 0.837.

Table 2. **Response Breakdown – Section One, Question One, Did you find the 20 test problems to be within the scope of the daily problem calls received at the Tier-2 help desk level?**

Response	Percentage
One – *Strongly Disagree*	0%
Two – *Disagree*	0%
Three – *Moderately Disagree*	0%
Four – *Neither Agree nor Disagree*	0%
Five – *Moderately Agree*	40%
Six – *Agree*	40%
Seven – *Strongly Agree*	20%
Total	**100%**

Section Two

The questions asked in this section, were based on comparisons between the CORVID rule-based system and the Spotlight case-based system to determine system effectiveness and accuracy. An identical set of questions was asked about each of the systems, rule and case-based utilizing the following comparison categories and questions:

1. For the category ease of use between the two systems; the question asked was "Did you find the Casebank Spotlight® case-based/Exsys'® CORVID™ rule-based user interfaces easy to use?"

2. For the category accuracy of the returned results between the two systems where a simple problem was submitted, the question asked was "Did you find the accuracy of the returned solutions from the Casebank case-based/Exsys'® CORVID™ rule-based systems to an easy request to be accurate?"

3. In the category accuracy of the returned results between the two systems where a problem was submitted that required a solution to a more complex problem, the question asked was "Did you find the accuracy of the returned solutions from the

Casebank case-based/Exsys'® CORVID™ rule-based systems to a complex problem to be accurate?"

4. The category, usefulness of the returned solution where a less than optimal solution was returned, the question asked was "Did you find the returned solutions, if any, from the Casebank Spotlight® case-based/Exsys'® CORVID™ rule-based systems, that was not the exact solution to the problem, to be of any use?"

5. For the category ease of use of the user interface for problem input, the question asked was "Did you find the user interface on the Casebank case-based/Exsys'® CORVID™ rule-based systems, in terms of problem input, easy to use?"

6. In the category dealing with the intuitiveness of the user interfaces, the question was asked "Did you find the overall intuitiveness of the Casebank Spotlight® case-based/Exsys'® CORVID™ rule-based systems to be intuitive for use in a Tier-2 help desk environment?"

7. For the category dealing with the returned solution matching the solutions found in relevant system manuals, the following question was asked "Did the solutions returned by the Casebank Spotlight® case-based/Exsys'® CORVID™ rule-based systems match the solutions found in the system manuals?"

8. This category dealt with the usefulness of a returned solution where the exact problem was not found on either of the knowledge bases. The final question dealt with a different scale, which asked the help desk technicians, using a scale from one to seven, (1 – Useless; 2 – Not Very Useful; 3 – Somewhat Useful; 4 – Unable to determine; 5 – Moderately Useful; 6 –Useful; and 7 – Very Useful) "How useful did you find the returned solutions from the Casebank Spotlight® case-based/Exsys'® CORVID™ rule-based system where an exact problem was not found in the knowledge base?"

Section Two Responses and Findings

Question One

The respondents found both the rule-based (Exsys'® CORVID™) and the case-based (Casebank Spotlight®) systems offered very little difficulty as to their access and ease of use. Table 3 shows that sixty percent of the respondents "strongly agree" that the Spotlight system was easy to access and use with forty percent "agree", whereas, twenty percent of the respondents "strongly agree" that the CORVID system was easy to access and use where eighty percent selected "agree". The Spotlight system offered a mean of 6.60, with a standard deviation of 0.548, where the CORVID system gave a mean of 6.20 with a standard deviation of 0.447. There were no comments from any of the respondents dealing with ease of use for the two systems.

Table 3. **Response Breakdown – Section Two, Question One, Did you find the Casebank Spotlight® case-based/Exsys'® CORVID™ rule-based user interfaces easy to use?**

Response	CORVID Percentage	Spotlight Percentage
One – *Strongly Disagree*	0%	0%
Two – *Disagree*	0%	0%
Three – *Moderately Disagree*	0%	0%
Four – *Neither Agree nor Disagree*	0%	0%
Five – *Moderately Agree*	0%	0%
Six – *Agree*	80%	40%
Seven – *Strongly Agree*	20%	60%
Total	**100%**	**100%**

Question Two

Table 4 shows that forty percent of the respondents "strongly agree"; forty percent "agree'; and twenty percent "moderately agree" that the solutions returned by the Spotlight system, for relatively simple problems were accurate. Table 4 also shows that for the CORVID system, sixty percent "strongly agree" and forty percent "agree" that the solutions returned were accurate. The Spotlight system offered a mean of 6.20, with a standard deviation of 0.837 where the CORVID system gave a mean of 6.60 with a standard deviation of 0.548. There were no comments from any of the respondents dealing with accuracy of the two systems.

Table4. **Response Breakdown – Section Two, Question Two, Did you find the accuracy of the returned solutions from the Casebank Spotlight® /Exsys'® CORVID™ case-based/rule-based systems of an easy request to be accurate?**

Response	CORVID Percentage	Spotlight Percentage
One – *Strongly Disagree*	0%	0%
Two – *Disagree*	0%	0%
Three – *Moderately Disagree*	0%	0%
Four – *Neither Agree nor Disagree*	0%	0%
Five – *Moderately Agree*	0%	20%
Six – *Agree*	40%	40%
Seven – *Strongly Agree*	60%	40%
Total	**100%**	**100%**

Question Three

Table 5 shows that twenty percent of the respondents "strongly agree" that the

Spotlight system returned accurate solutions when encountering a complex problem;

sixty percent "agree"; and twenty percent "moderately agree". The mean of the Spotlight

system ratings was 6.00, with a standard deviation of 0.707. Table 5 shows that sixty

percent of the respondents "agree" that the CORVID system returned accurate solutions

to a complex problem; and forty percent "moderately agree". The mean for the CORVID

system was 5.60 with a standard deviation of 0.548. There were no comments relative to

complex problems from the respondents.

Table 5. **Response Breakdown – Section Two, Question Three, Did you find the accuracy of the returned solutions from the Casebank Spotlight® case-based/Exsys'® CORVID™ rule-based systems for a complex problem to be accurate?**

Response	CORVID Percentage	Spotlight Percentage
One – *Strongly Disagree*	0%	0%
Two – *Disagree*	0%	0%
Three – *Moderately Disagree*	0%	0%
Four – *Neither Agree nor Disagree*	0%	0%
Five – *Moderately Agree*	40%	20%
Six – *Agree*	60%	60%
Seven – *Strongly Agree*	0%	20%
Total	**100%**	**100%**

Question Four

With the Spotlight system, this meant: Were the results of any of the solutions within the same system category, of any use in solving the current problem. As shown in Table 6, the Spotlight system was evaluated as forty percent of the respondents "agree"; forty percent "moderately agree"; and twenty percent "neither agree nor disagree". The mean of the Spotlight system ratings was 5.20 with a standard deviation of 0.837. The CORVID system's evaluation (Table 9) was sixty percent "moderately disagree"; forty percent "disagree". The mean of the CORVID system ratings was 2.60 with a standard deviation of 0.548. There were several comments presented by the respondents stating that although the solutions returned by the Spotlight system were not the exact solution the solutions that were returned gave them information that allowed them to find the correct solution in reference manuals without a great deal of research. CORVID, on the other hand, returned no solutions when a problem was not in the rule base.

Table 6. **Response Breakdown – Section Two, Question Four, Did you find the returned solutions, if any, from the Casebank Spotlight® case-based/Exsys'® CORVID™ rule-based systems, that was not the exact solution to the problem, to be of any use?**

Response	CORVID Percentage	Spotlight Percentage
One – *Strongly Disagree*	0%	0%
Two – *Disagree*	0%	0%
Three – *Moderately Disagree*	60%	0%
Four – *Neither Agree nor Disagree*	40%	20%
Five – *Moderately Agree*	0%	40%
Six – *Agree*	0%	40%
Seven – *Strongly Agree*	0%	0%
Total	**100%**	**100%**

Question Five

The easier software is to use in the help-desk area, the less resistance there is to its

adaptation. This, of course, assumes that the software will create and store viable

knowledge bases. Table 7 shows the Spotlight system was evaluated as forty percent

"strongly agree"; and sixty percent "agree" that the system was simple to input problems.

The mean of the Spotlight system ratings was 6.40 with a standard deviation of 0.548.

Table 7 also shows that the evaluation of the CORVID system indicated that forty percent

"strongly agree"; forty percent "agree"; and twenty percent "moderately agree". The

mean of the CORVID system ratings was 6.20 with a standard deviation of 0.837. The

Spotlight interface was found easier to use. There were no comments pertaining to this

question.

Table 7. **Response Breakdown – Section Two, Question Five, did you find the user interface on the Casebank Spotlight® /Exsys'® CORVID™ systems, in terms of problem input, easy to use?**

Response	CORVID Percentage	Spotlight Percentage
One – *Strongly Disagree*	0%	0%
Two – *Disagree*	0%	0%
Three – *Moderately Disagree*	0%	0%
Four – *Neither Agree nor Disagree*	0%	0%
Five – *Moderately Agree*	20%	0%
Six – *Agree*	40%	60%
Seven – *Strongly Agree*	40%	40%
Total	**100%**	**100%**

Question Six

Given that new technicians would, in all likihood, use the systems, the Spotlight system was rated as twenty percent "strongly agree"; eighty percent "agree". The mean of the Spotlight system ratings was 6.20 with a standard deviation of 0.447. Table 8 shows that the CORVID system was rated as forty percent "strongly agree"; twenty percent "agree"; and forty percent "moderately agree". The mean of the CORVID system ratings was 6.00 with a standard deviation of 1.000. The comments presented by the respondents for this question stated in general that there was not a great deal of difference between the two systems in terms of intuitiveness.

Table 8. **Response Breakdown – Section Two, Question Six, did you find the overall intuitiveness of the Casebank Spotlight® case-based/Exsys'® CORVID™ rule-based systems to be intuitive for use in a Tier-2 help desk environment?**

Response	CORVID Percentage	Spotlight Percentage
One – *Strongly Disagree*	0%	0%
Two – *Disagree*	0%	0%
Three – *Moderately Disagree*	0%	0%
Four – *Neither Agree nor Disagree*	0%	0%
Five – *Moderately Agree*	40%	0%
Six – *Agree*	20%	80%
Seven – *Strongly Agree*	40%	20%
Total	**100%**	**100%**

Question Seven

The Spotlight system solution returns were rated, as shown in Table 9, as twenty percent "strongly agree"; and eighty percent "agree". The CORVID systems solution returns were rated somewhat higher, they were forty percent "strongly agree"; and sixty

percent "agree". The mean of the Spotlight system ratings was 6.20 with a standard

deviation of 0.447, while the CORVID's mean and was 6.40 with a standard deviation of

0.548. There were no comments offered for this question.

Table 9. **Response Breakdown – Section Two, Question Seven, did the solutions returned by the Casebank Spotlight® /Exsys'® CORVID™ systems match the solutions found in the systems manuals?**

Response	CORVID Percentage	Spotlight Percentage
One – *Strongly Disagree*	0%	0%
Two – *Disagree*	0%	0%
Three – *Moderately Disagree*	0%	0%
Four – *Neither Agree nor Disagree*	0%	0%
Five – *Moderately Agree*	0%	0%
Six – *Agree*	60%	80%
Seven – *Strongly Agree*	40%	20%
Total	**100%**	**100%**

Question Eight

This question was deemed to be very important inasmuch as it deals directly with

the capabilities of case-based versus rule-based technology in an IT help desk

environment. In the event the case-based search engine cannot find an exact match for

the problem entered into the system, it will return as many as 10 of the closest matches

for solution to the problem case in terms of percentages of closeness to the solution based

on the criteria of the entered problem. The Exsys'® CORVID™ rule-based system

returned no possible solutions inasmuch as there were no exact matches for the sample

problem on the knowledge-base.

The Spotlight system, as shown in Table 10, was evaluated as eighty percent "moderately useful"; and twenty percent "unable to determine", inasmuch as it at least gave them some probable solutions or starting points, to solving the problem. The mean of the Spotlight system ratings was 4.80 with a standard deviation of 0.447. The CORVID system was rated as one-hundred percent "useless". The mean of the CORVID system ratings was 1.00 with a standard deviation of 0.000. The respondents stated that the CORVID system offered no problem solution assistance whatsoever where an exact problem was not listed within the problem categories.

Table 10. **Response Breakdown – Section Two, Question Eight, how did you find the returned solutions from the Casebank Spotlight® case-based/Exsys'® CORVID™ rule-based systems where an exact problem was not found on the knowledge base?**

Response	CORVID Percentage	Spotlight Percentage
One – Useless	100%	0%
Two – *Not very useful*	0%	0%
Three – Somewhat useful	0%	0%
Four – Unable to determine	0%	20%
Five – *Moderately Useful*	0%	80%
Six – Useful	0%	0%
Seven – Very Useful	0%	0%
Total	**100%**	**100%**

Section Three

The questions asked in this section, were based on comparisons between the CORVID rule-based system and the Spotlight case-based system to determine the difficulty of maintaining the system and their related knowledge-bases. An identical set

of questions was asked about each of the systems, rule and case-based utilizing the following comparison categories and questions:

1. For the category, the ease in learning the two systems, the question asked was "Did you find your learning experience with regards to learning Casebank Spotlight® /Exsys'® CORVID™ systems as easy to use?"

2. In the category relating to the technicians learning experience dealing with the advanced features of the two systems, the question asked was "Did you find your learning experience with regards to learning Casebank's Spotlight/Exsys'® CORVID™'s more advanced features as easy?"

3. The category dealing with the period of time taken to learn the systems, the question asked was "Were you able to learn the Casebank Spotlight® /Exsys'® CORVID™ systems in a short period of time?"

4. In the category of the straight-forwardness of using the various features of the two systems by trial and error, the question asked was "Did you find, based on your experience, that exploring the features of the system by trial and error to be very straight forward?"

5. For the category dealing with the exploration of the features of the two systems via random selection which may tend to be risky, the question was asked "Did you find the exploration of the features of the Casebank Spotlight® /Exsys'® CORVID™ systems via random selection of features, to be risky (could cause problems)?"

6. In the category of learning and remembering the names and uses of the various commands utilized by the two systems, the question was asked "Did you find remembering names and uses of the various Casebank Spotlight® /Exsys'® CORVID™ system commands to be an easy task?"

7. For the category of remembering the rules required to enter the various commands in the systems, the question was asked "Did you find remembering specific rules about entering commands on the Casebank Spotlight® /Exsys'® CORVID™ systems to be an easy task?"

8. The category dealing with the intuitiveness regarding the performance of the various tasks within the two systems, posed the question "Did you find the ability to perform various tasks using the Casebank Spotlight® /Exsys'® CORVID™ systems to be straight forward?"

9. In the category dealing with the ability to perform various tasks in a logical sequence, the question was asked "Are you able to rate the ability to perform various steps to complete various tasks in the Casebank Spotlight® /Exsys'® CORVID™ systems following a logical sequence?"

10. The final category dealt with the overall difficulty of performing various maintenance tasks on the two systems. The question asked for this category was "Do you believe that overall difficulty of performing assigned maintenance procedures for the Casebank Spotlight® case-based system/Exsys'® CORVID™ rule-based system is relatively straight forward?"

Section Three Responses and Findings

Question One

Question one was asked to determine how easy or difficult each of the respondents found each of the systems to use. The respondents agreed, with very little variation, that the two systems were easy to use. Table 11 shows the Spotlight system was evaluated as forty percent "agree" and sixty percent "moderately agree". The mean of the Spotlight system ratings was 5.40 with a standard deviation of 0.548. The

CORVID system was evaluated as sixty percent "agree" and forty percent "moderately

agree". The mean of the CORVID system ratings was 5.60 with a standard deviation of

0.548.

Table 11. **Response Breakdown – Section Three, Question One did you find your learning experience with regards to learning Casebank Spotlight® /Exsys'® CORVID™ systems as easy to use?**

Response	CORVID Percentage	Spotlight Percentage
One – *Strongly Disagree*	0%	0%
Two – *Disagree*	0%	0%
Three – *Moderately Disagree*	0%	0%
Four – *Neither Agree nor Disagree*	0%	0%
Five – *Moderately Agree*	40%	60%
Six – *Agree*	60%	40%
Seven – *Strongly Agree*	0%	0%
Total	**100%**	**100%**

Question Two

Question two asked if the respondents felt that each of the systems, with regards

to learning their more advanced features, was an easy task. Table 12 shows that forty

percent of the respondents "strongly agree" and sixty percent "agree" that the Spotlight

system's more advanced features were simple to learn. For the CORVID system, the

respondents chose "agree" (eighty percent) and "moderately agree" (twenty percent).

The mean of the Spotlight system ratings was 6.40 with a standard deviation of 0.548.

The CORVID systems mean was 5.80 with a standard deviation of 0.447.

Table 12. **Response Breakdown – Section Three, Question Two Did you find your learning experience with regards to learning Casebank's Spotlight/Exsys'® CORVID™'s more advanced features as an easy task?**

Response	CORVID Percentage	Spotlight Percentage
One – *Strongly Disagree*	0%	0%
Two – *Disagree*	0%	0%
Three – *Moderately Disagree*	0%	0%
Four – *Neither Agree nor Disagree*	0%	0%
Five – *Moderately Agree*	20%	0%
Six – *Agree*	80%	60%
Seven – *Strongly Agree*	0%	40%
Total	**100%**	**100%**

Question Three

Question three addressed the ability to learn to use each of the systems in a short period of time. The Spotlight system, as shown in Table 13, was evaluated as twenty percent "agree" and eighty percent "moderately agree", whereas the respondents evaluated the CORVID system eighty percent "agree" and twenty percent "moderately agree". The mean of the Spotlight system ratings was 5.20 with a standard deviation of 0.447, while the CORVID system returned a mean of 5.80 with a standard deviation of 0.447.

Table 13. **Response Breakdown – Section Three, Question Three, were you able to learn the Casebank Spotlight® /Exsys'® CORVID™ systems in a short period of time?"**

Response	CORVID Percentage	Spotlight Percentage
One – *Strongly Disagree*	0%	0%
Two – *Disagree*	0%	0%
Three – *Moderately Disagree*	0%	0%
Four – *Neither Agree nor Disagree*	0%	0%
Five – *Moderately Agree*	20%	80%
Six – *Agree*	80%	20%
Seven – *Strongly Agree*	0%	0%
Total	**100%**	**100%**

Question Four

Question four asked the respondents if they found exploring the features of each of the systems by trial and error to be very straight forward. Table 14 shows the Spotlight system was rated forty percent "agree" and sixty percent "moderately agree", whereas the CORVID system was evaluated twenty percent "agree", sixty percent "moderately agree", and twenty percent "neither agree nor disagree". The mean of the Spotlight system ratings was 5.40 with a standard deviation of 0.548, while the CORVID system returned a mean of 5.00 with a standard deviation of 0.707.

Table 14. **Response Breakdown – Section Three, Question Four, did you find, based on your experience, that exploring the features of the system by trial and error to be very straight forward?**

Response	CORVID Percentage	Spotlight Percentage
One – *Strongly Disagree*	0%	0%
Two – *Disagree*	0%	0%
Three – *Moderately Disagree*	0%	0%
Four – *Neither Agree nor Disagree*	20%	0%
Five – *Moderately Agree*	60%	60%
Six – *Agree*	20%	40%
Seven – *Strongly Agree*	0%	0%
Total	**100%**	**100%**

Question Five

Question five addressed the exploration of randomly selected features as being "risky" (could cause problems). The Spotlight system, as shown in Table 15, was rated twenty percent "agree", forty percent "moderately agree" and forty percent "neither agree nor disagree" that going through the Spotlight system randomly could cause problems. The CORVID system was rated somewhat higher. The ratings were twenty percent "agree", sixty percent "moderately agree", and twenty percent "neither agree nor disagree". The mean of the Spotlight system ratings was 4.80 with a standard deviation of 0.837, while the CORVID system returned a mean 5.00 with a standard deviation of 0.707.

Table 15. **Response Breakdown – Section Three, Question Five, did you find the exploration of the features of the Casebank Spotlight® /Exsys'® CORVID™ systems via random selection of features, to be risky (could cause problems)?**

Response	CORVID Percentage	Spotlight Percentage
One – *Strongly Disagree*	0%	0%
Two – *Disagree*	0%	0%
Three – *Moderately Disagree*	0%	0%
Four – *Neither Agree nor Disagree*	20%	40%
Five – *Moderately Agree*	60%	40%
Six – *Agree*	20%	20%
Seven – *Strongly Agree*	0%	0%
Total	**100%**	**100%**

Question Six

Question six addressed the retention and uses of the various commands in both the Spotlight and CORVID systems as being easily accomplished. As shown in Table 16, the respondents rated the Spotlight system as twenty percent "strongly agree", and eighty percent "agree" while the CORVID system was rated as sixty percent "agree" and forty percent "moderately agree". The mean of the Spotlight system ratings was 6.20 with a standard deviation of 0.447, while the CORVID system returned a mean 5.60 with a standard deviation of 0.548.

Table 16. **Response Breakdown – Section Three, Question Six, did you find remembering names and uses of the various Casebank Spotlight® /Exsys'® CORVID™ system commands to be an easy task?**

Response	CORVID Percentage	Spotlight Percentage
One – *Strongly Disagree*	0%	0%
Two – *Disagree*	0%	0%
Three – *Moderately Disagree*	0%	0%
Four – *Neither Agree nor Disagree*	0%	0%
Five – *Moderately Agree*	40%	0%
Six – *Agree*	60%	80%
Seven – *Strongly Agree*	0%	20%
Total	**100%**	**100%**

Question Seven

Question seven asked the respondents if they found that remembering specific rules pertaining to entering the various commands as a simple task. The respondents rated the Spotlight system, as shown in Table 17, as sixty percent "agree", and forty percent "moderately agree". Table 17 also shows that the CORVID system rated as forty percent "moderately agree", twenty percent "neither agree nor disagree", and forty percent "moderately disagree". The mean of the Spotlight system ratings were 5.60 with a standard deviation of 0.548, while the CORVID system returned a mean of 4.00 with a standard deviation of 1.000.

Table 17. **Response Breakdown – Section Three, Question Seven, did you find remembering specific rules about entering commands on the Casebank Spotlight® /Exsys'® CORVID™ systems to be an easy task?**

Response	CORVID Percentage	Spotlight Percentage
One – *Strongly Disagree*	0%	0%
Two – *Disagree*	0%	0%
Three – *Moderately Disagree*	40%	0%
Four – *Neither Agree nor Disagree*	20%	0%
Five – *Moderately Agree*	40%	40%
Six *– Agree*	0%	60%
Seven – *Strongly Agree*	0%	0%
Total	**100%**	**100%**

Question Eight

Question eight addressed the straight forwardness of performing the various tasks required for performing maintenance on the systems. As shown in Table 18, the respondents rated the Spotlight system as one-hundred percent "agree" whereas the rating for the CORVID system was forty percent "strongly agree", twenty percent "agree", and forty percent "moderately agree". The mean of the Spotlight system ratings was 6.00 with a standard deviation of 0.000, while the CORVID system returned a mean 6.00 a standard deviation of 1.000.

Table 18. **Response Breakdown – Section Three, Question Eight, did you find the ability to perform various tasks using the Casebank Spotlight® /Exsys'® CORVID™ systems to be straight forward?**

Response	CORVID Percentage	Spotlight Percentage
One – *Strongly Disagree*	0%	0%
Two – *Disagree*	0%	0%
Three – *Moderately Disagree*	0%	0%
Four – *Neither Agree nor Disagree*	0%	0%
Five – *Moderately Agree*	40%	0%
Six – *Agree*	20%	100%
Seven – *Strongly Agree*	40%	0%
Total	**100%**	**100%**

Question Nine

Question nine asked the respondents if they were able to perform all of the various tasks required for maintenance in a logical sequence. The respondents rated the Spotlight system as shown in Table 19, forty percent "strongly agree", and sixty percent "agree", whereas the respondents rated the CORVID system as one-hundred percent "strongly agree". The mean of the Spotlight system ratings was 6.40 with a standard deviation of 0.548, while the CORVID system returned a mean of 7.00 with a standard deviation of 0.000. As a result, the technicians found that the CORVID system offered a more logical methodology for performing the requisite maintenance steps.

Table 19. **Response Breakdown – Section Three, Question Nine, are you able to rate the ability to perform various steps to complete various tasks in the Casebank Spotlight® /Exsys'® CORVID™ systems following a logical sequence?**

Response	CORVID Percentage	Spotlight Percentage
One – *Strongly Disagree*	0%	0%
Two – *Disagree*	0%	0%
Three – *Moderately Disagree*	0%	0%
Four – *Neither Agree nor Disagree*	0%	0%
Five – *Moderately Agree*	0%	0%
Six – *Agree*	0%	60%
Seven – *Strongly Agree*	100%	40%
Total	**100%**	**100%**

Question Ten

Question ten addressed the overall difficulty of performing assigned maintenance procedures for both of the systems as being/not being relatively straight forward. Table 20 shows that the respondents rated the Spotlight system as eighty percent "agree" and twenty percent "neither agree nor disagree", while the CORVID was rated as twenty percent "strongly agree", and eighty percent "agree". The mean of the Spotlight system ratings was 4.80 with a standard deviation of 0.447, while the CORVID system returned a mean 6.20 with a standard deviation of 0.447. Table 20 shows a substantial difference in the ease of performing maintenance on the two systems. CORVID is shown to be much easier to maintain than the Spotlight system.

Table 20. **Response Breakdown – Section Three, Question Ten, do you believe that overall difficulty of performing assigned maintenance procedures for the Casebank Spotlight® case-based system/Exsys'® CORVID™ rule-based system is relatively straight forward?**

Response	CORVID Percentage	Spotlight Percentage
One – *Strongly Disagree*	0%	0%
Two – *Disagree*	0%	0%
Three – *Moderately Disagree*	0%	0%
Four – *Neither Agree nor Disagree*	0%	20%
Five – *Moderately Agree*	0%	0%
Six – *Agree*	80%	80%
Seven – *Strongly Agree*	20%	0%
Total	**100%**	**100%**

Section Four

The results categorized in this section were based on comparisons between the CORVID Rule-Based system and the Spotlight Case-Based system in terms of the time taken to enter a problem into each of the systems and retrieve a solution. Further, any time required for manual research to determine or clarify a solution for a problem was documented. Table 22 shows the time taken by each of the respondents by problem number and reflects the average time in minutes to find the applicable solution for problems that were not entered into the respective knowledge bases. Table 21 shows the time taken by each of the respondents by problem number and reflects the average time, in minutes, to find the applicable solution for problems that were entered into the respective knowledge bases. If the problem was not contained in the knowledge base(s) or required clarification, the time required to perform addition research is documented in

each of the tables (Table 21 and Table 22). The times and amounts reflected in Tables 21 and 22 do not include the time that would be necessary to actually make the necessary repairs.

Section Four Responses and Findings

This section, details by problem, the metrics given in Table 21 (problems contained in the knowledge bases) and Table 22 (problems that were not contained in the knowledge bases) by providing a description of the actions taken with each of the problems entered into the systems by the respondents. This detail will include:

1. Problem entry/solution recovery time

2. Time involved in solution recovery outside the knowledge-based systems (manual research)

3. The standard deviation of the time taken in solution entry/recovery

Table 21. **Section 4 - Time Required for Problem Entry/Solution Recovery (Including any research time) for Problems Contained in Knowledge Bases**

Problem Number	System Average Time	Standard Deviation
Spotlight Problem 16	2.500	0.500
CORVID Problem 16	1.800	0.447
Spotlight Problem 36	2.400	0.548
CORVID Problem 36	2.000	0.000
Spotlight Problem 64	2.000	0.000
CORVID Problem 64	1.000	0.000
Spotlight Problem 76	1.300	0.447
CORVID Problem 76	1.200	0.447
Spotlight Problem 100	2.600	0.548
CORVID Problem 100	2.000	0.707
Spotlight Problem 103	2.200	0.447
CORVID Problem 103	1.600	0.548
Spotlight Problem 165	1.600	0.548
CORVID Problem 165	1.600	0.548
Spotlight Problem 174	1.000	0.000
CORVID Problem 174	1.000	0.000
Spotlight Problem 175	1.000	0.000
CORVID Problem 175	1.000	0.000
Spotlight Problem 191	1.200	0.447
CORVID Problem 191	1.200	0.447
Spotlight Problem 216	1.000	0.000
CORVID Problem 216	1.400	0.548
Spotlight Problem 221	1.800	0.837
CORVID Problem 221	1.600	0.894
Total Spotlight System Minutes	20.600	
Total CORVID System Minutes	17.400	

Problems Contained in the Knowledge Bases

The problems itemized in Table 21 are those problems that were entered into the

knowledge bases based on random selection of cases. The system average time, and the

standard deviation are reflected in Table 21. The total time for each of these efforts is outlined below.

Problem 16 (CD ROM – Can't boot from CD-ROM drive) was one of the random problems that existed on both of the knowledge bases. Both the Spotlight and CORVID systems returned an exact solution to the problem. The average entry/recovery time for the Spotlight system was 2.50 minutes. The CORVID system's average entry/recovery time was 1.80 minutes.

Problem 36 (Hard Drive – UDMA/66 or UDMA/100 drive runs at UDMA/33 on systems that support UDMA/66 or UDMA/100) was one of the random problems that existed on both of the knowledge bases. Both the Spotlight and CORVID systems returned an exact solution to the problem. The average entry/recovery time for the Spotlight system was 2.40 minutes. The CORVID system's average entry/recovery time was 2.00.

Problem 64 (Modem – Modem works correctly with Internet access, but computer-to-computer terminal emulation produces garbage screens) was one of the random problems that existed on both of the knowledge bases. Both the Spotlight and CORVID systems returned an exact solution to the problem. The average entry/recovery time for the Spotlight system was 2.00 minutes, whereas the CORVID system's average entry/recovery time was 1.00 minute.

Problem 76 (Mouse – Wireless mouse doesn't work at some angles relative to the computer) was one of the random problems that existed on both of the knowledge bases. Both the Spotlight and CORVID systems returned an exact solution to the problem. The average entry/recovery time for the Spotlight system was 1.30 minutes while the CORVID system's average entry/recovery time was 1.20 minutes.

Problem 100 (Optical Drives – Can't read CD-RW media on MultiRead CD-ROM drive) was one of the random problems that existed on both of the knowledge bases. Both the Spotlight and CORVID systems returned an exact solution to the problem. The average entry/recovery time for the Spotlight system was 2.60 minutes. The CORVID system's average entry/recovery time was 2.00 minutes.

Problem 103 (Optical Drives – Can't write to CD-RW or DVD-RW 1x media) was one of the random problems that existed on both of the knowledge bases. Both the Spotlight and CORVID systems returned an exact solution to the problem. The average entry/recovery time for the Spotlight system was 2.20 minutes. The CORVID system's average entry/recovery time was 1.60 minutes.

Problem 165 (System – System is dead, no beeps, or locks up before POST begins) was one of the random problems that existed on both of the knowledge bases. Both the Spotlight and CORVID systems returned an exact solution to the problem. The average entry/recovery time for the Spotlight system was 1.60 minutes. The CORVID system's average entry/recovery time was exactly the same as the time taken using Spotlight.

Problem 174 (System – System locks up after running for a time), was one of the random problems that existed on both of the knowledge bases. Both the Spotlight and CORVID systems returned an exact solution to the problem. The average entry/recovery time for the Spotlight system was 1.00 minute. The CORVID system's average entry/recovery time was exactly the same as that for Spotlight.

Problem 175 (System – System locks when office equipment such as copiers or microwave ovens nearby are operated) was one of the random problems that existed on both of the knowledge bases. Both the Spotlight and CORVID systems returned an exact solution to the problem. The average entry/recovery time for the Spotlight system was

1.00 minute. The CORVID system's average entry/recovery time was exactly the same as the time required for Spotlight.

Problem 191 (USB – USB 2.0 ports aren't supporting USB 2.0 devices at top speed) was one of the random problems that existed on both of the knowledge bases. Both the Spotlight and CORVID systems returned an exact solution to the problem. The average entry/recovery time for the Spotlight system was 1.20 minute. The CORVID system's average entry/recovery time was exactly the same as the time utilized for Spotlight system.

Problem 216 (Windows – Operating system will not boot) was one of the random problems that existed on both of the knowledge bases. Both the Spotlight and CORVID systems returned an exact solution to the problem. The average entry/recovery time for the Spotlight system was 1.00 minute. The CORVID system's average entry/recovery time was 1.40 minutes.

Problem 221 (Windows – The PC starts in Safe mode (Windows 9x, Windows Me) was one of the random problems that existed on both of the knowledge bases. Both the Spotlight and CORVID systems returned an exact solution to the problem. The average entry/recovery time for the Spotlight system was 1.80 minutes. The CORVID system's average entry/recovery time was 1.60 minutes.

Table 22. **Section 4 - Time Required for Problem Entry/Solution Recovery (Including any research time) for Problems Not Contained in the Knowledge Bases**

Problem Number	Average Total Time		Standard Deviation	Standard Deviation
	System	Manual	System	Manual
Spotlight Problem 5	1.100	0.000	0.224	0.000
CORVID Problem 5	1.000	5.200	0.000	0.837
Spotlight Problem 26	1.000	0.000	0.000	0.000
CORVID Problem 26	1.000	2.500	0.000	0.447
Spotlight Problem 41	4.200	1.200	0.837	0.447
CORVID Problem 41	1.000	5.000	0.000	0.707
Spotlight Problem 67	1.000	0.000	0.000	0.000
CORVID Problem 67	1.000	5.000	0.000	0.707
Spotlight Problem 113	2.400	2.200	0.548	0.447
CORVID Problem 113	1.000	3.200	0.000	1.095
Spotlight Problem 121	2.000	2.400	0.707	0.548
CORVID Problem 121	1.000	5.200	0.000	0.447
Spotlight Problem 129	1.000	0.000	0.000	0.000
CORVID Problem 129	1.000	2.200	0.000	0.447
Spotlight Problem 197	1.000	0.000	0.000	0.000
CORVID Problem 197	1.000	1.600	0.000	0.548
Total Spotlight System & Manual Minutes	13.700	5.800		
Total CORVID System & Manual Minutes	8.000	29.900		

Problems Not Contained in the Knowledge Bases

The problems itemized in Table 22 are those problems that were not entered into the knowledge bases due to random selection of cases. The system and manual averages,

along with the system and manual standard deviations are reflected in Table 22. The total times for each of these efforts are outlined below.

Problem five (Audio – Game port on sound card conflicts with other game port in system) was one of the random problems that did not exist in either of the knowledge bases. The Spotlight system presented several solutions within the Audio realm that could either be the solution or lead the technician to a suitable solution for the problem. The average entry time for this problem was 1.10 minutes and required no manual research to obtain a solution. The technicians were unable to find the exact problem in the CORVID system necessitating manual research. The average time taken to see if a problem existed on the rule base was one minute; however, the average time taken for the manual research was 5.20 minutes.

Problem 26 (Floppy Drive – Disk access light stays on continuously after system is started) was one of the random problems that did not exist on either of the knowledge bases. The Spotlight system presented several solutions within the Floppy Disk problem realm that could either be the solution or lead the technician to a suitable solution for the problem. The average entry time for this problem was 1.00 minutes and required no manual research to obtain a solution. The technicians were unable to find the exact problem in the CORVID system necessitating manual research. The average time taken to see if a problem existed on the rule base was one minute; however, the average time taken for the manual research was 2.50 minutes.

Problem 41 (Hard Drive – Can't boot from SCSI Hard Drive) was one of the random problems that did not exist on either of the knowledge bases. The Spotlight system presented several solutions within the Hard Disk problem realm that could either be the solution or lead the technician to a suitable solution for the problem. The average entry/retrieval time for this problem was 4.20 minutes. Manual research was required for

this solution to validate one of the probable solutions. This manual research required 1.20 minutes to validate the solution. The technicians were unable to find the exact problem in the CORVID system necessitating manual research. The average time taken to see if a problem existed on the rule base was 1.00 minute; however, the average time taken for the manual research was 5.00 minutes.

Problem 67 (Modem – Can't dial with analog modem) was one of the random problems that did not exist on either of the knowledge bases. The Spotlight system presented several solutions within the Modem problem realm that could either be the solution or lead the technician to a suitable solution for the problem. The average entry/retrieval time for this problem was 1.00 minute and required no manual research. The technicians were unable to find the exact problem in the CORVID system necessitating manual research. The average time taken to see if a problem existed on the rule base was 1.00 minute; however, the average time taken for the manual research was 5.00 minutes.

Problem 113 (Optical Drives – Can't burn a CD-R disk while performing other tasks) was one of the random problems that did not exist on either of the knowledge bases. The Spotlight system presented several solutions within the Optical Drive problem realm that could either be the solution or lead the technician to a suitable solution for the problem. Manual research was required to validate one of the solutions returned by the Spotlight system. The average entry/retrieval time for this problem was 2.40 minutes and required manual research time of 2.20. The technicians were unable to find the exact problem in the CORVID system necessitating manual research. The average time taken to see if a problem existed on the rule base was 1.00 minute; however, the average time taken for the manual research was 3.20 minutes.

Problem 121 (Optical Drives – Can't create a writeable DVD) was one of the random problems that did not exist on either of the knowledge bases. The Spotlight system presented several solutions within the Optical Drive problem realm that could either be the solution or lead the technician to a suitable solution for the problem. Manual research was required to validate one of the solutions returned by the Spotlight system. The average entry/retrieval time for this problem was 2.00 minutes and required 2.40 minutes of manual research, inasmuch as the solution derived from the system required conformation. The technicians were unable to find the exact problem in the CORVID system necessitating manual research. The average time taken to see if a problem existed on the rule base was 1.00 minute; however, the average time taken for the manual research was 5.20 minutes.

Problem 129 (Optical Drives – Can't boot from a bootable CD) was one of the random problems that did not exist on either of the knowledge bases. The Spotlight system presented several solutions within the Optical Drive problem realm that could either be the solution or lead the technician to a suitable solution for the problem. The average entry/retrieval time for this problem was 1.00 minute and required no manual research. The technicians were unable to find the exact problem in the CORVID system necessitating manual research. The average time taken to see if a problem existed on the rule base was 1.00 minute; however, the average time taken for the manual research was 2.20 minutes.

Problem 197 (Video – Can't use AGP card as primary video) was one of the random problems that did not exist on either of the knowledge bases. The Spotlight system presented several solutions within the Video problem realm that could either be the solution or lead the technician to a suitable solution for the problem. The average entry/retrieval time for this problem was 1.00 minutes and required no manual research. The technicians were unable to find the exact problem in the CORVID system

necessitating manual research. The average time taken to see if a problem existed on the rule base was 1.00 minute; however, the average time taken for the manual research was 2.60 minutes.

Findings

The purpose of Section One was to determine whether or not the 20 problems given to each of the respondents were within the scope of problems normally encountered by technicians at the Tier-2 help desk level. This question was not directed toward either the Casebank Spotlight® or the Exsys'® CORVID™ systems, rather to the scope of the individual problems. The respondent's replies, with a mean of 5.80 and a standard deviation of 0.837, were in agreement that the problems were within the scope of the actual problems received daily at the Tier-2 help desk level. However, given that $\sigma = .0837$, the range of the positive replies varied between "Moderately Agree" and "Strongly Agree" with the majority in moderate agreement or agreement.

Section Two, utilizing the first seven questions, was designed to determine the value of: (1) a rule-based expert system; and (2) a case-based knowledge-based system utilized as a tool to help solve daily Tier-2 help desk problems in terms of the systems effectiveness and accuracy. The second part of Section Two, consisting of a single question, was designed to determine the usefulness of the solutions that were returned when the exact problem was not found on either of the knowledge bases.

The mean for the first seven questions pertaining to the Spotlight case-based system, based on the respondents input was 6.114 out of 7.000 with a standard deviation of 2.168 as shown in part one of Table 23. The mean for the last question, question eight, again, based on the respondents input, was 4.800 out of 7.000 with a standard deviation of 0.447.

The mean for the first seven questions pertaining to the CORVID rule-based system was 5.657 out of 7.000 with a standard deviation of 1.517 as shown in part one of Table 24. The mean for the last question, question eight, using the respondents input was 1.000 out of 7.000 with a standard deviation of 0.000.

The respondents found that the ability to retrieve an acceptable solution from the Spotlight knowledge base, when the exact problem was not found, was determined to be "moderately useful" with a mean of 4.800 and a standard deviation of 0.447 (Table 23). Finally, the respondents found that the ability to retrieve an acceptable solution from the CORVID system when the exact problem was not found, was "useless", given a mean of 1.00 and a standard deviation of 0.00. This indicated that all respondents rated this ability within CORVID with a one. The difference in the means for question eight was 3.800 (Table 24).

Question four, which asked "were the solutions returned by the two systems of any value when the exact solution was not returned", in other words, were the results of any of the solutions in the same category of any use, and was the only question that had a large variance in the means of the two systems. The Spotlight system earned a mean of 5.20 where the CORVID system had a mean of 2.60. The other six questions, reflecting the effectiveness and accuracy of the systems when being used as a knowledge-based tool for a Tier-2 help desk, was accepted by the respondents with a difference in the means of only 0.100. This difference is based on the Spotlight mean for the six questions (1, 2, 3, 5, 6, and 7) of 6.267 and the CORVID mean of 6.167 (See Tables 23 and 24).

The purpose of Section three was to determine which system, case or rule-based, was the easiest to use and maintain. The mean for the questions as they pertained to Spotlight, was 5.620 out of 7.000 as shown in Table 25. The mean for the CORVID

system was 5.600 out of 7.000 as shown in Table 26. The overall difference in means of

0.02 was insignificant and did not identify which system was the easiest to use and

maintain. Rather, the results indicated that the respondents "moderately agreed" to

"agreed" that the systems were both easy to use and maintain. Two of the questions,

seven and ten, seven dealing with being able to retain specific rules about entering

requisite commands on each of the systems and ten, dealing with performing assigned

maintenance procedures for each of the systems, had differences in means worth

mentioning.

Question seven, as it applies to the Spotlight system had a mean of 5.600

compared with the CORVID mean of 4.000. This difference in means of 1.600 seems to

indicate that the Spotlight system's intuitiveness pertaining to remembering and using

various rules and commands would allow the individual technician to learn and use the

system faster than the CORVID system. Question ten, as it applies to the Spotlight

system had a mean of 4.800 compared with the CORVID mean of 6.200. The difference

in means of 1.400 seems to indicate that the CORVID system is easier to maintain than is

Spotlight. This reinforces the research findings that a casebase is very difficult to

maintain (Roth-Berghofer and Iglezakis (2001).

The purpose of Section Four was to determine the amount of time, in minutes, it

would require for a help desk technician to enter each of the 20 problems and retrieve a

solution from each of the knowledge-based systems. Additionally, any time required,

again, in minutes, to perform research for a specific solution, outside the knowledge-

based system, was also documented. Table 27 shows the results in time spent processing

eight of the 20 random problems that were not in either of the knowledge bases. Table 28

displays the results in time that were spent processing the remaining 12 random problems that were entered into the knowledge bases.

Table 23. Section Two (Part 1) Comparison of Means and Standard Deviation (Spotlight)

Section Two - Respondent answers to Spotlight - Questions 1 - 7 (Value of a case-based system as a help desk tool) Part 1			
		Section 2 Mean	Section 2 Standard Deviation
Question Number:			
1		6.600	0.548
2		6.200	0.837
3		6.000	0.707
4		5.200	0.837
5		6.400	0.548
6		6.200	0.447
7		6.200	0.447
Mean of Total Scores		6.114	2.168
Mean of Questions 1-3 & 5-7		6.267	
Section Two - Respondent answers to Spotlight - Question 8 (Value of a case-based system as a help desk tool) Part 2			
		Section 2 (Part 2) Mean	Section 2 (Part 2) Standard Deviation
Question Number:			
8		4.800	0.447

Table 24. Section Two (Part 2) Comparison of Means and Standard Deviation (CORVID)

Section Two - Respondent answers to CORVID - Question 8 (Value of a case-based system as a help desk tool) Part 1			
		Section 2	Section 2
Question Number:		Mean	Standard Deviation
1		6.200	0.516
2		6.600	0.516
3		5.600	0.548
4		2.600	0.516
5		6.200	0.753
6		6.000	0.983
7		6.400	0.516
Mean of Total Scores		5.657	1.517
Mean of Questions 1-3 & 5-7		6.167	
Difference between the means		0.100	
Section Two - Respondent answers to CORVID - Questions 1 - 7 (Value of a case-based system as a help desk tool) Part 2			
		Section 2 (Part 2)	Section 2 (Part 2)
Question Number:		Mean	Standard Deviation
8		1.000	0.000
Difference between the means		3.800	

Table 25. Section Three - Comparison of Means and Standard Deviation (Spotlight)

Section Three - Respondent answers to Spotlight - Questions 1 -10 (Ease of use and Maintenance)				
		Section 3	Standard	
Question Number:		Mean	Deviation	
1		5.400	0.548	
2		6.400	0.548	
3		5.200	0.447	
4		5.400	0.548	
5		4.800	0.837	
6		6.200	0.447	
7		5.600	0.548	
8		6.000	0.000	
9		6.400	0.548	
10		4.800	0.447	
		5.620	1.304	

Table 26. Section Three - Comparison of Means and Standard Deviation (CORVID)

Section Three - Respondent answers to CORVID - Question 1 - 10 (Ease of Use and Maintenance)				
		Section 3	Standard	
Question Number:		Mean	Deviation	
1		5.600	0.548	
2		5.800	0.447	
3		5.800	0.447	
4		5.000	0.707	
5		5.000	0.707	
6		5.600	0.548	
7		4.000	1.000	
8		6.000	1.000	
9		7.000	0.000	
10		6.200	0.447	
		5.600	3.16227766	

Table 27. Processing Time for Problems not contained in the Knowledge Bases

Section Four (A) - Processing Time for Problems Not Contained in the Knowledge Bases								
		Average Total Time			Average Total		Standard Deviation		Standard Deviation
		System	Manual		System & Manual		System	Manual	System & Manual
Spotlight Problem 5		1.100	0.000		1.100		0.224	0.000	0.599
CORVID Problem 5		1.000	5.200		6.200		0.000	0.837	2.283
Spotlight Problem 26		1.000	0.000		1.000		0.000	0.000	0.527
CORVID Problem 26		1.000	2.500		3.500		0.000	0.500	0.858
Spotlight Problem 41		4.200	1.200		5.400		0.837	0.447	1.703
CORVID Problem 41		1.000	5.000		6.000		0.000	0.707	2.160
Spotlight Problem 67		1.000	0.000		1.000		0.000	0.000	0.527
CORVID Problem 67		1.000	5.000		6.000		0.000	0.707	2.160
Spotlight Problem 113		2.400	2.200		4.600		0.548	0.447	0.483
CORVID Problem 113		1.000	3.200		4.200		0.000	1.095	1.370
Spotlight Problem 121		2.000	2.400		4.400		0.707	0.548	0.632
CORVID Problem 121		1.000	5.200		6.200		0.000	0.447	2.234
Spotlight Problem 129		1.000	0.000		1.000		0.000	0.000	0.527
CORVID Problem 129		1.000	2.200		3.200		0.000	0.447	0.699
Spotlight Problem 197		1.000	0.000		1.000		0.000	0.000	0.527
CORVID Problem 197		1.000	1.600		2.600		0.000	0.548	0.483
Spotlight Mean System Time:		13.700							
CORVID Mean System Time:		8.000							
Spotlight Mean Manual Time:			5.800						
CORVID Mean Manual Time:			29.900						
Total Spotlight Time:					19.500				
Total CORVID Time:					37.900				

Table 28. Processing Time for Problems contained in the Knowledge Bases

Section Four (B) - Processing Time for Problems Contained in the Knowledge Bases						
	Average Total Time		Average Total	Standard Deviation		Standard Deviation
	System	Manual	System & Manual	System	Manual	System & Manual
Spotlight Problem 16	2.500	0.000	2.500	0.500	0.000	1.359
CORVID Problem 16	1.800	0.000	1.800	0.837	0.000	0.994
Spotlight Problem 36	2.400	0.000	2.400	0.548	0.000	1.317
CORVID Problem 36	2.000	0.000	2.000	0.816	0.000	1.054
Spotlight Problem 64	2.000	0.000	2.000	0.000	0.000	1.054
CORVID Problem 64	1.000	0.000	1.000	0.408	0.000	0.527
Spotlight Problem 76	1.300	0.000	1.300	0.447	0.000	0.747
CORVID Problem 76	1.200	0.000	1.200	0.632	0.000	0.699
Spotlight Problem 100	2.600	0.000	2.600	0.548	0.000	1.418
CORVID Problem 100	2.000	0.000	2.000	1.033	0.000	1.155
Spotlight Problem 103	2.200	0.000	2.200	0.447	0.000	1.197
CORVID Problem 103	1.600	0.000	1.600	0.816	0.000	0.919
Spotlight Problem 165	1.600	0.000	1.600	0.548	0.000	0.919
CORVID Problem 165	1.600	0.000	1.600	0.816	0.000	0.919
Spotlight Problem 174	1.000	0.000	1.000	0.000	0.000	0.527
CORVID Problem 174	1.000	0.000	1.000	0.408	0.000	0.527
Spotlight Problem 175	1.000	0.000	1.000	0.000	0.000	0.527
CORVID Problem 175	1.000	0.000	1.000	0.408	0.000	0.527
Spotlight Problem 191	1.200	0.000	1.200	0.447	0.000	0.699
CORVID Problem 191	1.200	0.000	1.200	0.632	0.000	0.699
Spotlight Problem 216	1.000	0.000	1.000	0.000	0.000	0.527
CORVID Problem 216	1.400	0.000	1.400	0.753	0.000	0.823
Spotlight Problem 221	1.800	0.000	1.800	0.837	0.000	1.101
CORVID Problem 221	1.600	0.000	1.600	1.033	0.000	1.033
Spotlight Mean System Time:	20.600					
CORVID Mean System Time:	17.400					
Spotlight Mean Manual Time:		0.000				
CORVID Mean Manual Time:		0.000				
Total Spotlight Time:			20.600			
Total CORVID Time:			17.400			
Grand Total Spotlght (Sections A & B):	40.100					
Grand Total CORVID (Sections A & B):	**55.300**					

Table 27 shows the time required to locate a problem and retrieve a solution for the eight problems that were not entered into either the CORVID rule base or the Spotlight knowledge base. The mean system time required by the respondents to retrieve a solution from the Spotlight system was 13.700 minutes whereas the mean attempted retrieval time from the CORVID system was 8.000 minutes. The 8.000 minutes used in the CORVID system was not necessarily used to retrieve a solution, rather, it was used to see if the problem existed. The mean manual retrieval time required by the respondents to enhance or verify a solution retrieved from Spotlight from system manuals was 5.800 minutes. The mean manual retrieval time for the CORVID system was 29.900 minutes and was used for searching system manuals for the appropriate solution.

Table 28 shows the time required to locate a problem and retrieve a solution for the 12 problems that were entered into both the CORVID rule-base and the Spotlight case-base. The mean system time required by the respondents to retrieve a solution from the Spotlight system was 20.600 minutes whereas the mean retrieval time from the CORVID system was 17.400 minutes. There was no manual retrieval required for either the Spotlight or the CORVID systems. The difference between the two means is only 3.200 minutes, however, Section three (question one) identified the CORVID system to be somewhat easier to use, albeit by an insignificant amount. The sufficiency of the solutions returned by both the Spotlight and CORVID systems made it possible for the respondents not to have to perform any manual research.

Summary of Results

The three questions that were addressed by this exploratory study were answered as follows:

The first question to be addressed was which paradigm, rule-based or case-based reasoning resulted in more precise solutions to problems when compared to the solutions derived from system manuals. This question was addressed by first determining whether or not the actual problem existed on the knowledge base and, if so, which of the two systems better depicted the degree which the returned solutions emulated the system reference manuals. The second determination was made based on the fact that the problem did not exist on the knowledge base.

The results of the first determination found that the rule-based CORVID system had a slightly higher mean, 6.40, compared to the case-based Spotlight systems mean of 6.20. This difference is considered insignificant inasmuch as the posted problem solutions were derived from the same reference, further, it can be attributed to other factors used in the attainment of the solutions using each of the systems.

The results of the second determination, the problem did not exist on either of the knowledge bases, offered a remarkable difference between the two means. The rating mean for the Spotlight system was 4.80 which was closest to "moderately useful". On the other hand, the rating mean and median for the CORVID system was 1.00 which is in the category of "useless" which means that there are exactly zero solutions presented when no rule exists on the rule-base.

The second question, which paradigm, rule or case-based reasoning, is more convenient to maintain in terms of knowledge modification (i.e. addition, deletion, or modification of rules/cases). This question consisted of two parts; first, the ease of use of the overall systems, the overall difficulty or ease of the learning the various commands utilized to perform maintenance, and the length of time required to learn each of the

systems. The second part was the actual difficulty of performing the actual maintenance procedures e.g., inserting a new rule or case; correcting an existing rule/case, etc. The first part demonstrated that both of the systems were comparatively easy to use and learn. The second part, however, demonstrated that the CORVID system was much easier to maintain (delete rules/cases, add rules/cases, and modify rules/cases) than was the Spotlight system.

The third question, which paradigm, rule or case-based reasoning, enabled help-desk technicians to solve problems in shorter time frame, therefore resulting in a lower cost. The first part of this question deals with problems and solutions that were not entered into either the CORVID rule-base or the Spotlight case-base. The mean system time required by the respondents to retrieve a solution from the Spotlight system was 13.700 minutes whereas the mean attempted retrieval time from the CORVID system was 8.000 minutes. The 8.000 minutes used in the CORVID system was not necessarily used to retrieve a solution, rather, it was used to see if the problem existed. The mean manual retrieval time required by the respondents to enhance or verify a solution retrieved from Spotlight from system manuals was 5.800 minutes. The mean manual retrieval time for the CORVID system was 29.900 minutes and was used for searching system manuals for the appropriate solution.

The second part of this question dealt with the time required to locate a problem and retrieve a solution for the 12 problems that were entered into both the CORVID rule base and the Spotlight knowledge base. The mean system time required by the respondents to retrieve a solution from the Spotlight system was 20.600 minutes whereas the mean retrieval time from the CORVID system was 17.400 minutes. There was no manual retrieval required for either the Spotlight or the CORVID systems. The difference between the two means is only 3.200 minutes, however, Section three

(question one) identified the CORVID system to be somewhat easier to use, albeit by an insignificant amount. The sufficiency of the solutions returned by both the Spotlight and CORVID systems made it possible for the respondents not to have to perform any manual research.

Cost/Benefit Summary

The cost/benefit summary was based on the experience of each of the technicians working in a Tier-two environment (technicians with one year experience; technicians with approximately five years experience; and technicians with ten years experience). This summary compared the time taken and the cost related to each of the problems and resulting solutions where time taken using CORVID and Spotlight were not the same. Table 29 compares these time/cost results for the more experienced technician (ten years). The costs and percentages highlighted in yellow indicate the Spotlight system and the cost and percentages highlighted in blue represent the CORVID system. Seven of the problems show Spotlight to offer savings in both time and cost from twenty to five-hundred percent over the CORVID system, whereas the CORVID system offered only three problems all with a time and cost savings over Spotlight of one-hundred percent.

The cost metric was based on the Help Desk Institute's nationwide average cost for a Tier-2 help desk analyst which is $18.71 per hour or $0.31 per minute which is used in the cost/benefit summary tables.

Overall, the experienced technician with ten plus years experience at the Tier-2 help desk level found the Spotlight system to be 135.29% more cost/time effective than the CORVID system for processing problem reports.

Table 29. **Cost/Time Effectiveness of the more experienced Technician**

System	Problem Number	System Time	Manual Time				
		System & Manual Minutes			**Experienced Tech (10+ years of Tier-2)**		
Spotlight	5	1	0	1	$0.31	$1.56	500.00%
CORVID	5	1	5	6	$1.87		
Spotlight	16	2	0	2	$0.62		
CORVID	16	1	0	1	$0.31	$0.31	100.00%
Spotlight	26	1	0	1	$0.31	$0.94	300.00%
CORVID	26	1	3	4	$1.25		
Spotlight	36	2	0	2	$0.62		
CORVID	36	2	0	2	$0.62		
Spotlight	41	4	1	5	$1.56	$0.31	20.00%
CORVID	41	1	5	6	$1.87		
Spotlight	64	2	0	2	$0.62		
CORVID	64	1	0	1	$0.31	$0.31	100.00%
Spotlight	67	1	0	1	$0.31	$1.56	500.00%
CORVID	67	1	5	6	$1.87		
Spotlight	76	1	0	1	$0.31		
CORVID	76	1	0	1	$0.31		
Spotlight	100	2	0	2	$0.62		
CORVID	100	1	0	1	$0.31	$0.31	100.00%
Spotlight	103	2	0	2	$0.62		
CORVID	103	2	0	2	$0.62		
Spotlight	113	2	2	4	$1.25		
CORVID	113	1	3	4	$1.25		
Spotlight	121	2	2	4	$1.25	$0.62	50.00%
CORVID	121	1	5	6	$1.87		
Spotlight	129	1	0	1	$0.31	$0.62	200.00%
CORVID	129	1	2	3	$0.94		
Spotlight	165	1	0	1	$0.31		
CORVID	165	1	0	1	$0.31		
Spotlight	174	1	0	1	$0.31		
CORVID	174	1	0	1	$0.31		
Spotlight	175	1	0	1	$0.31		
CORVID	175	1	0	1	$0.31		
Spotlight	191	1	0	1	$0.31		
CORVID	191	1	0	1	$0.31		
Spotlight	197	1	0	1	$0.31	$0.62	200.00%
CORVID	197	1	2	3	$0.94		
Spotlight	216	1	0	1	$0.31		
CORVID	216	1	0	1	$0.31		
Spotlight	221	1	0	1	$0.31		
CORVID	221	1	0	1	$0.31		
SubTotal		52	35		$0.62	$5.30	135.29%
Total			87		$0.31	$7.17	

The more experienced technician, in terms of Tier-2 problem solutions,
found the Spotlight system to be 135.29% more cost/time effective
over the CORVID system for processing problem reports.

Table 30 compares these time/cost results for the average experienced technician with five years experience. The costs and percentages highlighted in yellow indicate the Spotlight system and the cost and percentages highlighted in blue represent the CORVID system. Eight of the problems show Spotlight to offer savings in both time and cost from 33.33 to 533.33 percent over the CORVID system, whereas the CORVID system offered nine problems with a time and cost savings 12.50 to 100.00 percent over the Spotlight system.

Overall, the average experienced technician with five plus years experience at the Tier-2 help desk level found the Spotlight system to be 130.43% more cost/time effective than the CORVID system for processing problem reports.

Table 31 compares these time/cost results for the average technician with two years experience. The costs and percentages highlighted in yellow indicate the Spotlight system and the cost and percentages highlighted in blue represent the CORVID system. Ten of the problems show Spotlight to offer savings in both time and cost from 20.00 to 400.00 percent over the CORVID system, whereas the CORVID system offered three problems with a time and cost savings 25.00 to 100.00 percent over the Spotlight system.

Overall, the average technician with two plus years experience at the Tier-2 help desk level found the Spotlight system to be 111.63% more cost/time effective than the CORVID system for processing problem reports.

Table 30. **Cost/Time Effectiveness of Technicians with Average Experience**

System	Problem Number	Sys	Man	Total	Average Tech (+/- Five years Experience)		
Spotlight	5	1.00	0.00	1.00	$0.31	$1.56	500.00%
CORVID	5	1.00	5.00	6.00	$1.87		
Spotlight	16	2.67	0.00	2.67	$0.83		
CORVID	16	2.00	0.00	2.00	$0.62	$0.21	33.33%
Spotlight	26	1.00	0.00	1.00	$0.31	$0.78	250.00%
CORVID	26	1.00	2.50	3.50	$1.09		
Spotlight	36	2.67	0.00	2.67	$0.83		
CORVID	36	2.00	0.00	2.00	$0.62	$0.21	33.33%
Spotlight	41	4.33	1.00	5.33	$1.66	$0.21	12.50%
CORVID	41	1.00	5.00	6.00	$1.87		
Spotlight	64	2.00	0.00	2.00	$0.62		
CORVID	64	1.00	0.00	1.00	$0.31	$0.31	100.00%
Spotlight	67	1.00	0.00	1.00	$0.31	$1.66	533.33%
CORVID	67	1.00	5.33	6.33	$1.97		
Spotlight	76	1.50	0.00	1.50	$0.47		
CORVID	76	1.00	0.00	1.00	$0.31	$0.16	50.00%
Spotlight	100	2.67	0.00	2.67	$0.83		
CORVID	100	2.33	0.00	2.33	$0.73	$0.10	14.29%
Spotlight	103	2.33	0.00	2.33	$0.73		
CORVID	103	1.33	0.00	1.33	$0.42	$0.31	75.00%
Spotlight	113	2.33	2.33	4.67	$1.46		
CORVID	113	1.00	2.67	3.67	$1.14	$0.31	27.27%
Spotlight	121	2.00	2.33	4.33	$1.35	$0.52	38.46%
CORVID	121	1.00	5.00	6.00	$1.87		
Spotlight	129	1.00	0.00	1.00	$0.31	$0.62	200.00%
CORVID	129	1.00	2.00	3.00	$0.94		
Spotlight	165	1.67	0.00	1.67	$0.52		
CORVID	165	1.67	0.00	1.67	$0.52		
Spotlight	174	1.00	0.00	1.00	$0.31		
CORVID	174	1.00	0.00	1.00	$0.31		
Spotlight	175	1.00	0.00	1.00	$0.31		
CORVID	175	1.00	0.00	1.00	$0.31		
Spotlight	191	1.33	0.00	1.33	$0.42		
CORVID	191	1.00	0.00	1.00	$0.31	$0.10	33.33%
Spotlight	197	1.00	0.00	1.00	$0.31	$0.52	166.67%
CORVID	197	1.00	1.67	2.67	$0.83		
Spotlight	216	1.00	0.00	1.00	$0.31	$0.10	33.33%
CORVID	216	1.33	0.00	1.33	$0.42		
Spotlight	221	2.33	0.00	2.33	$0.73		
CORVID	221	2.00	0.00	2.00	$0.62	$0.10	16.67%
SubTotal					$0.48	$5.98	130.43%

Table 31. **Cost/Time Effectiveness of Technicians with Minimal Tier-2 Experience**

System	Problem Number	System & Manual Minutes			Average Technician (two years experience)		
		Sys	Man				
Spotlight	5	1.5	0	1.5	$0.47	$1.72	366.67%
CORVID	5	1	6	7	$2.18		
Spotlight	16	2.5	0	2.5	$0.78		
CORVID	16	2	0	2	$0.62	$0.16	25.00%
Spotlight	26	1	0	1	$0.31	$0.62	200.00%
CORVID	26	1	2	3	$0.94		
Spotlight	36	2	0	2	$0.62		
CORVID	36	2	0	2	$0.62		
Spotlight	41	4	2	6	$1.87		
CORVID	41	1	5	6	$1.87		
Spotlight	64	2	0	2	$0.62		
CORVID	64	1	0	1	$0.31	$0.31	100.00%
Spotlight	67	1	0	1	$0.31	$1.25	400.00%
CORVID	67	1	4	5	$1.56		
Spotlight	76	1	0	1	$0.31	$0.31	100.00%
CORVID	76	2	0	2	$0.62		
Spotlight	100	3	0	3	$0.94		
CORVID	100	2	0	2	$0.62	$0.31	50.00%
Spotlight	103	2	0	2	$0.62		
CORVID	103	2	0	2	$0.62		
Spotlight	113	3	2	5	$1.56	$0.31	20.00%
CORVID	113	1	5	6	$1.87		
Spotlight	121	2	3	5	$1.56	$0.62	40.00%
CORVID	121	1	6	7	$2.18		
Spotlight	129	1	0	1	$0.31	$0.94	300.00%
CORVID	129	1	3	4	$1.25		
Spotlight	165	2	0	2	$0.62		
CORVID	165	2	0	2	$0.62		
Spotlight	174	1	0	1	$0.31		
CORVID	174	1	0	1	$0.31		
Spotlight	175	1	0	1	$0.31		
CORVID	175	1	0	1	$0.31		
Spotlight	191	1	0	1	$0.31	$0.31	100.00%
CORVID	191	2	0	2	$0.62		
Spotlight	197	1	0	1	$0.31	$0.31	100.00%
CORVID	197	1	1	2	$0.62		
Spotlight	216	1	0	1	$0.31	$0.31	100.00%
CORVID	216	2	0	2	$0.62		
Spotlight	221	1	0	1	$0.31		
CORVID	221	1	0	1	$0.31		
SubTotal		62	39		$0.58	$6.70	111.63%
Total			101		$0.52	$7.48	

Table 32 compares the average time/cost results for all technicians. The costs and percentages highlighted in yellow indicate the Spotlight system and the cost and percentages highlighted in blue represent the CORVID system. The average of the time/cost of the problems show CORVID to have an average percentage increase of 310.71% over using the Spotlight system whereas Spotlight has only a percentage increase of 132.09% over using CORVID. This means that an average savings of 54.36% was realized by using the Spotlight system over using the CORVID system with an average savings of 21.65%.

With the exception of knowledge base maintenance, the Spotlight system seems to be the better choice of knowledge based systems for use in the Tier-2 Help Desk environment.

Table 32. **Average Overall Cost/Time Effectiveness of All Technicians**

Average System	Average Manual	Total Average	Average cost per issue	Additional cost Spotlight	Additional cost CORVID	Spotlight	CORVID	%	System	Issue Number
1.1	0	1.1	$0.34						Spotlight	5
1	5.2	6.2	$1.93		$1.59	82.26%		563.64%	CORVID	5
2.5	0	2.5	$0.78	$0.22			28.00%	138.89%	Spotlight	16
1.8	0	1.8	$0.56						CORVID	16
1	0	1	$0.31						Spotlight	26
1	2.5	3.5	$1.09		$0.78	71.43%		350.00%	CORVID	26
2.4	0	2.4	$0.75	$0.12			16.67%	120.00%	Spotlight	36
2	0	2	$0.62						CORVID	36
4.2	1.2	5.4	$1.68						Spotlight	41
1	5	6	$1.87		$0.19	10.00%		111.11%	CORVID	41
2	0	2	$0.62	$0.31			50.00%	200.00%	Spotlight	64
1	0	1	$0.31						CORVID	64
1	0	1	$0.31						Spotlight	67
1	5	6	$1.87		$1.56	83.33%		600.00%	CORVID	67
1.3	0	1.3	$0.41	$0.03			7.69%	108.33%	Spotlight	76
1.2	0	1.2	$0.37						CORVID	76
2.6	0	2.6	$0.81	$0.19			23.08%	130.00%	Spotlight	100
2	0	2	$0.62						CORVID	100
2.2	0	2.2	$0.69	$0.19			27.27%	137.50%	Spotlight	103
1.6	0	1.6	$0.50						CORVID	103
2.4	2.2	4.6	$1.43	$0.12			8.70%	109.52%	Spotlight	113
1	3.2	4.2	$1.31						CORVID	113
2	2.4	4.4	$1.37						Spotlight	121
1	5.2	6.2	$1.93		$0.56	29.03%		140.91%	CORVID	121
1	0	1	$0.31						Spotlight	129
1	2.2	3.2	$1.00		$0.69	68.75%		320.00%	CORVID	129
1.6	0	1.6	$0.50	$0.00					Spotlight	165
1.6	0	1.6	$0.50		$0.00		0.00%		CORVID	165
1	0	1	$0.31	$0.00					Spotlight	174
1	0	1	$0.31		$0.00		0.00%		CORVID	174
1	0	1	$0.31	$0.00					Spotlight	175
1	0	1	$0.31		$0.00		0.00%		CORVID	175
1.2	0	1.2	$0.37	$0.00					Spotlight	191
1.2	0	1.2	$0.37		$0.00		0.00%		CORVID	191
1	0	1	$0.31						Spotlight	197
1	1.6	2.6	$0.81		$0.50	61.54%		260.00%	CORVID	197
1	0	1	$0.31						Spotlight	216
1.4	0	1.4	$0.44		$0.12	28.57%		140.00%	CORVID	216
1.8	0	1.8	$0.56	$0.06			11.11%	112.50%	Spotlight	221
1.6	0	1.6	$0.50						CORVID	221
34.3	5.8	40.1								
25.4	29.9	55.3		$1.25	$5.99	54.36%	21.56%	310.71% Average % increase in cost over using Spotlight for these problems		
								132.09% Average % increase in cost over using CORVID for these problems		

54.36% Average saving over using CORVID

21.56% Average saving over using spotlight

Chapter Five

Conclusions, Implications, Recommendations and Summary

Introduction

This exploratory study was performed to determine which of the paradigms, case or rule-based reasoning, would be the better choice to provide a knowledge-based expert system for an information technology (IT) help-desk. Three exploratory study questions were developed to determine, first, which of the paradigms resulted in more precise solutions to problems when compared to the solutions derived from system manuals, second, which of the paradigms was more convenient to maintain in terms of knowledge modification (i.e. addition, deletion, or modification of rules/cases), and third, which of the paradigms enabled the help-desk technicians to solve problems in a shorter time frame therefore lowering the cost of attaining problem solutions. The expert system shells utilized in this exploratory study were the Exsys'® CORVID™ rule-based and the Casebank Spotlight® case-based systems, and determine which of the two paradigms, rule or case based, are a better fit in an IT Help desk. The objective of this chapter is to summarize the conclusions attained by this exploratory study, the implications that this exploratory study could have on the IT help desk, recommendations for further research in expert systems as it pertains to the IT help desk and call centers, and finally a summation of the overall exploratory study.

Conclusions

The goal of this exploratory study was to investigate the relative merits of a rule-based (CORVID) and a case-based (Spotlight) system to support help desk operations at

the Tier-2 level. The questions that were answered by this exploratory study are as follows:

1. Which paradigm, rule-based or case-based reasoning, resulted in more precise solutions to problems when compared to the solutions derived from system manuals?

2. Which paradigm, rule-based or case-based reasoning, was more convenient to maintain in terms of knowledge modification (i.e. addition, deletion, or modification of rules/cases)?

3. Which paradigm, rule or case-based reasoning, enabled the help-desk technicians to solve problems in shorter time, and therefore at a lower cost?

This exploratory study contrasted and compared the case and rule-based paradigms when used as help-desk decision support systems for solving Tier-2 problems based on the outcomes of the above three questions. This was accomplished by the development of two prototypes, one rule-based and one case-based. These shells were populated with problem and solution data categorized by problem type. Randomly selected problems were selected and entered into each of the prototypes. The solutions returned by each of the prototypes were then compared to determine which solution was the most accurate when compared to system maintenance manuals. The difficulty of maintenance for each of the prototypes was determined. Each maintenance item was evaluated by each of the help desk technicians as to the length of time taken to perform the maintenance item and the difficulty, based on the intuitiveness of each of the systems. Maintenance of these systems was defined as the addition of new cases or rules, the deletion of cases or rules and the reclassification of cases. Finally, the time required to

implement the solutions was evaluated. This exploratory study emphasized the conjectures that rule-based systems are better suited for problem solving when the system being analyzed is a single-purpose, specialized system and the rules for solving the problems are clear and do not change with high frequency.

The data and procedures utilized in this exploratory study support the hypothesis of this study, which was the case-based paradigm is better suited for use in the help desk environments at the Tier-2 level than is the rule-based paradigm. The case-based paradigm, because of its ability to offer alternative solutions for a given problem, gave the help-desk technician flexibility in applying a solution. Alternatively, the rule-based paradigm provided a solution if, and only if, a rule existed for a solution meeting the exact problem specifications. Further, in the absence of a rule, problem research time, using the rule-based paradigm, extended the time required to formulate a solution thereby increasing the cost.

Implications

The growth of information technology over the past 10 years has been tremendous and with that growth, demands on Information Systems departments in both government and the private sector has grown proportionally. This growing user base has placed even greater demands on these entities. The cost of Tier-2 technicians has also increased. The various government agencies and private corporations have began to investigate the possibility or have actually implemented an expert system that will help current help-desk staffs better perform their jobs as the number of trouble calls increase. Data center management has expressed a strong interest in retaining the current help-desk employees

and precludes the need for additional personnel by the implementation of the expert system colleague.

The data collected by this exploratory study will better enable both public and private sector management a better understanding of expert systems in general and the paradigm that better fits the help-desk problem solving activity. In addition, the study will provide a better understanding of how the individual help-desk technicians perceive the use of an expert system in terms of how it can help them in performing their job and their own longevity in terms of retention.

Through this exploratory study, government and private sector entities will get the information necessary to build a viable expert system which will give the help-desk the ability to do more with the same number of employees.

Recommendations

It is understood in both the public and private sectors IT help desk departments that "knowledge reuse" increases the productivity of help-desk technicians who have answered the same questions for customers in the past and will certainly give new technicians a head start in answering these and similar questions in the future (Doctor, 2003). Delic and Hoelimer (2000) further emphasize this stating that help-desk operations at all three tiers are frequently supported by some sort of knowledge-based system.

Because of the cost variance in the three tiers of help desk activity, research should be initiated that will build a help desk knowledge base that will entertain all levels of help desk activity (Tier-1, Tier-2, and Tier-3). This exploratory study demonstrated that the technicians at the Tier-2 level are capable of performing repairs at the Tier-3

level provided they have the guidance to see the repairs through to completion. A single knowledge base, containing the problems and repair sequences of both the Tier-2 and Tier-3 problem base could save the company the difference between the Tier-3 ($800) and the Tier-2 ($200). This Tier-3 cost has caused most organizations to use some type of knowledge based systems to solve the more difficult problems (Delic and Hoelimer 2000).

Summary

This purpose of this exploratory study was to demonstrate the importance of the use of a knowledge-based system to provide problem solutions typically found in an Information Technology (IT) help-desk environment. Specifically, the relative merits of rule-based and case-based approaches to support help desk operations at the Tier-2 level was investigated.

The implementation of a knowledge management centric system at the organizations IT help desk can realize many benefits. The productivity and collaboration skills of the help desk technicians will be enhanced along with the sharing of their respective knowledge. These enhancements will, in a majority of cases, lead to increased customer satisfaction in terms of the speed and accuracy of system problem solutions (Farver, Joslin, and LaBounty, 2001).

The help desk industry divides support into three tiers (or levels) - Tiers 1, 2 and 3. The work breakdown for each of the three levels is as follows:

1. Tier-1 Support: Tier-1 provides basic application software and/or hardware support for the initial customer contact.

2. Tier-2 Support: Tier-2, or middle tier, provides more complex support and/or subject matter expertise on application software and/or hardware and is usually an escalation of a call from Tier-1.

3. Tier-3 Support: The Tier-3 Level provides support on complex hardware and network operating system software and usually involves certified systems engineers. Call lengths on Tier-3 vary widely depending upon the type of incident.

The cost of the initial call to the Tier-1 technicians is approximately $50; however, the solution cost in the Tier-2 grows to $200 and to $800 in Tier-3. This cost alone has caused most organizations to use some type of knowledge based system (KBS) to solve the more difficult problems thus avoiding the higher upper tier costs (Delic and Hoelimer 2000). This exploratory study has shown that the use of a KBS to solve the more difficult problems will also ensure that the cost at the lower tiers is maintained at the lowest rate possible.

The goal of this exploratory study was to investigate the relative merits of rule-based and case-based approaches to support help desk operations at the Tier-2 level. The questions that were answered from this study are as follows:

1. Which paradigm, rule-based or case-based reasoning, results in more precise solutions to problems when compared to the solutions derived from system manuals?

2. Which paradigm, rule-based or case-based reasoning, is more convenient to maintain in terms of knowledge modification (i.e. addition, deletion, or modification of rules/cases)?

3. Which paradigm, rule-based or case-based reasoning, enables help-desk technicians to solve problems in shorter time, and therefore at lower cost?

This was accomplished by the development of two prototypes, one rule-based and one case-based. These shells were populated with problem and solution data categorized by problem type. Randomly selected problems were then selected and entered into each of the prototypes. The solutions returned by each of the prototypes were compared to determine the more accurate solution when compared to system maintenance manuals. The difficulty of maintenance for each of the prototypes was determined. Each maintenance item was evaluated by one of the help desk technicians as to the length of time taken to perform the maintenance item and the difficulty, based on the intuitiveness of each of the systems. Maintenance of these systems was defined as the addition of new cases or rules, the deletion of cases or rules and the reclassification of cases. Finally, the time required to implement the proposed solutions was evaluated. This exploratory study emphasized the conjectures that rule-based systems are better suited for problem solving when the system being analyzed is a single-purpose, specialized system and the rules for solving the problems are clear and do not change with high frequency.

The hypothesis of this study was that the case-based paradigm is better suited for use in the Tier-2 computer workstation (workstation hardware/software problems) help desk environment than is the rule-based paradigm. The case-based paradigm, because of its ability to offer alternative solutions for a given problem, gave the help-desk technician greater flexibility in applying a solution. Alternatively, the rule-based paradigm provided a solution if, and only if, a rule existed for a solution meeting the exact problem criteria. Further, in the absence of a rule, problem research time, using the rule-based paradigm,

extended the time required to formulate a solution thereby increasing the cost.

There have been many studies as to the merits of case and rule-based reasoning and text-based retrieval systems; however, there have only been a few relevant studies that have made actual comparisons between them. This exploratory study indicates that knowledge retrieval systems can be valuable assets to the information technology help desk (Kriegsman and Barletta, 1993; Delic and Hoelimer, 2000). This exploratory study performed comparisons of the accuracy of retrieved solutions, the difficulty of maintenance encountered, and the time in minutes that a call takes using each of the knowledge retrieval systems, case and rule-based shell applications coupled with any manual research if required. A review of the literature within the help desk domain revealed that an actual comparison of the rule-based versus the case-based paradigms does not appear to have taken place.

The outcome of this exploratory study depended on two environments being set up to develop, test, and maintain the case and rule-based systems. The rule-based system, Exsys'® CORVID™, and the case-based system, Casebank Spotlight® , version 3.26 were installed and maintained on a stand-alone Microsoft® XP Professional® desktop. Although the CORVID™ and Casebank Spotlight® software were designed to run in this environment, problems did arise that caused delays during the development and test phases of this exploratory study. There was no significant retrieval time difference between the rule and case-based implementations, however, when a rule was absent in the rule-based model, problem research time caused the solution period to be longer than that of the case-based system.

To ensure content validity was maintained, the data transcribed from the text sources were validated by researching a minimum of two help desks from the commercial and governmental environments. This ensured that the problems entered into the case and rule-based servers were actual or very similar problems encountered by the researched help desks.

The need for the information technology help desk has become critical over the past several years. With the growth of technology within the business and government entities, a simple help desk manned with technicians and reference manuals will no longer satisfy the need. The use of the knowledge base for solving problems has grown to where they provide answers to users problems without human intervention. Because the problems submitted to the help desk are very broad based, from printer to specific software problems, the case-based knowledge system is better suited to provide solutions.

This exploratory study supported the hypothesis of this study, which was the case-based paradigm is better suited for use in the help desk environments at the Tier-2 level than is the rule-based paradigm. The case-based paradigm, because of its ability to offer alternative solutions for a given problem, gave the help-desk technician flexibility in applying a solution. Alternatively, the rule-based paradigm provided a solution if, and only if, a rule existed for a solution meeting the exact problem specifications. Further, in the absence of a rule, problem research time, using the rule-based paradigm, extended the time required to formulate a solution thereby increasing the cost.

Appendix A

Questionnaire

Survey of Accuracy, Ease of Maintenance, and Time Period required to retrieve a solution from two Knowledge-Based Help Desk Systems: One developed with a Case-Based Shell – one using a Rule-Based Shell

Based on: Lewis, J. R. (1995) *IBM Computer Usability Satisfaction Questionnaires: Psychometric Evaluation and Instructions for Use.* **International Journal of Human-Computer Interaction**, 7:1, 57-78. [Abstract](#) About question.cgi

You may either print out this form or return it by email: see addresses at end

Disclaimer of Liability:
With respect to this questionnaire, the researcher makes no warranty, express or implied, including the warranties of fitness for a particular purpose; nor assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information or process disclosed; nor represents that its use would not infringe privately owned rights.

Michael F. Bryant, as part of his research for a Ph.D. in Information Systems at Nova Southeastern University, is comparing the accuracy of response to entered problems as compared to documented solutions found in various system manuals, the ease or difficulty of maintenance between the systems being evaluated, and the time required to enter a problem and retrieve its solution from each of the systems. The objective of this survey is to gather quantitative data from help desk technicians at two IT sites; one government and one private sector to be used to determine which expert system, the rule-based or the case-based, has the most value in helping them solve day to day Tier-2 trouble reports. All respondents will be notified of the results of the survey.

Please read the disclaimer of liability, above, and if you agree, complete the questionnaire and submit it directly to the name and address on the last page of this questionnaire. Please be clear in the selections you make:

SECTION ONE – Problems within the scope of a Tier-2 Help Desk

The question addressed in this section pertains to the scope of the 20 problems

that the help desk technicians are to enter into each of the systems; Exsys CORVID and

Casebank Spotlight.

1. Did you find the 20 test problems to be within the scope of the daily problem

calls received at the Tier-2 help desk level?

Strongly Disagree						Strongly Agree
1	**2**	**3**	**4**	**5**	**6**	**7**

SECTION TWO – System Effectiveness and Accuracy

The Case-Based system Casebank Spotlight: The first seven questions pertain

to the value of a case-based system utilized as a tool to help solve daily Tier-2 help-desk

problems. (1 – Strongly Disagree, 2- Disagree, 3 – Moderately Disagree, 4 – Neither

Agree nor Disagree, 5 – Mildly Agree, 6 – Moderately Agree, 7 – Strongly Agree).

Question eight asks for a determination of the usefulness of the solutions that were

returned when the exact problem was not found on the knowledge base (1 – Useless, 2 –

Not very useful, 3 – Moderately useful, 4 – Unable to determine, 5 – Mildly useful, 6 –

Moderately useful, 7 – Very useful).

1. Did you find the Casebank Spotlight case-based user interface, easy to use?

Strongly Disagree						Strongly Agree
1	**2**	**3**	**4**	**5**	**6**	**7**

2. Did you find the accuracy of the returned solutions from the Casebank

Spotlight case-based system to an easy request to be accurate?

Strongly Disagree						**Strongly Agree**
1	**2**	**3**	**4**	**5**	**6**	**7**

3. Did you find the accuracy of the returned solutions from the Casebank

Spotlight case-based system to a complex problem to be accurate?

Strongly Disagree						**Strongly Agree**
1	**2**	**3**	**4**	**5**	**6**	**7**

4. Did you find the returned solutions, if any, from the Casebank Spotlight case-

based system that was not the exact solution to the problem to be of any use?

Strongly Disagree						**Strongly Agree**
1	**2**	**3**	**4**	**5**	**6**	**7**

5. Did you find the user interface on the Casebank Spotlight system, in terms of

problem input, easy to use?

Strongly Disagree						**Strongly Agree**
1	**2**	**3**	**4**	**5**	**6**	**7**

6. Did you find the overall intuitiveness of the Casebank Spotlight case-based system to be intuitive for use in a Tier-2 help desk environment?

Strongly Disagree						**Strongly Agree**
1	2	3	4	5	6	7

7. Did the solutions returned by the Casebank Spotlight system match the solutions found in the systems manuals?

Strongly Disagree						**Strongly Agree**
1	2	3	4	5	6	7

8. On a scale of 1 to 7, (1 - Useless; 7 - Very useful) how did you find the returned solutions from the Casebank Spotlight case-based system where an exact problem was not found on the knowledge base?

Useless						**Very Useful**
1	2	3	4	5	6	7

Please write your comments about the accuracy of returned solutions pertaining to Spotlight here:

The Rule-Based system Exsys Corvid: The following questions pertain to the value of the rule-based system utilized as a tool to help solve daily Tier-2 help desk problems.

1. Did you find the Exsys Corvid rule-based user interface, easy to use?

Strongly   **Strongly**
Disagree   **Agree**

1   **2**   **3**   **4**   **5**   **6**   **7**

2. Did you find the accuracy of the returned solutions from the Exsys Corvid rule-based system to an easy request to be accurate?

Strongly   **Strongly**
Disagree   **Agree**

1   **2**   **3**   **4**   **5**   **6**   **7**

3. Did you find the accuracy of the returned solutions from the Exsys Corvid rule-based system to a complex problem to be accurate?

Strongly   **Strongly**
Disagree   **Agree**

1   **2**   **3**   **4**   **5**   **6**   **7**

4. Did you find the returned solutions, if any, from the Exsys Corvid rule-based system that was not the exact solution to the problem to be of any use?

Strongly   **Strongly**
Disagree   **Agree**

1   **2**   **3**   **4**   **5**   **6**   **7**

5. Did you find the user interface on the Exsys Corvid rule-based system, in terms of problem input, easy to use?

Strongly   **Strongly**
Disagree   **Agree**

1   **2**   **3**   **4**   **5**   **6**   **7**

6. Did you find the overall intuitiveness of the Exsys Corvid rule-based system to be intuitive for use in a Tier-2 help desk environment?

Strongly   **Strongly**
Disagree   **Agree**

1   **2**   **3**   **4**   **5**   **6**   **7**

7. Did the solutions returned by the Exsys Corvid rule-based system match the solutions found in the systems manuals?

Strongly   **Strongly**
Disagree   **Agree**

1   **2**   **3**   **4**   **5**   **6**   **7**

8. On a scale of 1 to 7, (1 - Useless; 7 - Very useful) how did you find the returned solutions from the Exsys CORVID rule-based system where an exact problem was not found on the knowledge base?

                                                                                 Very
Useless   **Useful**

1   **2**   **3**   **4**   **5**   **6**   **7**

Please write your comments about accuracy of returned solutions pertaining to CORVID here:

SECTION THREE – Difficulty of Maintenance

Casebank Spotlight Maintenance

1. Did you find your learning experience using the Casebank Spotlight system as easy to use?

Strongly						**Strongly**
Disagree						**Agree**
1	**2**	**3**	**4**	**5**	**6**	**7**

2. Did you find your learning experience with regards to learning Casebank's Spotlight's more advanced features as easy?

Strongly						**Strongly**
Disagree						**Agree**
1	**2**	**3**	**4**	**5**	**6**	**7**

3. Were you able to learn to use the Casebank Spotlight system in a short period of time?

Strongly						**Strongly**
Disagree						**Agree**
1	**2**	**3**	**4**	**5**	**6**	**7**

4. Did you find, based on your experience that exploring the features of the system by trial and error was very straight forward?

Strongly						**Strongly**
Disagree						**Agree**
1	**2**	**3**	**4**	**5**	**6**	**7**

5. Did you find the exploration of the features of the Casebank Spotlight system via random selection of features, as risky (could cause problems)?

Strongly Disagree						Strongly Agree
1	**2**	**3**	**4**	**5**	**6**	**7**

6. Did you find remembering names and use of the various Casebank Spotlight system commands as an easy task?

Strongly Disagree						Strongly Agree
1	**2**	**3**	**4**	**5**	**6**	**7**

7.   Did you find remembering specific rules about entering commands on the Casebank Spotlight system as an easy task?

Strongly Disagree						Strongly Agree
1	**2**	**3**	**4**	**5**	**6**	**7**

8. Did you find the ability to perform various tasks using the Casebank Spotlight system were straight-forward?

Strongly Disagree						Strongly Agree
1	**2**	**3**	**4**	**5**	**6**	**7**

9. Are you able to rate the ability to perform various steps to complete various

tasks in the Casebank Spotlight system following a logical sequence?

Strongly   **Strongly**
Disagree   **Agree**

1   **2**   **3**   **4**   **5**   **6**   **7**

10. Do you believe the overall difficulty of performing assigned maintenance
procedures for the Casebank Spotlight case-based system is relatively straight forward?

Strongly   **Strongly**
Disagree   **Agree**

1   **2**   **3**   **4**   **5**   **6**   **7**

Please write your comments about difficulties encountered in Spotlight

maintenance here:

Exsys CORVID Maintenance

1. Did you find your learning experience using the Exsys Corvid system as easy to use?

Strongly Disagree						**Strongly Agree**
1	**2**	**3**	**4**	**5**	**6**	**7**

2. Did you find your learning experience with regards to learning Exsys' Corvid's more advanced features as easy?

Strongly Disagree						**Strongly Agree**
1	**2**	**3**	**4**	**5**	**6**	**7**

3. Were you able to learn to use the Exsys Corvid system in a short period of time?

Strongly Disagree						**Strongly Agree**
1	**2**	**3**	**4**	**5**	**6**	**7**

4. Did you find, based on your experience that exploring the features of the system by trial and error was very straight forward?

Strongly Disagree						**Strongly Agree**
1	**2**	**3**	**4**	**5**	**6**	**7**

5. Did you find the exploration of the features of the Exsys Corvid system via random selection of features, as risky (could cause problems)?

Strongly Disagree						**Strongly Agree**
1	**2**	**3**	**4**	**5**	**6**	**7**

6. Did you find remembering names and use of the various Exsys Corvid system commands as an easy task?

Strongly Disagree						**Strongly Agree**
1	**2**	**3**	**4**	**5**	**6**	**7**

7. Did you find remembering specific rules about entering commands on the Exsys Corvid system as an easy task?

Strongly Disagree						**Strongly Agree**
1	**2**	**3**	**4**	**5**	**6**	**7**

8. Did you find the ability to perform various tasks using the Exsys Corvid system were straight-forward?

Strongly Disagree						**Strongly Agree**
1	**2**	**3**	**4**	**5**	**6**	**7**

9. Are you able to rate the ability to perform various steps to complete various tasks in the Exsys Corvid system following a logical sequence?

Strongly Disagree						**Strongly Agree**
1	**2**	**3**	**4**	**5**	**6**	**7**

10. Do you believe the overall difficulty of performing assigned maintenance procedures for the Exsys Corvid rule-based system is relatively straight forward?

Strongly Disagree						**Strongly Agree**
1	**2**	**3**	**4**	**5**	**6**	**7**

Please write your comments about any difficulties encountered in CORVID maintenance here:

Section Four – Time Requirements for Entry of Problems and Retrieval of Solutions

Time required entering/recovering each of the problems/solutions (Problems 1 – 20) into/from the **Casebank Spotlight System**:

    1. Please enter the time (in minutes) required to input the following problems and recover a solution from the Casebank Spotlight System. Note: Please include time spent performing manual research. (e.g., 2/20 where 2=input & retrieval and 20=manual research time)

Problem 1: _____   **Problem 2:** _____   **Problem 3:** _____

Problem 4: _____   **Problem 5:** _____   **Problem 6:** _____

Problem 7: _____   **Problem 8:** _____   **Problem 9:** _____

Problem 10: _____   **Problem 11:** _____   **Problem 12:** _____

Problem 13: _____   **Problem 14:** _____   **Problem 15:** _____

Problem 16: _____   **Problem 17:** _____   **Problem 18:** _____

Problem 19: _____   **Problem 20:** _____

Time required entering/recovering each of the problems/solutions (Problems 1 – 20) into/from the **Exsys CORVID system**:

    2. Please enter the time (in minutes) required to input the following problems and recover a solution from the Exsys CORVID System. Note: Please include time spent performing manual research. (e.g., 2/20 where 2=input & retrieval and 20=manual research time)

Problem 1: _____   **Problem 2:** _____   **Problem 3:** _____

Problem 4: _____   **Problem 5:** _____   **Problem 6:** _____

Problem 7: _____   **Problem 8:** _____   **Problem 9:** _____

Problem 10: _____   **Problem 11:** _____   **Problem 12:** _____

Problem 13: _____   **Problem 14:** _____   **Problem 15:** _____

Problem 16: _____   **Problem 17:** _____   **Problem 18:** _____

Problem 19: _____   **Problem 20:** _____

Please write your comments about problem entry/retrieval capabilities for each of the systems here:

*** END OF QUESTIONNAIRE ***

I would like to thank you for participating in this survey. I really appreciate the time you have taken: I will notify you as to the overall results of this exploratory study.

If you have any questions, please either email me at bryantmi@nova.edu or contact me at one of the below telephone numbers.

Telephone (Home):   (757) 549-1940

Telephone (Work):   (757) 523-6856

Fax: (757) 523-6030

Thank you,

Michael F. Bryant
740 Old Fields Arch
Chesapeake, VA 23320

Appendix B

Building the Rule-Based Exsys CORVID System

Rule-Based Reasoning (RBR) Prototype

All rule-based expert systems employ several basic concepts. These concepts are Heuristics and Rules, Inference Engine, Backward Chaining/Forward Chaining, Confidence, and Variables. Other concepts, used in other rule-based shells are Logic Blocks, and Command Blocks. A detailed description and some examples of these concepts are as follows.

Heuristics and Rules

Heuristics are defined, in expert system terminology as "rules of thumb". These "rules of thumb" are small, but specific facts that aid in the decision making process. The problem can therefore be solved when all of the relevant heuristics are combined. In the human mind these heuristics are combined in an intuitive and systemic manner to allow the decision making process to begin. A large part of building a rule-based expert system is identifying all of the necessary decision steps and making them computer executable.

Over the years, the IF/THEN rule has proven to be the best method of describing all necessary heuristics in the decision-making process, when used in a rule-based system. The "IF" part of a rule is the part that is tested to be either true or false based on a specific question. The "THEN" part of the rule then reflects the action to be taken when the "IF" part test true. Table 1 is an example of how basic rules are written. Table 2 is the decision table that implements the decisions to be made based on the outcome of rule testing.

Table 33. **Rule table**

> **1. If the system Hangs when starting = N THEN Decision = there is no problem (confidence level 100%)**
>
> **2. If the system Hangs when starting = Y AND the system hangs when rebooted = N THEN Decision = there is no problem on reboot (confidence level 100%)**
>
> **3. If the system Hangs when starting = Y AND the system hangs when rebooted = Y AND the system init files are OK = N THEN Decision = Check the system init files (confidence level 100%)**
>
> **4. If the System Hangs when starting = Y AND the system hangs when rebooted = Y AND the system init files are OK = Y AND the installed memory checks OK = N THEN Decision = Check the installed memory (confidence   level 95%)**
>
> **5. If the System Hangs when starting = Y AND the system hangs when rebooted = Y AND the system init files are OK = Y AND the installed memory checks OK = Y THEN Decision = Check Hard Drive for failure (confidence level 95%)**

Table 34. **Decision Table**

Rules	*Rule 1*	*Rule 2*	*Rule 3*	*Rule 4*	*Rule 5*
System hangs when starting	N	Y	Y	Y	Y
System hangs when rebooted		N	Y	Y	Y
System init files are OK			N	Y	Y
Installed memory checks OK			-	N	Y
DECISION	There is no problem	There is no problem on reboot	Check system init files	Check Installed Memory	Check Boot Hard Drive Failure

Inference Engine

Again, using the human mind as an example, our brain processes and combines these heuristics intuitively; however, the intuitiveness possessed by the computers inference engine is nowhere near as effective as the human mind. An inference engine is an algorithm, used in all rule-based expert systems to govern what the rules can do, when to activate or trigger the rule, and what order of priority is utilized for their validation and execution. The inference engine is further utilized to analyze and combine individual rules which solve the larger problem. Exsys (2007) states that the inference engine is utilized to determine all possible answers to a particular domain specific problem. It also determines what requisite data is needed to determine whether or not a given answer is appropriate. Further, the inference engine is used to determine if a method exist to see if the requisite data can be derived from other rules. It also determines when adequate data is available to eliminate one of the possible answers and thereby stop asking any unnecessary questions. Finally, the inference engine determines how to differentiate between the remaining answers and what will be the most likely answer based on the rule set:

The IF/THEN rules in an expert system are not the same as IF/THEN logic used in programming languages. The combination of these rules and the inference engine logic make the expert system a very powerful tool in the area of knowledge delivery. The effectiveness and maintainability is far simpler than that of maintaining the code in a traditional programming environment.

Backward Chaining/Forward Chaining

Luger (2002) states that Backward Chaining is how the Inference Engine combines the rules and causes the decisions to be goal driven. The expert system development process includes the setting of appropriate goals where the top-level goals are, at a minimum, potential recommendations and the possible answers to the problem. The determination of the needs requisite to meeting a certain goal or the determination of when or if the goal can be met is determined by the Inference Engine.

For example, we determine that a certain printer will not print. Because this printer will not print, a goal is set to determine whether or not the printer is out of paper. If a determination is made that the printer is out of paper, should the "refill the paper tray" decision be made? The rule would manifest itself as follows:

"IF The printer is not printing

AND   It is out of paper

THEN Refill the paper tray to continue printing."

The Inference Engine has found a potentially useful rule, but without more data it cannot determine if this rule should be used. To make a further determination, it needs to know if "The printer is out of paper". Determining if this statement is true becomes the new goal of the Inference Engine. The original part is not forgotten, but it is temporarily superseded by the new goal. The Inference Engine now looks for a rule that can tell it something about "out of paper".

It finds:

IF The printer is out of paper THEN The printer will not print

The Inference Engine would determine where and how to get the needed data. This process of having one goal requiring data, which leads to another goal, can be repeated many times. This "chain" of goals going backwards from the highest level to the lowest level is what gives backward chaining its name.

Luger (2002) further states that the Inference Engine also supports forward chaining. In this instance, data is used for determination rather than goals. The Inference Engine uses forward chaining when data is already available and the logic of the rules are used to analyze it. In the case of forward chaining, the rules are tested sequentially to see what conclusions were derived from the search.

Confidence

Rules containing a "confidence factor" allow the expert system to make several recommendations with various degrees of confidence (50, 90, 100, etc) which allows the system to employ a "best-fit" conclusion. When the rule specifies an exact fit, it gives a specific recommendation with absolute precision. This ability to use confidence factors in rule-based systems provides a much more effective way to build systems that emulate the real world and give the type of recommendations that human experts would.

Variables

Variables are the primary objects which are used to build rule-based expert systems. Variables can be thought of as elements that would be needed to incorporate into a decision-making process. For example, in the "printer will not print" example, if the system uses "The printer is out of paper" to help make a decision, there will need to be a variable called "The printer is out of paper" defined and used when you build the logic.

According to Exsys (2007), variables are used to define the logic, hold the data during the execution of the system, and to define system goals.

There are seven variable types which will be utilized in this system. These variable types each have special functionality and capability. Understanding and using the variables correctly is essential in building a rule-based expert system (Exsys, 2007). Table 3, below, describes the variable types and features of the seven CORVID™ variables.

Table 3 **– CORVID™ Variable Types (Exsys User Manual, p. 11)**

Variable Type	Properties
Static List	Multiple choice list with the values defined during development of the system
Dynamic List	Multiple choice list with the values defined dynamically during runtime. The values may come from external sources or be set by the logic of the system
Numeric	A numeric value that can be used in formulas or test expressions
String	A string value
Date	A date value that can be used in comparison tests
Collection	A list of values. Various operators allow you to add, remove and test items in the list. Any string or variable can be added to the Collection.
Confidence	A variable that can be assigned confidence value that reflect a degree of certainty. These values can be combined in various ways to produce an overall confidence value

Variables are used in various ways during the development of a rule-based expert system. All variable types can hold data, and at the same time these same variables can be utilized in a backward chaining goal. The developer has the freedom to assign and use variables as needed. Most of the rule-based systems, including Exsys, use either confidence or collection variables as the goals; however, there is no limitation.

Each variable has a name, such as the "Printer is out of paper", and at least one prompt, for example, "Is the printer out of paper". The name represents a value, and, in this case, "yes" or "no" is the shorter way to refer to the variable. The prompt is a longer text explaining what the variable means and is used when asking the system user for input or in displaying results. The usage can be described as the language the user speaks or the jargon that the individual user is familiar with.

A variable is normally assigned a value from user input, external data sources, e.g. spread sheets, databases, or in the logic in the rules, with each type of variable having a variety of properties and methods allowing other information to be obtained or set. For example, if we named a variable "CPU_Speed" and would like the variable to use the property "TIME", the variable would have the format [CPU_Speed.TIME].

Logic Blocks

Logic Blocks are blocks that are made up of rules that can be defined by tree diagrams, decision tables, or stated as individual rules. Each logic block may contain single or multiple rules. These blocks provide a convenient way to use a group of related rules from within the expert system. For example, examine the Rule and Decision tables shown in Tables 1 and 2. The logic shown below (Table 4), for example, is based on the Rule Table (Table 1) and the Decision Table (Table 2).

> If the System Hangs when starting = Y
> AND the system hangs when rebooted = Y
> AND the system init files are OK = Y
> AND the installed memory checks OK = Y
> THEN Decision = Check Hard Drive for failure (confidence level 95%)
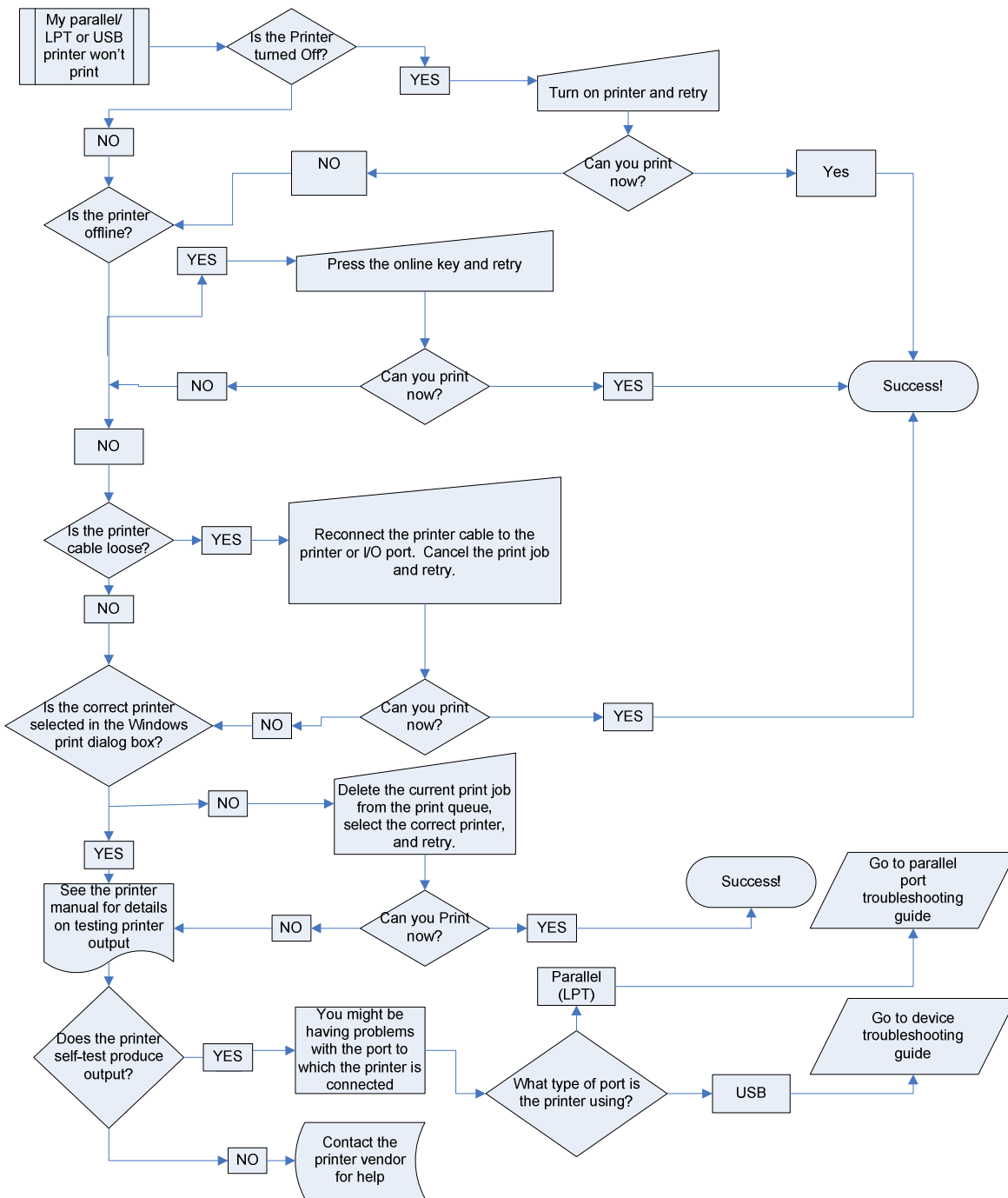
Figure 10. Printer Flow diagram

The rules, and the decisions made from these rules, are normally developed using a flow diagram or flow chart. Figure 10 shows a flow diagram for a complex situation where a either a parallel or USB printer will not print.

Command Blocks

The control layer in the majority of rule-based expert system shells including the CORVID™ expert system shell is the Command Block. This block maintains control of how the system to be developed operates, what actions to take, and in what order to perform those actions. Logic blocks in a rule-based system contain the detailed logic of how to make a decision, but these logic blocks must be invoked from a Command Block.

Command Blocks control the procedures that the system will be executing which includes how the system chains, how the logic blocks are executed, and how the systems loops and displays results.

The Command Block provides a graphical user interface (GUI) to the developer to describe the procedural operations, no matter how complex they get. The GUI also displays the system title, poses questions, and displays various messages or results.

Appendix C

Building the Case-Based Casebank Spotlight® System

Case-Based Reasoning (CBR) Prototype

The development shell used to develop the case-based help desk system for this exploratory study is Casebank's Spotlight®, Version 3.2.6. This section will provide a basic overview of the Spotlight® tool, and, in addition, the case-based mechanisms and methodologies that the shell uses. This section will further demonstrate how the Spotlight® tool provides solutions to help desk problems.

The Spotlight® tool uses all of the fundamental characteristics of the CBR process. It covers the complete cycle of case-based reasoning, i.e., retrieving cases similar to a user's specification, reusing a retrieved case as proposed solution, testing a solved case for success during the revision process, and retaining a new solution given in the form of a revised case by including the experiences (the case) into the existing case-base.

Besides the retrieval of cases, the Spotlight® tool supports modeling the cases' structure and maintenance of the case-base. The Spotlight® consultation mechanism covers the whole CBR cycle from retrieving to revising.

This section provides an overview of the basic concepts, procedures, and terminology the Spotlight® shell uses for the development of an IT Help Desk problem and solution system. The three major development stages are the Equipment Editor, the Domain Editor and finally the Solution Editor.

Equipment Editor

There are three major steps that must be taken to develop a knowledge base with the Spotlight® system. First, the Equipment Editor must be developed. The Equipment Editor defines the location of the equipment and the equipment type, in this case, the Help Desk (location) and Desk Top Computers (equipment type) (Figure 11).
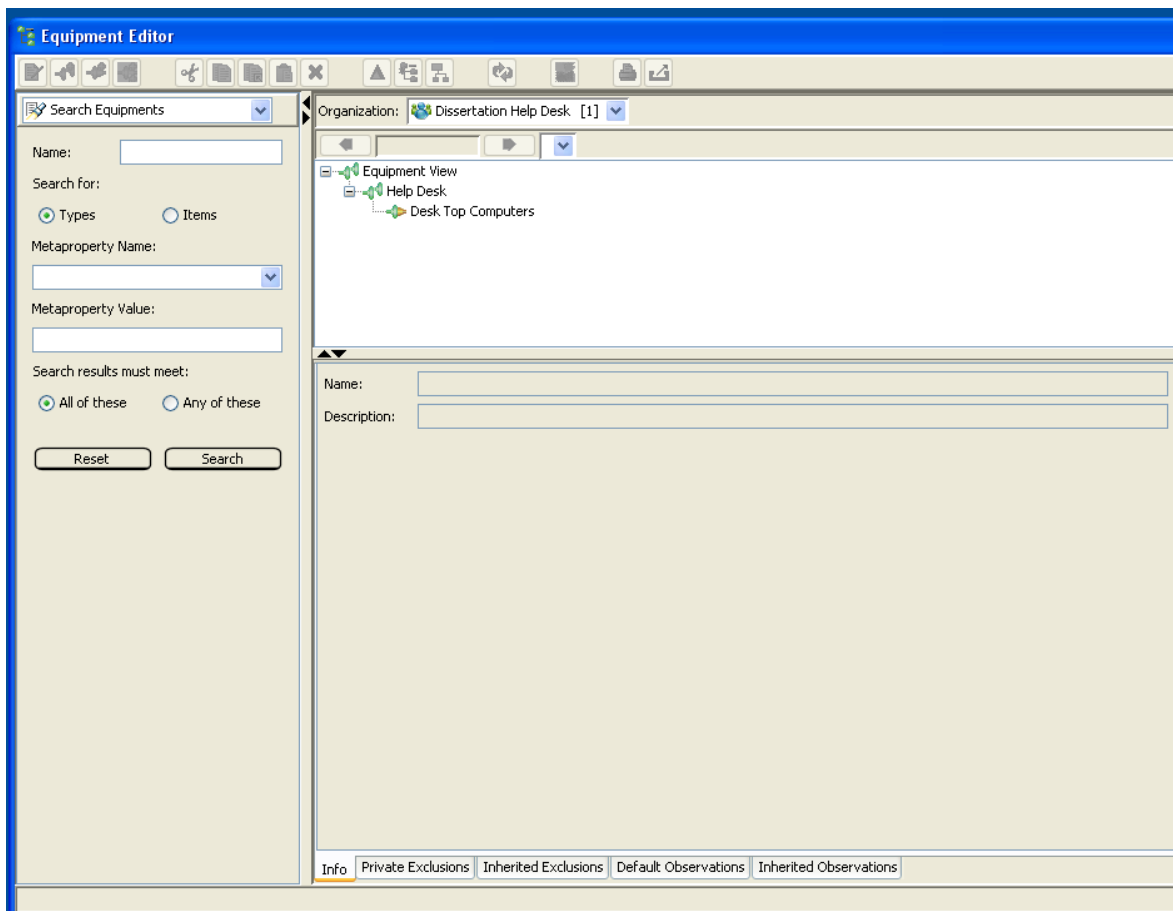
Figure 11. Equipment Editor

Domain Editor

The second major development effort entails building the Domain Editor. In this case, the Domain Editor defines the problems that may be encountered at the Help Desk with the Desk Top Computers and can be solved via the Spotlight® instance. The domain editor is where the problem categories that belong to the Help Desks' Desk Top Computers are set up. For example, the categories for this exploratory study (Audio, Data Recovery, Floppy Disk/Drives, Hard Disk/Drives, Keyboard, Mouse, Network, Optical Drives, Power Supply, Printer, Random Access Memory (RAM), Startup, System, USB, Video, and Windows) are entered into the Domain Editor along with the problems associated with each of the categories. Figure 12 shows all of the exploratory study categories (subjects) along with the first two problem areas associated with the Audio category.
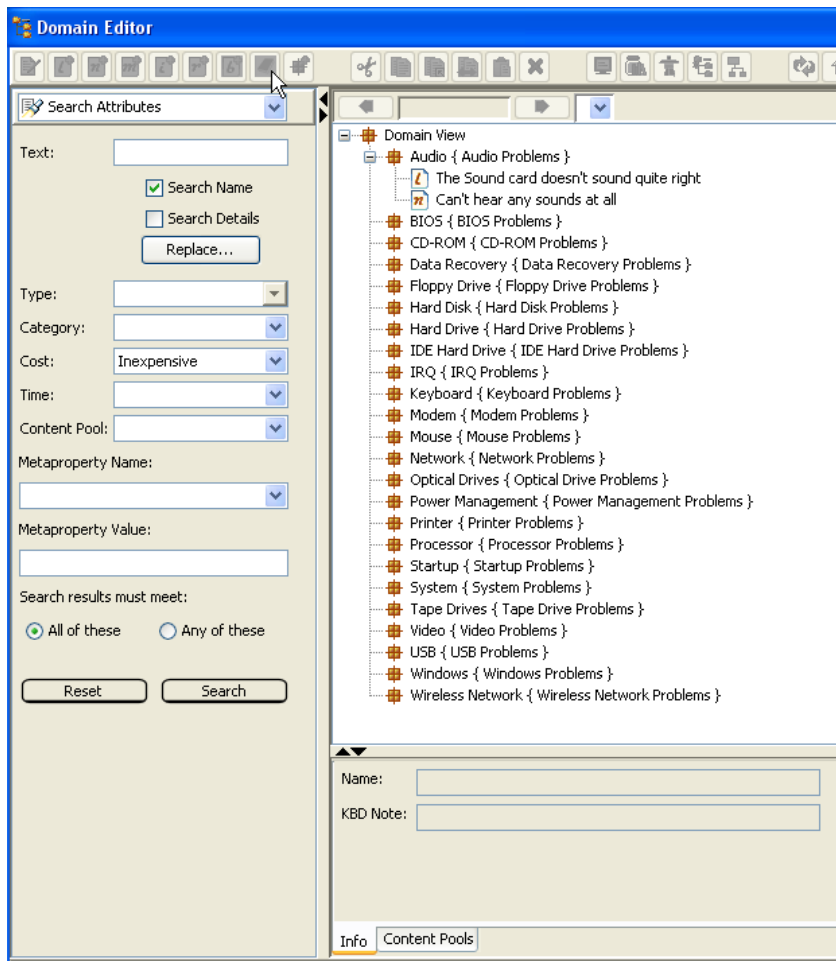
Figure 12 **Spotlight® Domain Editor listing all 24 of the exploratory study problem**

categories

For purposes of this demonstration, the first Audio problem, "The Sound card

doesn't sound quite right" will be used. When building the key elements of this problem,

attributes must be placed under each of the categories to list the problem name, the

question for the system to ask the technician, the attribute type, the category,

subcategory, cost and time, etc. Figure 13 shows the value assignment form used to enter

the appropriate values.

Figure 13. Form for entering values into the subject attributes

The form shows the name of the subject, "The Sound card doesn't sound quite right", the question to be asked of the technician when using the system, the attribute type (in this case the type is Symbolic Logical – Yes/No). The left pane of the Spotlight® form is for the entry of new categories and information pertaining to them.

The production system will have various types of attributes for each of the 24

categories (subjects) listed in Figure 12. Solutions for each of the problems under each of

these subjects (100) will have to be created. For purposes of this demonstration, a

solution was developed for the first Audio problem.

Solution Editor

The solution for the "The Sound card doesn't sound quite right" problem is

entered into the Solution Editor in the left pane of the form. In this case (Figure 14), the

solution is listed as Solution ID number 1-1, title, "Hardware resource conflict". Each of

the solution ID's are further described in the bottom right of the form (Figure 15). The

tabs at the bottom of Figure 15 are utilized to collect important data pertaining to the

solution. The current view in Figure 15 is the "Info" tab view. The "Description" tab

describes the problem, the "Observations" tab provides data to the retrieval engine that

describes the sequence, compared to other solutions, that this solution should be selected,

the "Cause" tab is the actual root cause of the problem, the "Repair" tab describes the

methodology to use when beginning to repair the problem, the "Explanation" tab gives

the reason why the problem exists, the "References" tab deals with the solution source or

where can the solution be found, the "Lessons" tab deals with lessons learned, for

example, if another solution, similar to the posted solution exists, then it will be posted in

the "Lessons" tab to insure an accurate solution, the "Notes" tab is used as a change log

where all changes to the solution ID are posted, the "Admin" tab is utilized essentially to

publish the solution so it can be utilized by the retrieval system, and the "Content Pool"

tab displays the name of the content pool in use for this equipment category.

Figure 14. Solution Editor displaying Solutions 1-1 and 1-2
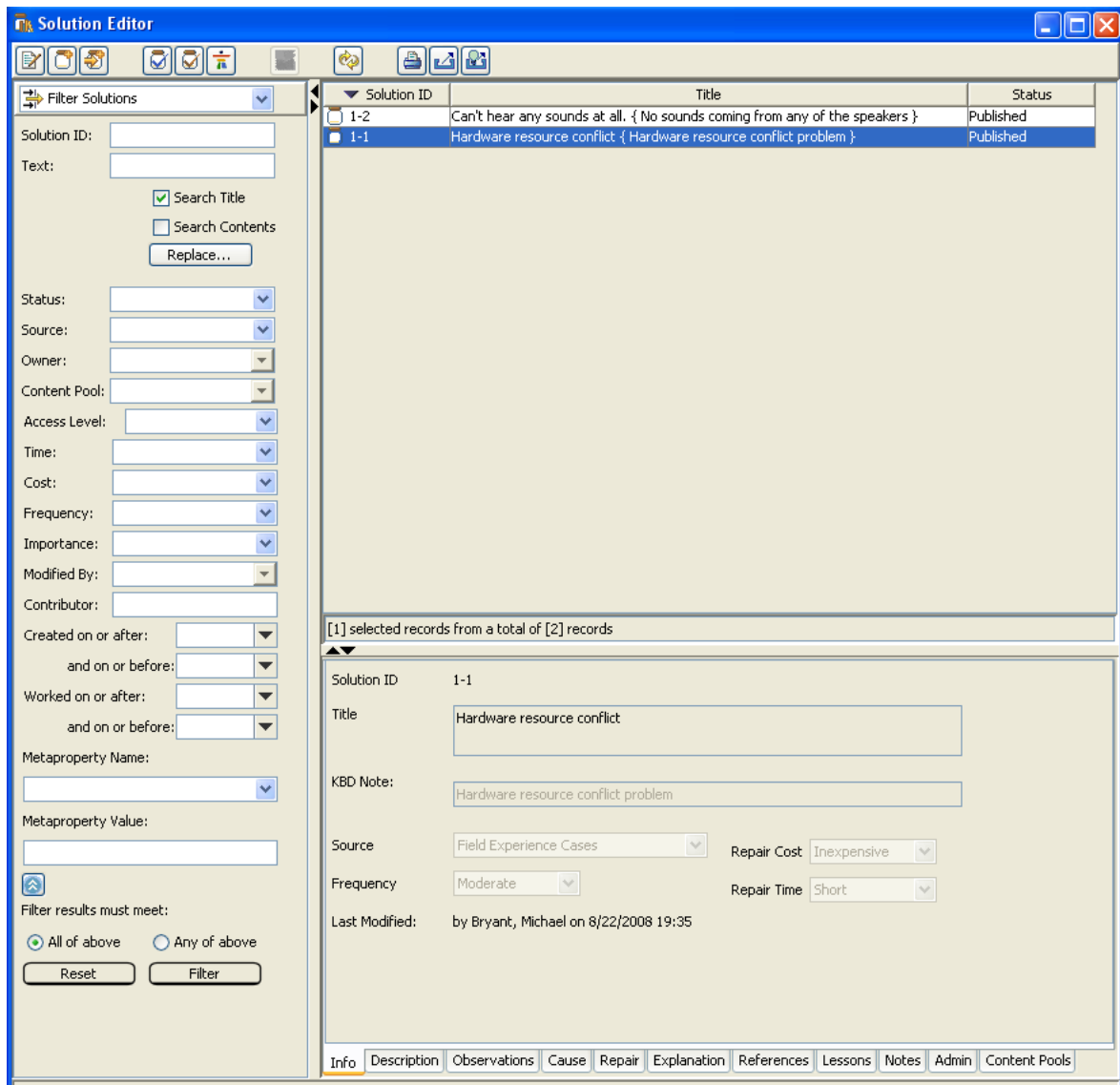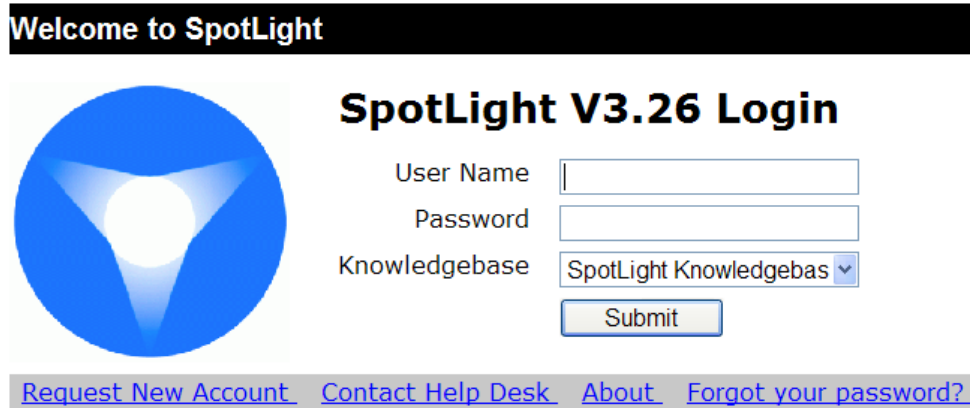
Figure 15. Problem Solution 1-1 Description Tabs

Retrieving a Solution

The Spotlight® retrieval application, or user application, is executed by the Help

Desk technician to retrieve solutions for the various problems. Figure 16 is a screen shot

of the Spotlight® Help Desk user login module. To access the casebase containing the

solutions for the Help Desk Equipment Editor, the help desk technician logs into the

system by entering the appropriate User Name and Password followed by the name of the

Knowledgebase containing the solutions for the Help Desk Equipment Editor.

Figure 16. Spotlight® User Login Screen

The technician is then presented with the form to select the Organization, the

Equipment Type, and the Equipment Unit. The screen is shown in Figure 17 showing the

Organization as "Dissertation Help Desk", the Equipment Type as "Help Desk", and the

Equipment Unit as "Desk Top Computers". Below the Equipment Unit title on the form

are two hyperlinks, "New" and "practice". For purposes of this demonstration, the
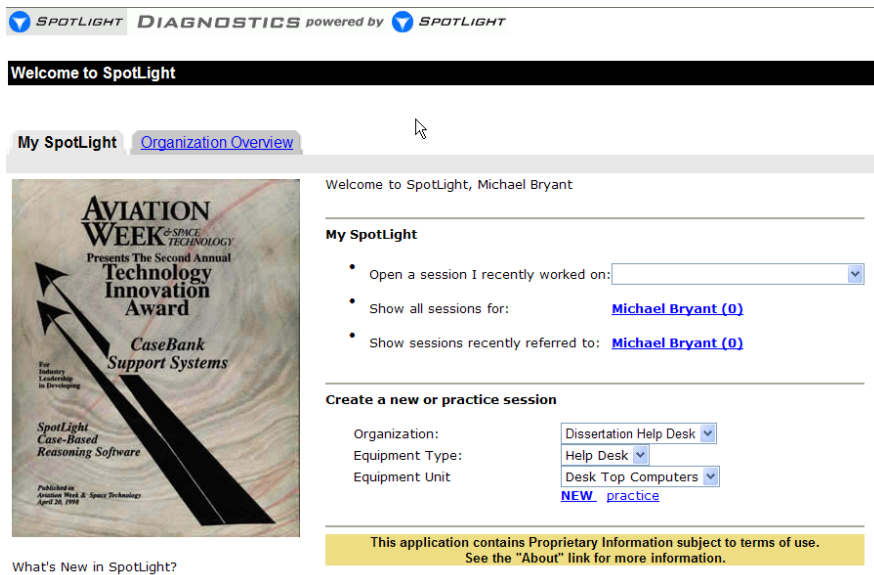
"practice" link was used.
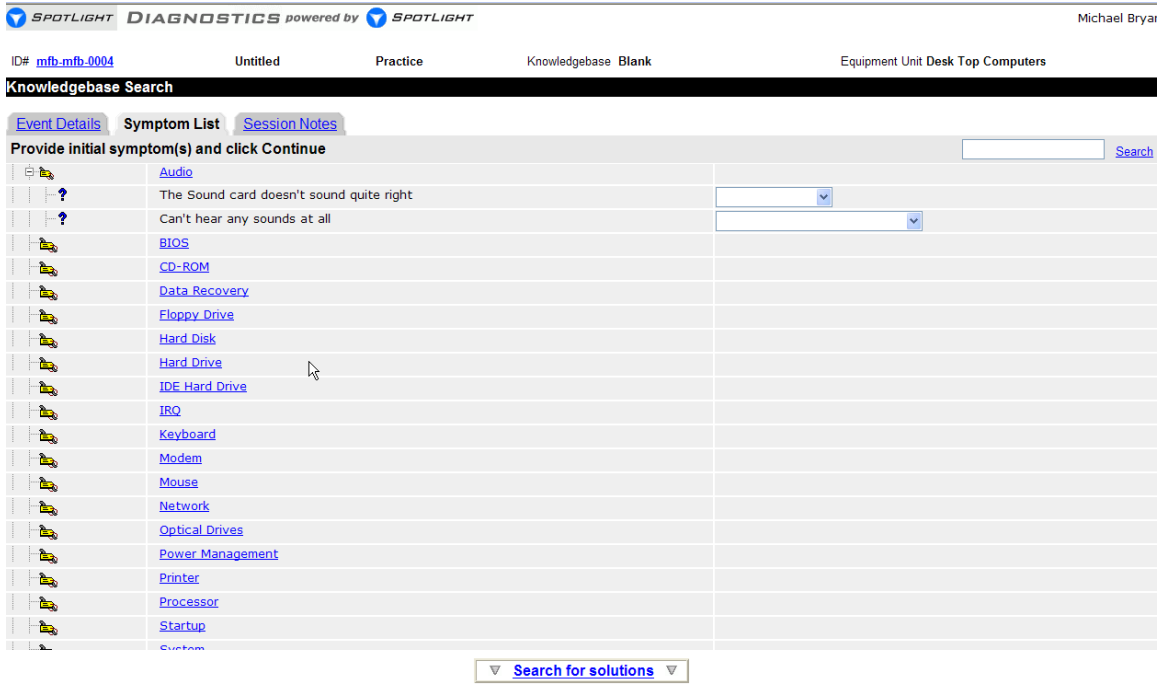
Figure 17. Session Selection Screen

Figure 18. Solution selection screen

The Solution selection screen (Figure 18) displays all of the problem domain and the first two problems under the Audio Equipment problems. The problem to be selected for this demonstration was the "The Sound card doesn't sound quite right" under Audio.

Figure 19 shows the choices presented by the drop down. The choices are "Yes", the sound card does not sound alright, or No, the sound card sounds alright. For purposes of this demonstration, the "Yes" drop down was selected.
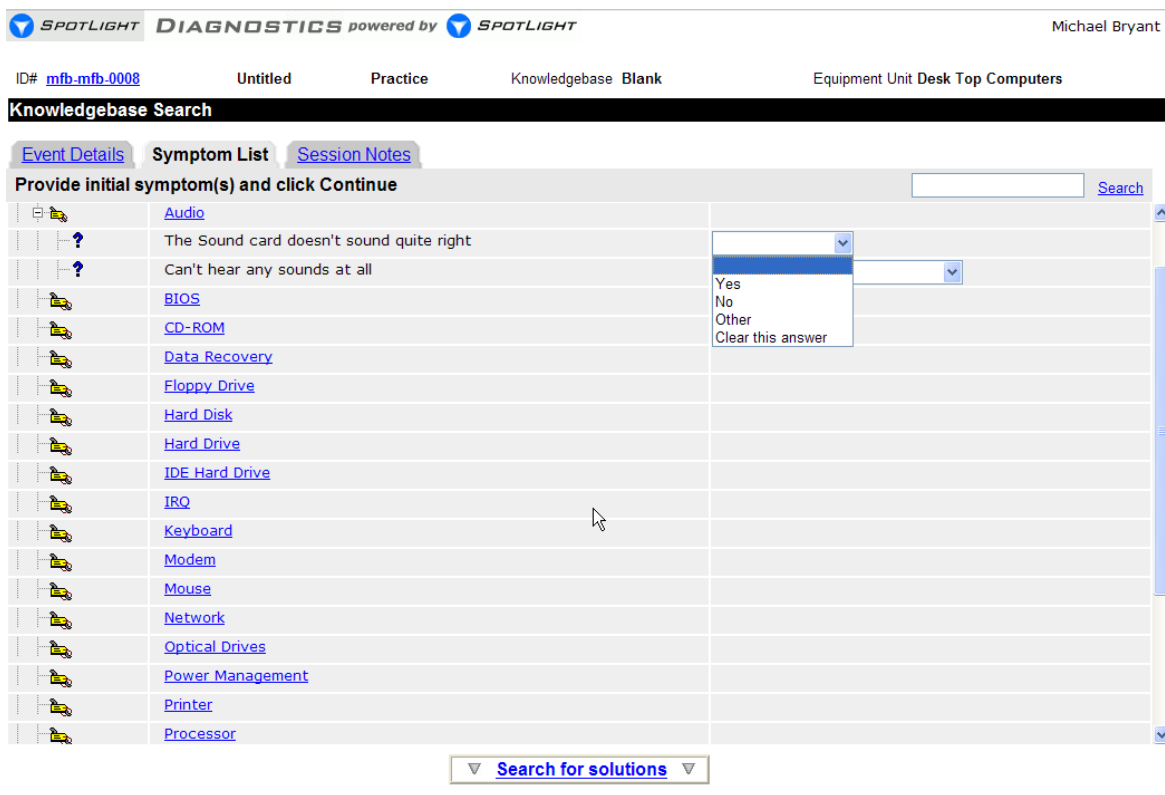

Figure 19. Selection List Drop down

Figure 20 shows the result of the query. The solution, listed at the bottom of the form, shows that the cause of the problem is a Hardware resource conflict and a Similarity factor of 100%. "Similarity" indicates how closely the symptoms resemble a

solution in the knowledgebase. It is not the probability that this solution will fix the problem and is not the number of times this problem has occurred.
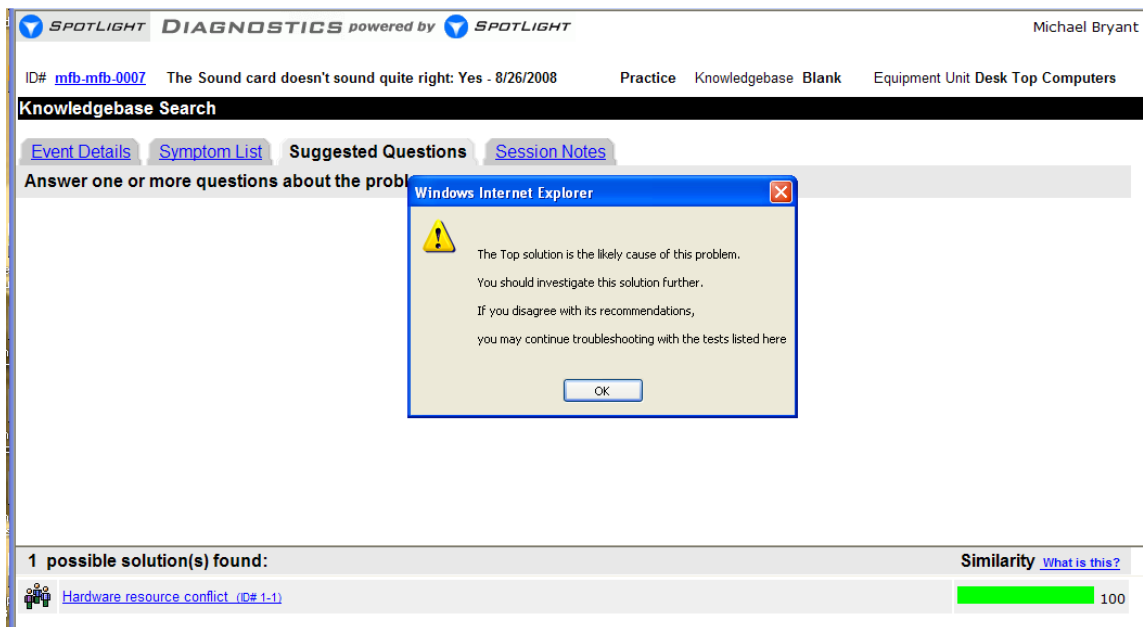

Figure 20. Solution Screen

If there were more than one possible solution for the problem, they would be listed on this media in order of their similarity factor.

Appendix D

Problem and Solution Listing

The 100 PC hardware/software related problems, taken from Scott Mueller's

Upgrading and Repairing PCs, 16th Edition, entered into the CORVID™ rule-based and

Casebank Spotlight® case-base system are as follows:

AUDIO

1. **Symptom: "sound card doesn't sound quite right"**

   Cause: Hardware resource conflict

   Solution(s): Use Windows Device Manager to find conflicts and resolve
                   them.

   Source: Page(s) 379, 1484.

2. **Symptom: "Cannot hear any sounds at all"**

   Cause: Various causes:

   Incorrect or defective speaker jack/plug
   Mixer controls

   Solution(s):

   - Make sure the audio adapter is set to use all default resources and
     that all other devices using these resources have been either
     reconfigured or removed if they cause a conflict. Use the device
     manager to determine this information.
   - Are the speakers connected? Check that the speakers are plugged
     into the sound card's stereo line-out or speaker jack (not the line-in
     or microphone jack)
   - Are the speakers receiving power? Check that the power "brick"
     or power cord in plugged in securely and that the speakers are
     turned on
   - Are the speakers stereo? Check that the plug inserted into the jack
     is a stereo plug, not mono
   - Are the mixer settings correct? Many audio adapters include a
     sound mixer application. The mixer controls the volume settings

for various sound devices, such as the microphone or the CD player. There might be separate controls for both recording and playback. Increase the master volume or speaker volume when you are in the play mode.

- If the mute option is selected in your sound mixer software, you won't hear anything. Depending on the speaker type and sound source type, you might need to switch from analog to digital sound for some types of sound output. Make sure that the correct digital audio volume controls are enabled in your audio device's mixer control.
- Use your audio adapter's setup or diagnostic software to test and adjust the volume of the adapter. Such software usually includes sample sounds used to test the adapter.
- Turn off your computer for 1 minute and turn it back on. A hard reset (as opposed to a pressing the Reset button or pressing Ctrl+Alt+Delete) might clear the problem.

Source: Page(s) 972, 1484

3. "Can hear sound through only one speaker"

Cause: Various causes including incorrect or defective speaker jack/plug, mixer controls, and others

Solution(s): If you hear sound coming from only one speaker, check out these possible causes:

- Are you using a mono plug in the stereo jack? A common mistake is to use a mono plug in the sound card's speaker or stereo-out jacks. Seen from the side, a stereo connector has two darker stripes. A mono connector has only one stripe.
- If you're using amplified speakers, are they powered on? Check the strength of the batteries or the AC adapter's connection to the electrical outlet. If each speaker is powered separately, be sure that both have working batteries.
- Are the speakers wired correctly? When possible, use keyed and color-coded connectors to avoid mistakes.
- Is the audio adapter driver loaded? Some sound cards provide only left-channel sound if the driver is not loaded correctly. Rerun your adapter's setup software or reinstall it in the operating system.
- Are both speakers set to the same volume? Some speakers use separate volume controls on each speaker. Balance them for best results. Separate speaker volume controls can be an advantage if one speaker must be farther away from the user than the other.

- Is the speaker jack loose? If you find that plugging your speaker into the jack properly doesn't produce sound but pulling the plug half-way out or "jimmying" it around in its hole can temporarily correct the problem, you're on the road to a speaker jack failure. There's no easy solution; buy a new adapter or whip out your soldering iron and spend a lot more time on the test bench than most audio adapters are worth. To avoid damage to the speaker jack, be sure you insert the plug straight in, not at an angle.

Source: Page(s) 973, 1484

4. "Volume is low"

Cause: Various causes, e.g. incorrect connections, mixer setup, power, etc.

If you can barely hear your sound card, try these solutions:

- Are the speakers plugged into the proper jack? Speakers require a higher level of drive signal than headphones. Again, adjust the volume level in your mixer application.
- Are the mixer settings too low? Again, adjust the volume level in your mixer application. If your mixer lets you choose between speakers and headphones, be sure to select the correct speaker configuration.
- Is the initial volume too low? If your audio adapter has an external thumbwheel volume control located on the card bracket, check to ensure that it is not turned down too low. Check the speakers' own volume controls as well.
- Are the speakers too weak? Some speakers might need more power than your audio adapter can produce. Try other speakers or put a stereo amplifier between your sound card and speakers.

Source: Page(s) 974, 1484

5. "Computer will not start after installing sound card"

Cause: Various causes:

- You might not have inserted the audio adapter completely into its slot. Turn off the PC and then press firmly on the card until it is seated correctly.
- If you cannot start your computer after installing a new sound card and its drivers, you can use the Windows "bootlog" feature to record every event during startup; this file records which hardware

drivers are loaded during startup and indicates whether the file loaded successfully, didn't load successfully, or froze the computer. See the documentation for your version of Windows for details on how to create a bootlog when necessary.

Source: Page(s) 975, 1484

6. "Cannot use onboard audio"

Cause: Audio might be disabled in BIOS

Solution: Enable audio

Source: Page(s) 437, 1484

BIOS

7. "Cannot install Flash BIOS update"

Cause: BIOS is write protected

Solution: Disable write protection

Source: Page(s) 420, 1484

8. "BIOS update fails"

Cause: BIOS is corrupted

Solution: Enable Flash Recovery feature and restart update process

Source: Page(s) 423, 1484

CD-ROM

9. "Cannot boot from CD-ROM drive"

Cause: BIOS is out of date

Solution: Upgrade Flash BIOS

Source: Page(s) 415, 1484

DATA RECOVERY

10. "Cannot retrieve a particular file stored on a system running Windows

NT/2000/XP"

        Cause: Hard drive sector damage or damage to the NTFS attribute table.

        Solution: An improved version of RECOVER that recovers data from a specified file is only one of the command-line programs provided with Windows NT, 2000, and XP. To use this version of RECOVER, which works with both FAT and NTFS file systems, open a command prompt and enter the command as shown here:

        RECOVER (drive\folder\filename)

        For example, to recover all readable sectors from a file called Mynovel.txt stored in C:\My Documents\Writings, you would enter the following command:

        RECOVER C:\My Documents\Writings\Mynovel.txt

        Because the NT/2000/XP version of RECOVER requires you to specify a filename and path, it cannot destroy a file system the way the DOS RECOVER command could. However, you should not use wildcards with the NT/2000/XP version of RECOVER. Instead, specify a single filename as shown in this example, or use a third-party tool such as Norton Disk Doctor to check the drive and attempt data recovery from damaged files.

        Source: Page(s) 1393, 1485

11. "Cannot locate files on a FAT disk after it was formatted"

        Cause: The file allocation tables (FATs) are cleared as part of the format process.

        Solution: Use third-party utilities to retrieve files.

        Source: Page(s) 1398, 1403, 1485

FLOPPY DRIVE

12. "Disks placed on top of a TV or monitor has data errors when read"

        Causes: Various as listed below.

        Disks can be damaged or destroyed easily by the following:

- Touching the recording surface with your fingers or anything else
- Writing on a disk label (which has been affixed to a disk) with a ball-point pen or pencil
- Bending the disk

- Spilling coffee or other substances on the disk
- Overheating a disk (leaving it in the hot sun or near a radiator, for example)
- Exposing a disk to stray magnetic fields, for example, all color monitors (and color TV sets) that use cathode-ray tube (CRT) technology have a degaussing coil around the face of the tube that demagnetizes the shadow mask when you turn on the monitor. If you keep your disks anywhere near (within 1[pr] of) the front of a color monitor, you expose them to a strong magnetic field every time you turn on the monitor. Keeping disks in this area is not a good idea because the field is designed to demagnetize objects, and it indeed works well for demagnetizing disks. The effect is cumulative and irreversible. Note that LCD or plasma displays don't have degaussing coils and therefore do not affect magnetic media.

Solution: Data has been destroyed and cannot be recovered.

Source: Page(s) 702, 1485

13. "Contents of all floppy disks viewed appear to be duplicates of the first disk, although the contents of each disk are different"

Cause: Changeline support (which detects disk changes) has failed; this problem is also called the "phantom directory."

Solution: Verify BIOS setup for drive is correct and that DC jumper (if any) has been set.

Source: Page(s) 698, 1485

HARD DISK

14. "Cannot access full capacity of hard drive over 8.4GB"

Cause: BIOS does not support drives with capacity of 8.4GB

Solution: For most BIOS upgrades, you must contact the motherboard manufacturer by phone or download the upgrade from its Web site. The BIOS manufacturers do not offer BIOS upgrades because the BIOS in your motherboard did not actually come from them. In other words, although you think you have a Phoenix, AMI, or Award BIOS, you really don't! Instead, you have a custom version of one of these BIOS, which was licensed by your motherboard manufacturer and uniquely customized for its board. As such, you must get any BIOSs upgrades from the

motherboard or system manufacturer because they must be customized for your board or system as well.

If BIOS upgrade is not available, you need to install an add-on BIOS card with EDD Support.

Source: Page(s) 415, 576, 1486

15. "Cannot use drive capacity beyond 528MB"

Cause: LBA mode not enabled in BIOS

Solution: Enable LBA mode.

Source: Page(s) 439, 1486

16. "Large number of files ending in .CHK are found in root directory of drive"

Cause: .CHK files are created by SCANDISK or CHKDSK from lost allocation units

Solution: Shut down system properly to avoid lost allocation units; test drive if problem persists; delete files to free up space.

Source: Page(s) 1398, 1403, 1485

HARD DRIVE

17. "UDMA/66 or UDMA/100 drive runs at UDMA/33 on systems that support UDMA/66 or UDMA/100"

Cause: Improper cable.

Solution: ATA-4 made ATAPI support a full part of the ATA standard, and thus ATAPI was no longer an auxiliary interface to ATA but merged completely within it. Thus, ATA-4 promoted ATA for use as an interface for many other types of devices. ATA-4 also added support for new Ultra-DMA modes (also called Ultra-ATA) for even faster data transfer. The highest-performance mode, called UDMA/33, had 33MBps bandwidth—twice that of the fastest programmed I/O mode or DMA mode previously supported. In addition to the higher transfer rate, because UDMA modes relieve the load on the processor, further performance gains were realized.

An optional 80-conductor cable (with cable select) is defined for UDMA/33 transfers. Although this cable was originally defined as optional, it would later be required for the faster ATA/66, ATA/100, and ATA/133 modes in ATA-5 and later.

Many hard drives purchased in retail kits include the 80-conductor cable, although other types of devices, such as optical drives, include only a 40-conductor cable.

Support for a reserved area on the drive called the host protected area (HPA) was added via an optional SET MAX ADDRESS command. This enables an area of the drive to be reserved for recovery software.

Also included was support for queuing commands, which is similar to that provided in SCSI-2. This enabled better multitasking as multiple programs make requests for ATA transfers.

Replace the 40 pin connector cable with the 80 pin connector cable.

Source: Page(s) 540, 1486

18. The error message "Immediately back up your data and replace your hard disk drive. A failure may be imminent." is seen

Cause: The drive uses SMART to predict back up failures, and the SMART system has detected a serious problem with the drive.

Solution: Follow the onscreen instructions to back up your drive.

Source: Page(s) 682, 1487

19. "Windows 98 FDISK misidentifies the capacity of a drive over 64GB"

Cause: FDISK incorrectly reads the disk capacity.

Solution: Download an updated version of FDISK from Microsoft's Web site.

Source: Page(s) 675, 1487

20. "Invalid Drive Specification error"

Cause: Drive has not been partitioned or high-level formatted, or wrong OS is being used to view drive.

Solution: Verify drive is empty with recent Windows versions before running FDISK and FORMAT.

Source: Page(s) 857, 1487

21. "Invalid Media Type error"

Cause: Drive has not been FDISKed, or drive's format is corrupt.

Solution: View drive with FDISK's #4 option, and create new partitions as necessary.

Source: Page(s) 857, 1487

IDE HARD DRIVE

22. "Cannot detect drive with BIOS setup program"

Cause: Power cable might be loose or missing.

Solution: Reattach power cable.

Source: Page(s) 841, 1487

23. "Cannot detect either drive on cable with BIOS setup program"

Cause: Both drives might be cabled as master or slave.

Solution: Change one drive to master and the other to slave.

Source: Page(s) 833, 1487

24. "Drive does not perform reliably"

Cause: IDE cable may be longer than 18 inches.

Solution: Switch to 18 inch cable.

Source: Page(s) 835, 1487

IRQ

25. "Conflicts between PCI devices"

Cause: PCI IRQ steering not enabled

Solution: Enable PCI IRQ steering

Source: Page(s) 370, 1488

26. "Conflicts between COM ports"

> **Cause:** IRQs shared between COM1 and 3; between COM2 and 4

> **Solution:** Disable unused COM port or change IRQ if possible.

> **Source:** Page(s) 373, 1488

KEYBOARD

27. "Num Lock stays off when starting system"

> **Cause:** Num Lock turned off in BIOS

> **Solution:** Turn on the Num Lock in the BIOS.

> **Source:** Page(s) 434, 1488

28. "Intermittent keyboard failures"

> **Causes:** Keyboard errors are usually caused by two simple problems. Other more difficult, intermittent problems can arise, but they are much less common. The most frequent problems are defective cables and stuck keys.

> **Solutions:** Defective cables are easy to spot if the failure is not intermittent. If the keyboard stops working altogether or every keystroke results in an error or incorrect character, the cable is likely the culprit. Troubleshooting is simple, especially if you have a spare cable on hand. Simply replace the suspected cable with one from a known, working keyboard to verify whether the problem still exists. If it does, the problem must be elsewhere.

Many times you first discover a problem with a keyboard because the system has an error during the POST. Many systems use error codes in a 3xx numeric format to distinguish the keyboard. If you encounter any such errors during the POST, write them down. Some BIOS versions do not use cryptic numeric error codes; they simply state something such as the following:

Keyboard stuck key failure

This message is usually displayed by a system with a Phoenix BIOS if a key is stuck. Unfortunately, the message does not identify which key it is! If your system displays a 3xx (keyboard) error preceded by a two-digit hexadecimal number, the number is the scan code of a failing or stuck keyswitch. Look up the scan code in the tables provided in the Technical Reference to determine which keyswitch is the culprit. By removing the keycap of the offending key and cleaning the switch, you often can solve the problem.

Source: Page(s) 1033, 1488

29. "Wireless keyboard does not work at some angles relative to the computer

Cause: IR sensors in the keyboard and on the computer are losing line-of-sight connectivity.

Solution: Reposition IR sensor connected to the computer to maintain line-of-sight.

Source: Scott Mueller's Upgrading and Repairing PCs, 16th Edition, p. 1053, 1488

30. "Wireless keyboard does not work at long distances (such as with a Media Center PC and big-screen display"

Cause: Conventional wireless devices have a 6 foot range.

Solution: Use Bluetooth-enabled keyboard to have a range of up to 30 feet.

Source: Page(s) 1053, 1488

31. "Wireless keyboard stops working after you moved the computer

Cause: The most common cause is that the received might be disconnected from the USB or keyboard port.

Solution: Reconnect the receiver and resynchronize the keyboard and receiver.

Other causes are:

Cause: Battery failure. The transceivers attached to the computer are powered by the computer, but the input devices themselves are battery-powered.

Solution: Check the battery life suggestions published by the vendor; if your unit isn't running as long as it should, try using a better brand of battery or turning off the device if possible.

Cause: Lost synchronization between device and transceiver. Both the device and the transceiver must be using the same frequency to communicate.

Solution: Depending on the device, you might be able to resynchronize the device and transceiver by pressing a button, or you might need to remove the battery, reinsert the battery, and wait for several minutes to reestablish contact.

Cause: Interference between units.

Solution: Check the transmission range of the transceivers in your wireless units and visit the manufacturer's Web site for details on how to reduce interference. Typically, you should use different frequencies for wireless devices on adjacent computers.

Cause: Blocked line of sight.
Solution: If you are using infrared wireless devices, check the line of sight carefully at the computer, the space between your device and the computer, and the device itself. You might be dangling a finger or two over the infrared eye and cutting off the signal—the equivalent of putting your finger over the lens on a camera.

Cause: Serial port IRQ conflicts.

Solution: If the wireless mouse is connected to a serial port and it stops working after you install another add-on card, check for conflicts using the Windows Device Manager.
Cause: USB Legacy support not enabled.

Solution: If your wireless keyboard uses a transceiver connected to the USB port and the device works in Windows, but not at a command prompt, make sure you have enabled USB Legacy support in the BIOS or use the PS/2 connector from the transceiver to connect to the PS/2 keyboard port.

Source: Page(s) 1056, 1488

32. "Standard keys on keyboard work, but not multimedia or internet keys"

Cause: The keyboard driver is not installed or is defective.

Solution: Install the latest driver for your keyboard.

Source: Page(s) 1033, 1488

MODEM

     33. "Modem works correctly with internet access, but computer-to-computer terminal emulation produces garbage screens"

     Cause: Incorrect bps, word length, stop bit, or terminal emulation settings compared to remote system's requirements.

     Solution: Determine correct values for remote system and set up Hyper Terminal or other connection program accordingly.

     Source: Page(s) 1005, 1488

     34. "Modem drops calls unexpectedly"

     Cause: You might have call-waiting enabled, which interrupts the modem carrier signal.

     Solution: Disable call-waiting (ask phone company for detail), or upgrade to modems with call-waiting support.

     Source: Page(s) 1092, 1489

MOUSE

     35. "Mouse doesn't work"

     Cause: Hardware resource conflict.

     Solution: Use Windows Device Manager to find conflicts and resolve them.

     Source: Page(s) 379, 1489

     36. "Cannot use PS/2 mouse"

     Cause: PS/2 mouse port might be disabled.

     Solution: Enable PS/2 mouse port.

37. "Mouse pointer jerks on screen"

Cause: Mouse ball or rollers are dirty.

Solution: Clean mouse ball and/or rollers.

38. "Wireless mouse doesn't work at some angles relative to the computer"

Cause: IR sensors in the mouse and on the computer are losing line-of-sight connectivity.

Solution: Reposition IR sensor connected to the computer to maintain line-of-sight.

39. "Wireless mouse stops working after you move the computer"

Cause: The most common cause is that the receiver might be disconnected from the USB or mouse port.

Solution: Reconnect the receiver and resynchronize the mouse and receiver.

Other causes are:

Cause: *Battery failure.* The transceivers attached to the computer are powered by the computer, but the input devices themselves are battery-powered.

Solution: Check the battery life suggestions published by the vendor; if your unit isn't running as long as it should, try using a better brand of battery or turning off the device if possible.

Cause: *Lost synchronization between device and transceiver.* Both the device and the transceiver must be using the same frequency to communicate.

Solution: Depending on the device, you might be able to resynchronize the device and transceiver by pressing a button, or you might need to

remove the battery, reinsert the battery, and wait for several minutes to reestablish contact.

Cause: *Interference between units.*

Solution: Check the transmission range of the transceivers in your wireless units and visit the manufacturer's Web site for details on how to reduce interference. Typically, you should use different frequencies for wireless devices on adjacent computers.

Cause: *Blocked line of sight.*

Solution: If you are using infrared wireless devices, check the line of sight carefully at the computer, the space between your device and the computer, and the device itself. You might be dangling a finger or two over the infrared eye and cutting off the signal—the equivalent of putting your finger over the lens on a camera.

Cause: *Serial port IRQ conflicts.*

Solution: If the wireless mouse is connected to a serial port and it stops working after you install another add-on card, check for conflicts using the Windows Device Manager.

Cause: *USB Legacy support not enabled.*

Solution: If your wireless keyboard uses a transceiver connected to the USB port and the device works in Windows, but not at a command prompt, make sure you have enabled USB Legacy support in the BIOS or use the PS/2 connector from the transceiver to connect to the PS/2 keyboard port.

Source: Page(s) 1056, 1489

40. "Mouse works for basic operations, but extra buttons or scroll does not work"

Cause: Incorrect or outdated mouse driver is being used.

Solution: Download and install correct mouse driver from vendor site.

Source: Page(s) 1037, 1489

41. "Mouse works in Windows but not when booted to DOS"

Cause: DOS driver must be loaded from AUTOEXEC.BAT or

CONFIG.SYS

Solution: Install DOS mouse driver, and reference it in startup file(s).

Source: Page(s) 1046, 1489

NETWORK

42. System locks up after installing network card"

Cause: IRQ conflicts with other ports or devices.

Solution: Use Windows Device Manager to find conflicts and resolve

them.

Source: Page(s) 379, 1489

43. "Duplicate computer ID error"

Cause: More than one computer has the same name of IP address on the

network.

Solution: Ensure all computers on the network have different IP
addresses. To do this, adjust computer name or IP address with the Network properties
sheet.

Source: Page(s) 1148, 1490

**44. "Cannot connect to other computers on network after installing a new
custom-built cable"**

Cause: Cable might not match prevailing wiring standard on network.

Solution: Check wiring of other cables to see which wiring standard is
used; build new cable to match.

Source: Page(s) 1123, 1489

45. "Network changes made but do not work"

Cause: Most Windows systems must be rebooted to put network changes into effect.

Solution: Reboot system and then try network operations.

Source: Page(s) 1148, 1490

46. "One user can not access network, but others can"

Cause(s): There are three common causes for this problem:

(1) User might not have logged on to the network

(2) Loose cables at computer, hub, switch, or wiring closet

(3) Password cache might be corrupt or have outdated passwords.

Solution(s): The most common solutions to these problems are as follows:

(1) Log off system and log back on; provide name and password when prompted

(2) Check all cable connections

(3) Log on to resources again and give new password when prompted

Source: Page(s) 1149, 1490

47. "Cannot connect to other users on network, although card diagnostics check out"

Cause: Might not have correct network software components installed.

Solution: See below checklist:

Item	Workstation	Server
Windows Network client	Yes	No
NetBEUI or TCP/IP* protocol	Yes	Yes

File and print sharing for Microsoft Networks	No	Yes
NIC installed and bound to protocols and services above	Yes	Yes
Workgroup identification (same for all PCs in workgroup)	Yes	Yes
Computer name (each PC needs a unique name)	Yes	Yes

Source: Page(s) 1146, 1490

48. "Distant computer works with 10BASE-T network but not with Fast Ethernet"

Cause: Computer might be too far from hub or switch because Fast Ethernet has shorter maximum distance.

Solution: Install repeater, or use new switch/hub as repeater.

Source: Page(s) 1126, 1490

49. "Users cannot share printers or folders with others"

Cause: File/Print sharing might not be installed; folders or printers might not be set to shared.

Solution: Install File/Print sharing, and then set shared folders and printers.

Source: Page(s) 1148, 1490

50. "IP Address Conflict error"

Cause: Duplicate IP addresses on two or more machines.

Solutions: Open Network properties sheet and adjust TCP/IP settings as needed for your network.

Source: Page(s) 1149, 1490

51. "Need to create a NetBEUI network using Windows XP"

Cause: Cannot select NetBEUI as an option.

Solution: Install NetBEUI manually from the Windows XP CD-ROM.\

Source: Page(s) 1136, 1490

OPTICAL DRIVES

52. "Drive slows down when reading CD with a small paper label attached to the label side"

Cause: Drive cannot run at full speed due to uneven weight distribution and must slow down.

Solution: Use full-size labels that cover the entire CD's top surface, or use a marker instead of small labels.

Source: Page(s) 786, 1490

53. "Cannot read CD-R or CD-RW disc on a CD-ROM drive, but only on a CD-R/CD-RW drive"

Cause: CD was probably created with packet-writing software and was not closed before being removed.

Solution: Return CD-R or CD-RW disc to original system and close session.

Source: Page(s) 771, 1490

54. "Drive runs very slowly or has read errors"

Cause: CD lens might be dirty or dusty

Solution: Use a CD lens cleaner, or install a drive with a self-cleaning lens.

Source: Page(s) 798, 826, 1491

55. "Cannot write to CD-RW or DVD-RW 1x media"

Cause(s): There are six common causes for this problem:

(1) Media might not be formatted

(2) Media formatted with different UDF program

(3) Media might not be correctly identified

(4) UDF packet-writing software might not support drive

(5) Disc might have been formatted with Windows XP's own CD-writing software

(6) Drive firmware might be out of date

Solution(s): There are six common solutions for these problems:

(1) Format media with UDF packet-writing software before use

(2) Use same UDF packet-writing software to format media and write to media

(3) Eject and reinsert media to force redetection

(4) Contact software vendor for an update

(5) Erase media with Windows XP's CD writing software and reformat with preferred UDF solution.

(6) Update firmware

Source: Page(s) 827, 828, 1491

56. "CD-RW or rewriteable DVD drive writes to some types of media more slowly than others"

Cause: Drive firmware might not be fully compatible with media type in use

Solution: Download and install latest firmware for drive

Source: Page(s) 828, 1491

57. "Cannot create writeable DVD"

Cause(s): There are several common causes that prevent the creation of a writeable DVD:

(1) Incorrect media

(2) Wrong type of project selected in CD/DVD mastering software

(3) Wrong drive selected

(4) Media may be bad

Solution(s):

(1) Use +R media in DVD+RW drives; use –R media DVD-RW drives; either type works in dual mode drives

(2) Select DVD Project in mastering software

(3) Select correct drive

(4) Try different media

Source: Page(s) 826, 1492

58. "Cannot boot from bootable CD"

Cause(s): There are three probable causes for not being able to boot from a bootable CD:

(1) System might not support bootable CDs

(2) Wrong disc format (Joliet or other)

(3) SCSI drive and host adapter might not be configured as bootable

Solution(s): There are three probable solutions for not being able to boot from a bootable CD:

(1) Verify CD-ROM listed as bootable device and listed first in boot

(2) Must use ISO 9660 CD format

(3) Enable BIOS on SCSI adapter and disable IDE boo devices in system BIOS

Source: Page(s) 828, 1493

59. "Cannot read CD-RW media on MultiRead CD-ROM drive"

Cause: Compatible UDF reader might not be installed.

Solution: Install UDF reader from CD-RW disc or by downloading reader from software vendor.

Source: Page(s) 826, 1491

60. "Cannot read CD-RW media on an older drive"

Cause: Drives that aren't MultiRead compliant cannot read CD-RW media (usually slower than 24x speed.

Solution: Replace drive with a MultiRead compatible CD-ROM or DVD drive or a CD-RW drive.

Source: Page(s) 806, 1491

61. "Cannot install new drive firmware"

Cause: Drive is being controlled by other software.

Solution: Disable CD-writing software before performing firmware update.

Source: Page(s) 830, 1491

POWER MANAGEMENT

62. "System cannot use power management features"

Cause: Power Management is disabled.

Solution: Enable power management.

Source: Page(s) 446, 1493

63. "Cannot use ACPI power management"

Cause: BIOS is out-of-date.

Solution: Upgrade Flash BIOS.

Source: Page(s) 415, 1493

PRINTER

64. "Your printer prints gibberish"

Cause: Hardware resource conflict if the correct driver is used.

Solution: Use Windows Device Manager to find conflicts and resolve

them.

Source: Page(s) 379, 1494

PROCESSOR

65. "Improper CPU identification during POST"

Cause: Old BIOS.

Solution: Update BIOS from manufacturer.

Source: Page(s) 198, 1494

66. "Cannot install newer processors"

Cause: BIOS is out-of-date.

Solution: Upgrade Flash BIOS.

Source: Page(s) 415, 1495

STARTUP

67. "System will not start, no error messages on screen"

Cause: Various fatal errors

Solution: Install POST care; restart system to determine error codes and diagnose problem.

Source: Page(s) 453, 1496

68. "System won't start, various error messages indicating system cannot boot"

Cause: Hard disk might not be connected to system, partitioned, formatted, or set up correctly in BIOS

Solution: Check drive cabling, drive partitions, and BIOS configuration

Source: Page(s) 454, 1496

69. "System beeps several times, does not start properly"

Cause: Serious or fatal hardware errors.

Solution: Count the beeps and pattern; determine BIOS used and look up beep code to determine problem.

Source: Page(s) 1287, 1497

70. "System displays error message when turned on; doesn't start properly"

Cause: Serious hardware error.

Solution: Look up error code in technical reference located on CD

Source: Page(s) 1288, 1497

71. **"Invalid drive specification error"**

Cause: No partition on disk.

Solution: Use FDISK or equivalent to partition drive.

Source: Page(s) 1415, 1497

SYSTEM

72. **"System unstable when overclocking"**

Cause: Incorrect voltage to processor

Solution: Use motherboard that allows fine adjustments to processor

voltage.

Source: Page(s) 58, 1497

73. **"System is dead, no beeps, no cursor, no fan"**

Cause(s): There are four common causes to this problem:

(1) Power cord failure

(2) Power supply failure

(3) Motherboard failure

(4) Memory failure

Solution(s): There are four common solutions to this problem:

(1) Plug in or replace power cord

(2) Replace power supply with known good one

(3) Replace motherboard with known good one

(4) Remove all memory except bank 1 and retest; swap bank 1 if no boot.

74. "System is dead, no beeps, or locks up before POST begins"

Cause: All components either not installed or incorrectly installed.

Solution: Check all peripherals, especially memory and graphics adapter.

Reseat all boards and socketed components.

75. "System beeps on startup, fan is running, no cursor onscreen. Locks up during or shortly after POST"

Cause(s): There are three common causes of this problem:

(1) Improperly seated or failing graphics adapter

(2) Poor heat dissipation

(3) Improper voltage settings

Solution(s):

(1) Reseat or replace graphics adapter. Use known good spare for testing

(2) Check CPU heatsink/fan; replace if necessary; use one with higher capacity.

(3) Set motherboard for proper core processor voltage

76. "System powers up, fan is running, but no beep or cursor"

Cause: Processor not properly installed

Solution: Reseat or remove and reinstall processor and heatsink

77. "System locks up after running for a time"

Cause: Overheating

Solution: Check case and processor fans

Source: Page(s) 1321, 1498

78. "System locks up when office equipment such as copiers or microwave ovens nearby are operated"

Cause: Corrupted power

Solution: Plug computer into a separate circuit from such devices

Source: Page(s) 1335, 1498

79. "Memory address conflict between devices"

Cause: Two devices are using the same upper memory block

Solution: Move one device to a non-conflicting UMB address

Source: Page(s) 530, 1498

80. "Intermittent lockups, memory and drive glitches"

Cause(s): There are two common causes for intermittent system lockups, memory and drive glitches:

(1) Improperly wired outlets might be providing bad power

(2) Other devices on circuit could be causing problems, such as AC units, coffee makers, etc.

Solution(s): There are two common solutions for these problems:

(1) Use an outlet tester to check ground and polarity

(2) Move computers to their own circuit

Source: Page(s) 1317, 1335, 1498, 1499

81. "System frequently locks up"

Cause: Hardware resource conflict.

Solution: Use Windows Device Manager to find conflicts and resolve

them

Source: Page(s) 379, 1498

82. "Hardware and software bugs"

Cause: BIOS is out of date.

Solution: Upgrade Flash BIOS.

Source: Page(s) 415, 1498

83. "Slow system performance"

Cause: System BIOS might not be cached.

Solution: Enable caching of system BIOS.

Source: Page(s) 435, 1498

TAPE DRIVES

84. "Cannot run tape backup or restore; bad block errors during restore"

Cause: Defective tape cartridge, dirty heads, defective cabling, or

incorrect software settings

Solution: Replace cartridge, clean heads, check cabling, and rerun

confidence test with blank cartridge

Source: Page(s) 735, 1499

VIDEO

85. "Onscreen icons too small at high resolutions"

Cause: High resolutions use more dots on screen, so each dot takes less

screen area and fixed-size icons are smaller.

Solutions: If you use Windows 98, 2000, or XP, enable Large Icons.

Source: Page(s) 880, 1499

86. **"Slow video performance with any card type"**

Cause: Video BIOS might not be cached.

Solution: Enable caching of video BIOS.

Source: Page(s) 435, 1499

87. **"Slow video performance with any card type"**

Cause: Video BIOS might not be cached.

Solution: Enable caching of video BIOS.

Source: Page(s) 435, 1499

88. **"Garbage appears on your video screen for no apparent reason"**

Cause: Hardware resource conflict.

Solution: Use Windows Device Manager to find conflicts and resolve

them.

Source: Page(s) 379, 1499

89. **"Frequent screen lockups or invalid page fault errors"**

Cause: Buggy video driver.

Solution: Upgrade video driver or adjust acceleration to None.

Source: Page(s) 910, 1500

USB

90. **"Cannot use USB keyboard and mouse outside of Windows"**

Cause: USB Legacy support is disabled in BIOS.

Solution: Enable USB Legacy support.

Source: Page(s) 437, 1499

91. "Cannot use USB devices"

Cause: USB is disabled or not assigned an IRQ.

Solution: Enable USB; assign IRQ to USB.

Source: Page(s) 444, 1499

92. "USB 2.0 ports aren't supporting USB 2.0 devices at top speed"

Cause: USB 2.0 ports might not be configured correctly.

Solution: Enable USB 2.0 support in system BIOS and install correct

drivers.

Source: Page(s) 989, 1499

WINDOWS

93. "Operating system will not boot"

Cause(s): There are five common reasons why the operating system will

not boot:

(1) Poor Heat dissipation

(2) Improper voltage settings

(3) Wrong motherboard bus speed

(4) Wrong CPU clock multiplier

(5) Applications will not install or run

Solution(s): The five most common solutions to this problem are:

(1) Check CPU fan; replace if necessary; might need higher capacity

heatsink

(2) Set motherboard for proper core processor voltage

(3) Set motherboard for proper speed

(4) Set motherboard jumpers for proper clock multiplier

(5) Improper drivers or incompatible hardware; update drivers and check for compatibility issues.

Source: Page(s) 198, 1501

94. **"Virus warning triggered when trying to upgrade Windows"**

Cause: Virus warning feature enabled in system BIOS.

Solution: Disable virus warning or boot sector write-protect feature.

Source: Page(s) 449, 1501

95. **"The PC starts in Safe mode [Windows 9x/Me]**

Cause: Hardware resource conflict.

Solution: Use Windows Device Manager to find conflicts and resolve them.

Source: Page(s) 379, 1501

96. **"Problems with operating system During the POST"**

Cause: Various causes (see checklist).

Solutions: Problems that occur during the POST are usually caused by incorrect hardware configuration or installation. Actual hardware failure is a far less-frequent cause. If you have a POST error, check the following:

1. Are all cables correctly connected and secured?

2. Are the configuration settings correct in Setup for the devices you have installed? In particular, ensure the processor, memory, and hard drive settings are correct.

3. Are all drivers properly installed?

4. Are switches and jumpers on the baseboard correct, if changed from the default settings?

5. Are all resource settings on add-in boards and peripheral devices set so that no conflicts exist—for example, two add-in boards sharing the same interrupt?

6. Is the power supply set to the proper input voltage (110V–120V or 220V–240V)?

7. Are adapter boards and disk drives installed correctly?

8. Is a keyboard attached?

9. Is a bootable hard disk (properly partitioned and formatted) installed?

10. Does the BIOS support the drive you have installed, and if so, are the parameters entered correctly?

11. Is a bootable floppy disk installed in drive A:?

12. Are all memory SIMMs or DIMMs installed correctly? Try reseating them.

13. Is the operating system properly installed?

Source: Page(s) 1341, 1501

97. "File system problems with Windows 9x/ME or DOS"

Cause: Various causes (see checklist)

Solutions: Here are some general procedures to follow for troubleshooting drive access, file system, or boot problems for these OSs:

1. Start the system using a Windows startup disk, or any bootable MS-DOS disk that contains FDISK.EXE, FORMAT.COM, SYS.COM, and SCANDISK.EXE (Windows 95B or later versions preferred).

2. If your system cannot boot from the floppy, you might have more serious problems with your hardware. Check the floppy drive and the motherboard for proper installation and configuration. On some systems, the BIOS configuration doesn't list the floppy as a boot device or puts it after the hard disk. Reset the BIOS configuration to make the floppy disk the first boot device if necessary and restart your computer.

3. Run FDISK from the Windows startup disk. Select option 4 (Display Partition Information).

4. If the partitions are listed, make sure that the bootable partition (usually the primary partition) is defined as active (look for an uppercase *A* in the Status column).

5. If no partitions are listed and you do not want to recover any of the data existing on the drive now, use FDISK to create new partitions, and then use FORMAT to format the partitions. This overwrites any previously existing data on the drive.

6. If you want to recover the data on the drive and no partitions are being shown, you must use a data recovery program, such as the Norton Utilities by Symantec or Lost and Found (also by Symantec; formerly PowerQuest), to recover the data.

7. If all the partitions appear in FDISK.EXE and one is defined as active, run the SYS command as follows to restore the system files to the hard disk:

SYS C:

8. For this to work properly, it is important that the disk you boot from be a startup disk from the same operating system (or version of Windows) you have on your hard disk.

9. You should receive the message System Transferred if the command works properly. Remove the disk from drive A:, and restart the system. If you still have the same error after you restart your computer, your drive might be improperly configured or damaged.

10. Run SCANDISK from the Windows startup disk or an aftermarket data-recovery utility, such as the Norton Utilities, to check for problems with the hard disk.

11. Using SCANDISK, perform a surface scan. If SCANDISK reports any physically damaged sectors on the hard disk, the drive might need to be replaced.

Source: Page(s) 1415, 1501

98. "File system problems with Windows 2000/XP"

Cause: Various causes (see checklist)

Solutions: The process for file system troubleshooting with Windows 2000/XP is similar to that used for Windows 9x. The major difference is the use of the Windows 2000/XP Recovery Console, which is clarified here:

If the Recovery Console was added to the boot menu, start the system normally, log in as Administrator if prompted, and select the Recovery Console.

If the Recovery Console was not previously added to the boot menu, start the system using the Windows CD-ROM or the Windows Setup disks. Select Repair from the Welcome to Setup menu, and then press C to start the Recovery Console when prompted.

If your system cannot boot from CD-ROM or the floppy, you might have more serious problems with your hardware. Check your drives, BIOS configuration, and motherboard for proper installation and configuration. Set the floppy disk as the first boot device and the CD-ROM as the second boot device and restart the system.

After you start the Recovery Console, do the following:

1. Type **HELP** for a list of Recovery Console commands and assistance.

2. Run DISKPART to examine your disk partitions.

3. If the partitions are listed, make sure that the bootable partition (usually the primary partition) is defined as active.

4. If no partitions are listed and you do not want to recover any of the data existing on the drive now, use FDISK to create new partitions, and then use FORMAT to format the partitions. This overwrites any previously existing data on the drive.

5. If you want to recover the data on the drive and no partitions are being shown, you must use a data recovery program, such as Norton Utilities by Symantec or Lost and Found by Symantec, to recover the data.

6. If all the partitions appear in DISKPART and one is defined as active, run the FIXBOOT command as follows to restore the system files to the hard disk:

FIXBOOT

7. Type **EXIT** to restart your system. Remove the disk from drive A: or the Windows 2000 or XP CD-ROM from the CD-ROM drive.

8. If you still have the same error after you restart your computer, your drive might be improperly configured or damaged.

9. Restart the Recovery Console and run CHKDSK to check for problems

with the hard disk

Source: Page(s) 1416, 1417, 1501

99. "System running Windows NT 4.0 cannot access a drive prepared with Windows 2000 or Windows XP".

Cause: If drive is running NTFS 5, Windows NT needs Service Pack 4 or above.

Solution: Install Service Pack 4 or above to be compatible with NTFS 5;

third-party add-ons must be used for compatibility with FAT32.

Source: Page(s) 1387, 1501

WIRELESS NETWORK

100. "Wi-Fi 5GHz band device cannot connect to other Wi-Fi devices"

Cause: Wi-Fi 5GHz is the same as IEEE 802.11a, which is not

compatible with other Wi-Fi standards.

Solution: Use dual-band devices to connect to all Wi-Fi networks.

Source: Page(s) 1128, 1501

Appendix E

Permissions for the Use of Copyrighted Material

ELSVIER Publishing Co.

Bryant, Michael

From:	dr_bryant@cox.net on behalf of Michael Bryant [dr_bryant@cox.net]
Sent:	Tuesday, August 12, 2008 7:40 AM
To:	Bryant, Michael
Subject:	FW: Obtain Permission

```
-----Original Message-----
From: Jones, Jennifer (ELS-OXF) [mailto:J.Jones@elsevier.com]
Sent: Thursday, July 31, 2008 6:14 AM
To: DR_BRYANT@COX.NET
Subject: RE: Obtain Permission
```

Dear Michael Bryant
We hereby grant you permission to reprint the material detailed below at
no charge in your thesis subject to the following conditions:

1.   If any part of the material to be used (for example, figures)
has appeared in our publication with credit or acknowledgement to
another source, permission must also be sought from that source. If
such permission is not obtained then that material may not be included
in your publication/copies.

2.   Suitable acknowledgment to the source must be made, either as a
footnote or in a reference list at the end of your publication, as
follows:

        "This article was published in Publication title, Vol
number, Author(s), Title of article, Page Nos, Copyright Elsevier (or
appropriate Society name) (Year)."

3.   Your thesis may be submitted to your institution in either print
or electronic form.

4.   Reproduction of this material is confined to the purpose for
which permission is hereby given.

5.   This permission is granted for non-exclusive world English
rights only. For other languages please reapply separately for each one
required. Permission excludes use in an electronic form other than
submission. Should you have a specific electronic project in mind
please reapply for permission

6.   This includes permission for UMI to supply single copies, on
demand, of the complete thesis. Should your thesis be published
commercially, please reapply for permission.

Yours sincerely

Jennifer Jones
Rights Assistant
Elsevier is pleased to announce our partnership with Copyright Clearance
Center's Rightslink service. Rightslink will handle Elsevier's journal
permission requests. For your future requests, you have to go through
Rightslink to obtain permissions. With Rightslink (r) it's faster and
easier than ever before to obtain permission to use and republish
material from Elsevier. Using Rightslink is as simple as:

Simply visit: http://www.sciencedirect.com/ and locate your desired

1

content.
Click on the article.
Open the abstract or summary and then click on the 'Request Permission'
button to open the Rightslink web page which will launch you into the
Rightslink application and then follow the steps below.

1. Select the way you would like to reuse the content
2. Create an account if you haven't already
3. Accept the terms and conditions and you're done

Please contact Rightslink Customer Care with any questions or comments
concerning this service:
Copyright Clearance Center Rightslink Customer Care
Tel (toll free): 877/622-5543 Tel: 978/777-9929
E-mail: customercare@copyright.com

Elsevier Limited, a company registered in England and Wales with company
number 1982084, whose registered office is The Boulevard, Langford Lane,
Kidlington, Oxford, OX5 1GB, United Kingdom.

-----Original Message-----
From: DR_BRYANT@COX.NET [mailto:DR_BRYANT@COX.NET]
Sent: 30 July 2008 17:30
To: Rights and Permissions (ELS)
Subject: Obtain Permission

This Email was sent from the Elsevier Corporate Web Site
and is related to Obtain Permission form:

Product: Customer Support
Component: Obtain Permission
Web server:.   http://www.elsevier.com
IP address: 195.212.150.72
Client: Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.1; SV1;
InfoPath.1; .NET CLR 1.1.4322; .NET CLR 2.0.50727; .NET CLR
3.0.04506.30)
Invoked from:
http://www.elsevier.com/wps/find/obtainpermissionform.cws_home?isSubmitt
ed=yes&navigateXmlFileName=/store/scstargets/prd53/act/framework_support
/obtainpermission.xml

Request From:
Student Michael Bryant
Nova Southeastern University
740 Old Fields Arch
23320
Chesapeake
United States

Contact Details:
Telephone: 757 549-1940
Fax:
Email Address: DR_BRYANT@COX.NET

To use the following material:
ISSN/ISBN: Unknown
Title: Applying CBR: Tech for Enterprise Systems
Author(s):   Watson, Ian, (1997).
Volume: None
Issue: None
Year: 1997
Pages: None - None

2

Article title: Same as book title

How much of the requested material is to be used:
The CBR Cycle diagram

Are you the author: No
Author at institute: No

How/where will the requested material be used: [how_used]

Details:

My dissertation on CBR/RBR

Additional Info:

[acronym]
- end -

CAMBRIDGE UNIVERSITY PRESS

PERMISSION INVOICE

Inv. # P03J 15355

August 7, 2008

Michael Bryant
740 Old Fields Arch
Chesapeake, VA
23320

**CAMBRIDGE
UNIVERSITY PRESS**

32 Avenue of the Americas
New York, NY 10013-2473, USA

www.cambridge.org

Telephone 212 924 3900
Fax 212 691 3239

REFERENCE

Journal: The Knowledge Engineering Review, Vol. 00:0, 1-2, 2005

Author: Mantaras, Ramon, et al.

Title:

Selection/pp.:   Figure 1, page 2, Figure 2, page 3

Additional

USE

Reprint Title: n.a.

Publisher: Nova Southeastern University

Format: dissertation / thesis

Quantity (Limit*):   20

Avail. Date: 2008

RIGHTS/ACKNOWLEDGEMENT

Permission is granted for nonexclusive rights throughout the   World   in the   English   language for interior text editorial use in the format described above only. Please fully acknowledge our material and indicate the copyright notice as it appears in our publication, followed by the phrase "Reprinted with the permission of Cambridge University Press."
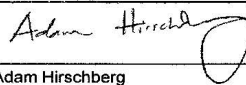
All requests from third parties to reproduce this material must be forwarded to Cambridge University Press.

FEES/RESTRICTIONS

$0.00

*You must re-apply for permission if this print run is exceeded. This permission is restricted to the indicated format and excludes reproduction in any other medium; for additional use, you must apply for permission separately. This permission does not allow reprinting of any material copyrighted by or credited in our publication to another source; Cambridge disclaims all liability in connection with the use of such material without proper consent. A COPY OF THIS INVOICE MUST ACCOMPANY PAYMENT. Payment is due upon publication or within 12 months, whichever is sooner. Make check payable to Cambridge University Press, Attn: Rights and Permissions (CUP Fed. I.D. #: 13 -1599108.)

This permission does not supersede permission that may be required from the original source indicated in our publication.

This permission requires that you send   zero (0)   copies of your publication directly to our author and   zero (0) copy of your publication to this office upon availability

Authorization: _____
Adam Hirschberg
Rights and Permissions Associate

DR. THOMAS ROTH-BERGHOFER

Bryant, Michael

From:	dr_bryant@cox.net on behalf of Michael Bryant [dr_bryant@cox.net]
Sent:	Monday, August 11, 2008 7:50 AM
To:	Bryant, Michael
Subject:	FW: Use of two figures in one of your articles

Attachments: Dissertation Roth-Berghofer_Web.pdf; ATT00042.htm; PGP.sig

Dissertation ATT00042.htm (14 PGP.sig (745 B)
:oth-Berghofer_We.. KB)

From: Dr. Thomas Roth-Berghofer [mailto:Thomas.Roth-Berghofer@dfki.uni-kl.de]
Sent: Monday, August 11, 2008 2:45 AM
To: Michael Bryant
Subject: Re: Use of two figures in one of your articles

Dear Michael,

Please, go ahead and use the figures :-) They are also used in my dissertation (which I
just attached to this email for your convenience). I would be happy if you point me to
your dissertation once it is finished. If you think I could be of any further assistance,
e.g., for some feedback on your thesis, let me know.

Cheers and good luck,

Thomas

Am 09.08.2008 um 22:22 schrieb Michael Bryant:

Dr. Roth-Berghofer

I am writing my doctoral dissertation and would like to have your permission to use two
figures from your article "Developing maintainable Case-Based Reasoning Systems: Applying
SIAM to empolis orenge, (2003)"

The figures of interest are figures 1 and 2 on page two of your article.

1

Thank you for your consideration.

Michael Bryant, Ph.D. (ABD)

IOS PRESS, BV

From: Carry Koolbergen [mailto:c.koolbergen@iospress.nl]
Sent: Tuesday, August 12, 2008 8:47 AM
To: dr_bryant@cox.net
Subject: RE: Article Use

Dear Dr. Bryant,

We hereby grant you permission to reproduce the below mentioned material in print and electronic format at no charge subject to the following conditions:

1. If any part of the material to be used (for example, figures) has appeared in our publication with credit or acknowledgement to another source, permission must also be sought from that source. If such permission is not obtained then that material may not be included in your publication/copies.

2. Suitable acknowledgement to the source must be made, either as a footnote or in a reference list at the end of your publication, as follows:

"Reprinted from Publication title, Vol number, Author(s), Title of article, Pages No., Copyright (Year), with permission from IOS Press".

3. This permission is granted for non-exclusive world English rights only. For other languages please reapply separately for each one required.

4. Reproduction of this material is confined to the purpose for which permission is hereby given.

Yours sincerely

Carry Koolbergen
Contracts, Rights & Permissions Coordinator

IOS Press BV

Nieuwe Hemweg 6B

1013 BG Amsterdam

The Netherlands

Tel.: +31 (0)20 687 0022

Fax.: +31 (0)20 687 0019

Van: Michael Bryant [mailto:dr_bryant@cox.net]
Verzonden: zaterdag 9 augustus 2008 19:17
Aan: info@iospress.nl
CC: dr_bryant@cox.net
Onderwerp: Article Use

Sir

I am writing my doctoral dissertation and would like to use the CBR Cycle
figure (Figure 1) from the Aamodt and Plaza article "Case-Based Reasoning:
Foundational Issues, Methodological Variations, and System Approaches",
published in Vol. 7: 1, pp. 39-59 of Artificial Intelligence Communications.

If this is not the correct method to request the permission, would you
please let me know who I need to contact to gain permission?

Thank you very much

Regards

Michael Bryant, Ph.D. (ABD)

SHAKER VERLAG

SHAKER
VERLAG

Shaker Verlag GmbH, Kaiserstr. 100, D - 52134 Herzogenrath

Mr.
Michael Bryant, Ph.D. (ABD)

Ihr Zeichen, Ihre Nachricht vom	Unser Zeichen, unsere Nachricht vom	Telefax (0 24 07) 95 96-9	Mail: L.Maassen@shaker.de
		Telefon, Name (0 24 07) 95 96-	
	Sh/Ma	32 Maaßen	Datum 15.08.2008

Copyright Permission

Dear Mr. Bryant,

Thank you very much for your E-Mail of 11th August 2008 regarding a copyright permission. We hereby grant permission to reprint figure 1 (p. 201) and fig. 2 (p. 202) at no charge:

Roth-Berghofer, T. & Iglezakis, I. (2001). Six Steps in Case-Based Reasoning: Towards a maintenance methodology for case-based reasoning systems. In: Schnurr et al. (Hrsg.), *Professionelles Wissensmanagement: Erfahrungen und Visionen*. Aachen: Shaker Verlag, pp. 198-208.

This permission is granted for non-exclusive world rights in the **English language** only. For other languages please reapply separately for each one required. Permission includes use in an electronic form.

Full acknowledgment to the source as mentioned above must be made, either as a footnote or in a reference list at the end of the publication.

The reprint of this material is confined to the purpose for which permission is hereby given.

Yours sincerely,

L. Maaßen
Shaker Verlag GmbH

Reference List

Aamodt, A., & Plaza, E. (1994). Foundational issues, methodological variations, and system approaches. *Artificial Intelligence Communications,* 7(1): 39-59, 1993

Bergmann, R., Althoff, K., Breen, S., Göker, M., Manago, M., Traphöner, R., and Wess, S. (2003). Developing industrial case-based reasoning applications, the INRECA methodology, *Lecture Notes in Computer Science 1612,* Springer-Verlag Berlin Heidelberg 2003

Bigelow, S. (2001). Troubleshooting, maintaining & repairing PCs, Fifth Edition, New York, Osborne/McGraw-Hill Book Company.

Carrico, M., Girard, J., & Jones, J. (1989). Building knowledge systems: developing and managing rule-based applications, New York, New York, McGraw-Hill Book Company.

Crossman, F., Achenback, J., Gegel, H., Hadcock, R., Kaczmarek, T., Kaufman, J. et al. (1995). Computer-Aided Materials Selection During Structural Design, National Materials Advisory Board, Commission on Engineering and Technical Systems, National Research Council, Washington, DC: National Academy Press

Delic, K., & Hoelimer, B. (2000). Knowledge-based support in help-desk environments, *IT Pro,* January/February 2000, IEEE

Delic, K., & Dayal, U. (2000). Knowledge-based support services: monitoring and adaptation, *Proceedings of the 11ᵗʰ International Workshop on Database and Expert Systems Applications (DEXA'00),* 2000

Doctor, J. (2003). Knowledge management best practices for service and support, *ServiceWare Technologies,* Retrieved August 30, 2007 from http://www.helpdeskinst.com

Englemore, R. & Feigenbaum, E. (1993). Expert Systems and Artificial Intelligence, Loyola University Press

Exsys® Corvid (2007). Knowledge Automation Expert System Software Developer's Guide, Exsys, Inc., Albuquerque, NM

Farver, C., Joslin, R., & LaBounty, C. (2001). Knowledge Management, *Help Desk Institute,* Colorado Springs, CO

Göker, M., & Roth-Berghofer, T. (1999). Development and utilization of a case-based help-desk support system in a corporate environment, , *Lecture Notes in Artificial Intelligence 1650,Third International Conference on Case-Based Reasoning, ICCBR-99,* Seeon Monastery, Germany, July 1999, Springer-Verlag

Gonzalez, L., Giachetti, R., & Ramirez, G. (2005). Knowledge management-centric help desk: specification and performance evaluation, *Decision Support Systems,* Vol. 40, Issue 2, pp. 389-405

Graham, J., & Hart, B. (2000). Knowledgebase integration with a 24-hour help desk, *Proceedings of the Annual Conference of the ACM Special Interest Group on University and College Computing Services (SIGUCCS'00)*, October 29 - November 1, 2000, Richmond, VA

Halverson, C., Erickson, T. & Ackerman, M. (2004). Behind the help desk: evolution of a knowledge management system in a large organization, *Proceeding on the ACM 2004 Conference on Computer Supported Cooperative Work,* November 6 – 10, 2004, Chicago, IL, USA

Ignizio, J. P. (1991). Introduction to expert systems, the development and implementation of rule-based expert systems, McGraw-Hill, Inc., 1991

Intellix (2007). Getting Started with Intellix Designer, Intellix Corp., 2007

Kane, Mark (2001). Development of recommendations for automating an IT Help Desk. School of Computing, University of Abertay, Dundee.

Jackson, Peter (1999). Introduction to Expert Systems, third edition, Rochester, NY: Addison-Wesley, Inc.

Kolodner, J. L. (1984). Retrieval and organizational strategies in conceptual memory: A computer model. Hillsdale, NJ: Lawrence Erlbaum.

Kolodner, J. (1993). Case-Based Reasoning. San Mateo, CA: Morgan Kaufmann Publishers, Inc.

Kriegsman, M., & Barletta, R. (1993). Building a case-based help desk application, *IEEE Expert,* December 1993, pp. 18 – 26.

Laporte, L, & Soper, M. (2006). PC Help Desk, Indianapolis, Indiana, Que Publishing

Last, R. (2003). Build it or buy it? Deciding how to automate your help desk, *Help Desk Institute White Paper,* July 23, 2003

Lewis, J. (1995). IBM Computer Usability Satisfaction Questionnaires: Psychometric Evaluation and Instructions for Use. *International Journal of Human-Computer Interaction,* 7:1, 57-78.

Lopez de Mantaras, R., McSherry, D., Bridge, D., Leake, D., Smyth, B., Craw, S., Faltings, B., et al. (2005). Retrieval, reuse, revision, and retention in case-based reasoning, *The Knowledge Engineering Review,* Vol. 20:3, 1 – 2, 2005, Cambridge University Press

Luger, G. & Stubblefield, W. (2002). Artificial Intelligence – Structures and Strategies for Complex Problem Solving, California, Addison-Wesley

Marling, C., Sqalli, M., Rissland, E., Munoz-Avila, H., & Aha D. (2002). Case-based reasoning integrations. *AI Magazine,* 23, 1, 2002.

Main, J., Dillon, T., & Shiu, C. (2001). A tutorial on case based reasoning, *Soft Computing in Case Based Reasoning,* Pal, Dillon, and Yeung (Eds), Springer, 2001

Minasi, M. (2005). The complete PC upgrade and maintenance guide, 16th Edition, Alameda, CA, SYBEX, Inc.

Mueller, S. (2005). Upgrading and repairing PCs, 16th Edition, Indianapolis, IN, Que Publishing.

Noel, F., & Delic, K. (2002). Knowledge-based self-support system for corporate users. *Proceedings of the 13th International Workshop of Database and Expert Systems Applications (DEXA'02)*

Padeletti, A., Coltrane, B., & Kline, R. (2005). Customer Service – Help for the help desk, *Proceedings of the 5th Annual Conference of the ACM Special Interest Group on University Computer Centers (SIGUCC'05)*, November 6 – 9, 2005, Monterey, CA

Pal, S., & Shiu, S. (2004). Foundations of soft case-based reasoning, *Wiley Series on Intelligent Systems,* Wiley-Interscience, A John Wiley & Sons, Inc., Publication

Prerau, D. (1990). *Developing and Managing Expert Systems Proven Techniques for Business and Industry.* Reading, Massachusetts: Addison-Wesley Publishing Company.

Rajan, T., & Motta, E., (1998). Review: Acquist: a Tool for Knowledge Acquisition, British Computer Society Workshop Series Research and Development in Expert System V. Edited by B. Kelly and A. Rector, Cambridge University Press

Roth-Berghofer, T. (2003). Developing maintainable Case-Based Reasoning systems: Applying SIAM to empolis orange, Retrieved January 30, 2008 from http://citeseer.ist.psu.edu/roth-berghofer03developingl.html

Roth-Berghofer, T, & Iglezakis, I. (2001). Six Steps in Case-Based Reasoning: Towards a maintenance methodology for case-based reasoning systems, *Proceedings of the 9th German Workshop on Case-Based Reasoning, (GWCBR) 2001*, Baden-Baden, Germany

Schank, R. (1982). Dynamic memory, Cambridge: Cambridge University Press.

Sinz, C., Lumpp, T., Schneider, J., & Kuchlin, W. (2002). Detection of dynamic execution errors in IBM system automation's rule-based expert system. *Information and Software Technology,* 44, 857-873.

Sweat, J. (2001). Help Desks Think Bigger: Technology Support is shifting from troubleshooting simple questions to supporting companies' business strategy, *Information Week*

Watson, Ian, (1997). Applying Case-Based Reasoning: Techniques for Enterprise Systems. California: Morgan Kaufmann Publishers.

Watson, Ian (2002). Applying Knowledge Management: Techniques for Building Corporate Memories, *The Morgan Kaufmann Series in Artificial Intelligence,* Elsevier Science & Technology Books, December 2002

Watson, Ian (2002). Applying Knowledge Management: Techniques for Building Organisational Memories, *Advances in Case-Based Reasoning,* Proceedings of the 6th European Conference, ECCBR 2002, Aberdeen, Scotland, UK, September 2002