The Development of a Prototype Knowledge-Based Expert System to Assist Vocational Educators in the Development of the Local Plan Application for Vocational Education Funds.

Brady Keith Levrier

Louisiana State University and Agricultural & Mechanical College

Follow this and additional works at: https://digitalcommons.lsu.edu/gradschool_disstheses

Recommended Citation


This Dissertation is brought to you for free and open access by the Graduate School at LSU Digital Commons. It has been accepted for inclusion in LSU Historical Dissertations and Theses by an authorized administrator of LSU Digital Commons. For more information, please contact gradetd@lsu.edu.
INFORMATION TO USERS

The most advanced technology has been used to photograph and reproduce this manuscript from the microfilm master. UMI films the text directly from the original or copy submitted. Thus, some thesis and dissertation copies are in typewriter face, while others may be from any type of computer printer.

The quality of this reproduction is dependent upon the quality of the copy submitted. Broken or indistinct print, colored or poor quality illustrations and photographs, print bleedthrough, substandard margins, and improper alignment can adversely affect reproduction.

In the unlikely event that the author did not send UMI a complete manuscript and there are missing pages, these will be noted. Also, if unauthorized copyright material had to be removed, a note will indicate the deletion.

Oversize materials (e.g., maps, drawings, charts) are reproduced by sectioning the original, beginning at the upper left-hand corner and continuing from left to right in equal sections with small overlaps. Each original is also photographed in one exposure and is included in reduced form at the back of the book.

Photographs included in the original manuscript have been reproduced xerographically in this copy. Higher quality 6" x 9" black and white photographic prints are available for any photographs or illustrations appearing in this copy for an additional charge. Contact UMI directly to order.

UMI
University Microfilms International
A Bell & Howell Information Company
300 North Zeeb Road, Ann Arbor, MI 48106-1346 USA
313/761-4700  800/521-0600
The development of a prototype knowledge-based expert system to assist vocational educators in the development of the local plan application for vocational education funds

LeVrier, Brady Keith, Ph.D.
The Louisiana State University and Agricultural and Mechanical Col., 1990

Copyright ©1991 by LeVrier, Brady Keith. All rights reserved.
THE DEVELOPMENT OF A PROTOTYPE KNOWLEDGE-BASED EXPERT SYSTEM TO ASSIST VOCATIONAL EDUCATORS IN THE DEVELOPMENT OF THE LOCAL PLAN APPLICATION FOR VOCATIONAL EDUCATION FUNDS

A DISSERTATION

Submitted to the Graduate Faculty of the Louisiana State University and Agricultural and Mechanical College in partial fulfillment of the requirements for the degree of Doctor of Philosophy

in

The School of Vocational Education

by

Brady Keith LeVrier

B.S., Louisiana State University, 1978
M.S., Louisiana State University, 1983
May, 1990
ACKNOWLEDGEMENTS

A complete retrospective of the individuals who have made significant contributions to this study and enriched the life of this researcher during the course of his graduate studies would require the addition of another volume to this work. To my Graduate Committee, I offer my heartfelt thanks to Dr. Michael Burnett for setting a standard of excellence and professionalism that I would hope to emulate; Dr. Joe W. Kotrlik for pushing me to the limits of my ability and the providing the drive to redefine those limits; Dr. Betty C. Harrison for providing the "cure" for a bad case of "tunnel vision"; Dr. Terry Geske for providing me with new insights into the area of educational finance; and finally my committee chairperson, Dr. James W. Trott, who brings new meaning to the term "Thriving on Chaos" and of whom I am proud to claim as mentor and friend.

Four other individuals have also made an indirect impact on this study, but contributed greatly to my professional growth and development. A special thanks to Dr. James G. McMurry for sharing his considerable insight and concern for the quality of instruction in the Technical Institutes of this state and not keeping track of graduate student working hours. Dr. Diana Pounder, who has been described as a "...breath of fresh air in the halls of academia...", for her help and encouragement during the course of this project. Dr. Joe Liacata, for helping me overcome the fear of failure and to go
ahead and take risks. Finally, Dr. Vincent Kuetemeyer who
taught me to laugh at myself and take life a little easier.

Finally, I owe a debt of gratitude to my mother Leona,
sisters Drusilla and Mollie, and brother-in-law Roy for their
unerring love, support, and prayers that can never be repaid.
The same debt applies to my Aunts, Uncles, Relatives, and
Friends in Louisiana and Texas who provided the same emotional
support as my immediate family.
# TABLE OF CONTENTS

ACKNOWLEDGEMENTS ........................................ ii

TABLE OF CONTENTS ........................................ iv

LIST OF TABLES ........................................ vii

LIST OF FIGURES ........................................ viii

ABSTRACT .................................................. xi

CHAPTER I .................................................. 1

  Introduction ........................................ 1
  Statement of the Problem ............................ 1
  Purpose ............................................. 3
  Objectives ......................................... 4
  Significance of the Study ............................ 5
  Definition of Terms ................................ 6

CHAPTER II ............................................... 8

  Review of Literature ................................. 8
    Introduction ..................................... 8
    History of Expert System Technology ............ 8
    Expert System Components ....................... 13
      The Knowledge Base ............................ 13
      The Inference Engine .......................... 18
      The User Interface ............................. 21
    Expert System Shell Programs .................... 25
    Applications of Expert System Technology ....... 26
      Educational Applications of Expert Systems ... 28
Applications of Expert Systems in Vocational Education. 32

The Carl D. Perkins Vocational Educational Act of 1984 33

CHAPTER III 38
Methodology 38
Introduction 38
Stage 1 Identification and Definition of the Problem 40
Stage 2 Development of the Prototype 41
Stage 3 Construction of the Expert System 42
Stage 4 Testing and Evaluation of the Expert System 43
Stage 5 Integration and Implementation 44
Stage 6 Maintenance of the Expert System 44

CHAPTER IV 45
Expert System Organization and Development 45
Introduction 45
Section One 45
The Files Menu 52
The Definitions Menu 54
The Examples Menu 57
The Methods Menu 59
The Rule and Advisor Menus 61
Section Two 63
Section Three 66
Carl Perkins Legislative Advisor 66
Local Plan Advisor 83
LIST OF TABLES

Table 1. Beerel's Classification of Expert Systems .......................... 11
Table 2. Dimensions of Knowledge Base Evaluation .......................... 17
Table 3. Elements of the Carl D. Perkins Vocational Education Act ........ 35
Table 4. Six Stage Expert System Development Process ..................... 39
LIST OF FIGURES

Figure 1. Ingwersen's Classification of Searcher's Groups ........................................ 24
Figure 2. Examples Screen .................................................. 46
Figure 3. 1st Class Fusion Rule Tree ........................................... 48
Figure 4. 1st Class Fusion Menu Screens ......................................... 52
Figure 5. Files Screen .......................................................... 53
Figure 6. 1st Class Fusion Definition Screen ...................................... 54
Figure 7. 1st Class Fusion Examples Screen ........................................ 57
Figure 8. 1st Class Fusion Methods Menu .......................................... 59
Figure 9. 1st Class Fusion Rule Screen ........................................... 62
Figure 10. 1st Class Fusion Advisor Screen ......................................... 62
Figure 11. Map of Knowledge Base BEGIN ......................................... 66
Figure 12. Map of Knowledge Base CARLPERK .................................. 67
Figure 13. Map of Knowledge Base CP ........................................... 68
Figure 14. Map of Knowledge Base TITLE1 ........................................ 68
Figure 15. Maps of Knowledge Bases AA, IND, and SA .......................... 69
Figure 16. Map of Knowledge Base COUNCIL ...................................... 70
Figure 17. Maps of Knowledge Bases SP and CONTENT ............................ 71
Figure 18. Map of Knowledge Base TITLE2 ......................................... 71
Figure 19. Map of Knowledge Base TITLE3 .......................................... 73
Figure 20. Map of Knowledge Base 4PARTA ........................................ 74
Figure 21. Map of Knowledge Base TITLE4 .......................................... 75
Figure 22. Map of Knowledge Base TITLE5 .......................................... 76
Figure 23. Map of Knowledge Base WITH ........................................... 76
Figure 24. Map of Knowledge Bases DEF, DEF1A, and DEF2A ................. 77
Figure 51. Warning Screen 2 .......................... 101
Figure 52. Data Entry Screen .......................... 102
Figure 53. High School Data Entry Screen ............. 102
Figure 54. Initial Handicapped Financial Advisor Screen 103
Figure 55. Financial Advisor Data Entry Screen ....... 104
Figure 56. Financial Advisor Data Entry Screen 2 .... 105
Figure 57. Handicapped Financial Advisor Summary .... 106
Figure 58. Formula Screen ................................. 107
Figure 59. Continuation/Advisor Screen ................ 109
Figure 60. Local Plan Escape Menu ...................... 110
Figure 61. Escape/Print Screen ........................... 111
Figure 62. Default 1st Class Fusion Escape Screen .... 112
Figure 63. 1st Class Fusion Interrupt Screen .......... 113
Figure 64. 1st Class Hypertext Screen .................. 117
Figure 65. Hypertext Card Stacks ......................... 117
Figure 66. Applications of Expert Systems in Vocational Education ................. 120
Abstract

The Carl D. Perkins Act of 1984 provides significant financial support for the enhancement and expansion of secondary and post-secondary vocational education programs in the United States. Individual states are required to develop a State Plan for the use of Carl D. Perkins vocational funds. The formulation of this State Plan requires the development of Local Plans on the part of local education agencies who wish to participate in this program. These Local Plans are then compiled to form the State Plan which then is presented to the Department of Education for review. The annual Local Plan development process is complex and the possibilities for errors in the formulation of the plan are always present.

Expert Systems are specialized computer programs which provide a means for the storage and retrieval of knowledge. These systems have been developed to perform a variety of different tasks in business and industry. Expert Systems contain a Knowledge Base, Inference Engine, and User Interface. The Knowledge Base contains the knowledge relative to the particular area of application. The Inference Engine provide a means of access to this information, and the User
Interface provides a method of two-way communication between the user and the Expert System.

Expert System Shell programs are used to develop Expert Systems by individuals who may lack a background in computer programming. 1st Class Fusion is such a program, and was used in this study to develop a prototype Expert System to assist local vocational educators in the development of the Local Plan for the Application of Carl D. Perkins Funds. The program is divided into two parts, the Legislative Advisor and Local Plan Advisor. The Legislative Advisor is designed to access information by Title and subtopic within the Carl D. Perkins Act. The Local Plan Advisor contains the procedural guidelines for the development of the Local Plan, as well as a section to assist in the calculation of demographic and financial data associated with the Local Plan.
CHAPTER I
Introduction

The promise of computers that mimic human reasoning processes for many years resided only in the minds and imagination of science fiction writers such as Isaac Asimov, Arthur C. Clark, and Robert A. Heinlein. During the past twenty years computer scientists have been pursuing this dream with varying degrees of success under the broad research area known as Artificial Intelligence. One promising field of study within Artificial Intelligence is concerned with the development of Knowledge Based Expert Systems. These systems provide a means of storing information electronically in a data base; and a method for individuals to retrieve this information. Expert Systems provide a unique system of information retrieval which requires a two-way mode of communication between the user and computer. Likewise, expert systems offer the means to make the wisdom of experts more readily available for application to relevant issues.

Statement of the Problem

The Carl D. Perkins Vocational Act of 1984 provides significant financial support for the enhancement and expansion of secondary and post-secondary vocational education programs in the United States. Two major administrative components of this Act are the establishment of a State Board for Vocational Education and a State Plan for the use of Carl D. Perkins vocational funds. States desiring to receive
federal funds for vocational education must establish a State Board for vocational education. This state agency functions as the sole agent responsible for the administration of vocational education programs within the state. The State Plan contains a description of the planned uses of Carl D. Perkins funds by an individual state over a two to three-year period of time. Local educational agencies that desire to receive assistance under this Act are required by law to submit an application to the State Board. This application is known as the Local Plan for vocational education.

The policies and procedures governing the Local Plan Applications are established by the State Board for Vocational Education. The development of the Local Plan involves the gathering of demographic, statistical, and financial data. Rapid changes in policies and procedures at the federal and state level add to the complexity of local plan development; this process makes keeping abreast of the changes in state and federal policy a very difficult task for local educational agencies. Changes in the level of state and federal matching funds, amendments to the Act itself, state and local interpretation of the Act, or changes in the application procedure have a great impact on the development of the Local Plan.

Thus, information on any procedural changes must traverse the organizational communication network from the federal,
state, and local level; which can be a long process fraught with the potential for errors.

Since most local education agencies and vocational educators have access to personal computers, a software package that would assist local vocational educators in the development of the Local Plan Application would potentially be of significant value. At the present time no such software is available to assist vocational educators in accomplishing this task.

Purpose

The purpose of this research is the development of a prototype Knowledge Based Expert System computer program to assist local vocational educators in the annual development of a local plan for vocational education funds.

Expert Systems store information in a computer database called a Knowledge Base. The Knowledge Base must contain information pertinent to the subject for which it has been designed; in this case the Knowledge Base must contain pertinent information or data concerning the rules and regulations associated with the development of the Local Plan. This information may be in the form of textual or numerical data. The Knowledge Base should incorporate the most up-to-date and accurate information concerning the policies and procedures associated with the development of the Local Plan. The Expert System software itself should also provide a means
for making any modifications that may be needed in the Knowledge Base.

Expert Systems are not designed to function as a human being. These systems do not possess the creativity, insight, experience, or intelligence of human beings. However, such a system can serve as a viable source of information for use by a client; and can assist local educational agencies in the development of financial and procedural information associated with the Local Plan. In other applications, commercially developed Expert Systems have proven a cost-effective complement to human experts.

Objectives

The development of an annual Local Plan Application for Carl Perkins funds is a time consuming task due to the large amount of data that must be compiled and assimilated into the Local Plan. An Expert System to assist vocational educators in the preparation of the Local Plan Application for Vocational Education Funds must embody the following characteristics:

1. The ability to assist in the identification of the policies and procedures that must be followed in order to complete the Louisiana Local Plan Application for Carl Perkins funds. This includes required demographic, statistical, financial, and instructional information and data.
2. Must exhibit an ability to organize pertinent information and data into a form which would be compatible for use in a rule-based Expert System.

3. An interface that is as "user friendly" possible, so as to maximize its use by a wide variety of targeted individuals, regardless of their level of computer literacy.

4. The expert system must be designed so that the Knowledge Base may be modified to reflect future changes that may occur in the Carl Perkins Act itself, or modifications to the Local Plan for the Application of Vocational Education Funds.

Significance of the Study

Vocational education has long sought to assist individuals in gaining an understanding of technology and its impact on their daily lives. The application of a new and innovative technology to a complex administrative procedure specific to the profession is a logical extension of this objective. A thorough review of the related literature revealed no current applications of this or similar systems within the context of vocational education.

In Louisiana, queries related to the development of the Local Plan are handled by the State Department of Education's Research Coordinating Unit of the Division of Vocational Education. The nature of the questions posed to supervisory personnel may be considered to be procedural or
interpretative. The development of a Knowledge Based Expert System to assist vocational educators in the development of Local Plans could provide maximum assistance concerning questions of a procedural nature. However, there are times when the advice of state or federal experts will be needed regarding interpretations of state or federal guidelines concerning the implementation of the Carl Perkins Act. The successful development of an Expert System to meet the objectives outlined above should decrease the workload of state supervisors, as well as provide a measure of independence on the part of local vocational educators in the application process.

Finally, this project could also serve as a focal point for additional research into other possible applications of this technology within other areas of vocational education.

Definition of Terms

The terminology associated with Expert Systems technology tends to be technical in nature. The following is a list of operational definitions, acronyms, and terms which will be used in this document.

Artificial Intelligence - a subsection of computer science concerned with developing programs that in some way imitate human thought processes.

Backward Chaining - inferencing from a conclusion (or goal) to determine the reasoning behind the particular conclusion.

Computer Aided Instruction - a branch of Artificial Intelligence concerning the development of computer assisted learning software and the use of computers in instruction.
Control rules - rules governing the sequence of inference by giving the system special instructions.

Cognitive style - the manner in which an individual perceives data and formulates knowledge from the collected data.

Domain Expert - a human expert, recognized as such, who provides know-how to the system in a narrow area of specialization.

Decision Support System (DSS) - a computer system designed to provide information deemed relevant to the making of a decision. DSS provides support to the decision maker but does not replace him.

Expert System - a computer program that uses expert knowledge to reach a level of performance akin to that achievable by highly skilled experts. The knowledge is presented symbolically rather than numerically. The system is designed to address complex problems and to explain its reasoning processes.

Forward Chaining - inferencing from facts to a conclusion(s) supported by the facts.

Heuristics - "rules of thumb" that are used by individuals (experts) to solve problems.

Inference Engine - the inference engine processes the domain knowledge included in the system to reach new conclusions. The Inference Engine is created by special software in a computer.

Inferencing - forming logical conclusions from given facts or premises.

Knowledge Base - the part of an Expert System which contains the rule database.

Knowledge Based System - (see Expert System)

Knowledge Engineer - an individual experienced in the use of Expert Systems and the construction of knowledge bases.

Shell - a commercially available Expert System design tool which includes the inference engine from a previously designed Expert System.

User Interface - the means in which the user and Expert System communicate or interact with each other.
CHAPTER II
Review of Literature

Introduction

This chapter is divided into four sections of related literature to provide an overview of the research literature pertaining to Expert Systems. The first section of this chapter provides a historical overview of the development of Artificial Intelligence and Expert Systems. The second section provides a review and explanation of the elements which make up an Expert System, followed by a short definition of an Expert System shell program illustrating its applications. The third section is a discussion of existing commercial Expert Systems and their applications in General and Vocational education. The fourth section includes a description of the Carl D. Perkins Act of 1984.

History of Expert System Technology

The development of Artificial Intelligence (AI) can be traced to the Middle Ages. During the 1700's skilled artisans developed clocks, toys, and amusements that attempted to mimic human actions in order to entertain their patrons. During the twentieth century Artificial Intelligence evolved into an area of scientific interest.

According to Shurkin (1983) Artificial Intelligence formally began as a science in 1956 at Dartmouth College. Marvin Minsky, John McCarthy, Nathaniel Rochester, and Claude Shannon met to discuss ways of simulating human thought with
computers. As a result of the meeting the term "Artificial Intelligence" began to be used by computer scientists in reference to the development of human reasoning characteristics in computers. The scientists also unveiled the first Expert System during this meeting. The computer program was called Logic Theorist, and was written by Newell, Simon, and Shaw. Logic Theorist was developed to prove mathematical theorems proposed by Alfred North Whitehead and Bertrand Russell in their work, Principia Mathematica. In one particular case the expert system provided a better proof than human mathematicians. Ironically, when the scientists tried to publish their accomplishment, no journal wanted to accept a machine generated mathematical proof.

The term Artificial Intelligence is used in the literature to describe computer programs which attempt to imitate human reasoning processes. According to Jackson (1986) the goal of Artificial Intelligence research is to: (1) program computers to perform human tasks and (2) the simulation of human behavior and mental processes.

Artificial Intelligence research is multidisciplinary in nature. Research and development programs have drawn heavily on work done by psychologists who have studied the brain and human thought processes. Work related to logic systems has been gathered from such diverse areas as mathematics, philosophy, and computer science. The field of education has also made significant contributions to Artificial Intelligence.
research in areas related to the theory and mechanics of human learning.

Expert Systems research is a subset of Artificial Intelligence that is primarily concerned with the storage and retrieval of knowledge, not the development of machine cognition. In an attempt to define Expert Systems, Juell and Wasson (1988) explain that these systems "... provide a way to codify knowledge relevant to a particular domain into a computer format in such a way that a user may utilize the information in the absence of the human expert who originally provided the information for the Knowledge Base." (p. 19)

Expert Systems have been designed to perform a variety of different tasks. Beerel (1987) has developed a classification system for Expert Systems to categorize the various types of applications of these systems as shown in Table 1.
Table 1

**Beerel's Classification of Expert Systems**

<table>
<thead>
<tr>
<th>TYPE</th>
<th>PURPOSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interpretative</td>
<td>To infer situation descriptions from data.</td>
</tr>
<tr>
<td>Diagnostic</td>
<td>To analyze system performance so as to highlight malfunctions of people, systems, or organizational performance.</td>
</tr>
<tr>
<td>Design</td>
<td>To design objects given certain constraints.</td>
</tr>
<tr>
<td>Planning</td>
<td>To propose courses of action under different scenarios.</td>
</tr>
<tr>
<td>Monitoring</td>
<td>To compare and evaluate actual observation against a plan.</td>
</tr>
<tr>
<td>Education/Training</td>
<td>To provide and transfer knowledge to students in an appropriate fashion.</td>
</tr>
<tr>
<td>Control</td>
<td>To diagnose, debug, repair, and monitor system behaviors.</td>
</tr>
</tbody>
</table>

(Beerel 1987, p. 33)

The use of Expert Systems in the field of education has been primarily in Computer Assisted Instruction (CAI). Other recorded applications have been Diagnostic in nature. Hofmeister and Ferrara (1986) developed an Expert System called "CLAS.LD". The program was used to provide a second opinion concerning the accuracy of the classification of learning disabled children.

According to Siegel (1986) an Expert System has five major characteristics: a knowledge base, separate reasoning
capability, system-client communication, uncertainty, and explanation. The Knowledge Base constitutes a major portion of the Expert System, since it contains the accumulated expert knowledge of the topic at hand. This knowledge is then written into a series of IF-THEN rule statements which will be used to draw conditions or conclusions from the Knowledge Base. An "Inference Engine" is used as a means of attaining a separate reasoning capability. The "Inference Engine" is a special type of software and is a major component of the Expert System program. Basically, the "Inference Engine" uses the rules to infer from either a general to specific conclusion, or vise versa.

In order to obtain the maximum utilization of Expert System technology, there must be a system of two-way communication (User Interface) between the user and the system. This can be accomplished in a variety of ways, the most common being a series of questions posed by the Expert System and then answered by the individual user. Since there are very few absolutes in the real world, Expert Systems will only be as good as the data that makes up the Knowledge Base. Most systems are designed to be flexible, so as to allow any modifications that may be necessary to the Knowledge Base. Finally, the system should be able to graphically display to the client the line of reasoning the Expert System used to reach a specific conclusion.
Kriz (1987), in his explanation of Expert Systems, describes the following features that should be included in the design of these systems. First, the Expert System should provide the user, upon their request, an explanation of its behavior. Secondly, the system should utilize a user-friendly dialogue that takes into account the level of computer literacy on the part of the user and the system's area of application. Next, it should utilize an application-oriented programming language and the ability for modification to the Knowledge Base whenever it becomes necessary to do so.

Expert System designers must be cognizant of the user of the system, the Knowledge Base, and the programming language to be used by the system. Kritz (1987) indicates that a thorough understanding of these three elements is essential in order to design a Expert System; thus satisfying the needs of a particular client and insuring the efficient function of the system.

Expert System Components

The major parts of an Expert System are a Knowledge Base, User Interface, and the Inference Engine. The following section will provide the reader with more indepth explanation of these three components.

The Knowledge Base

Silverman (1987) states that the Knowledge Base of an Expert System consists of facts and heuristics. Facts are bits of information that are commonly shared, publicly
available, and generally agreed upon by experts in the field. Heuristics, on the other hand, are rules of good judgement that are characteristic to experts in the field. Another definition of heuristics is private knowledge on the part of experts that has not found its way into the public domain. This knowledge consists of "rules of thumb" which enable experts to make educated guesses whenever necessary. (Hayes-Roth, Waterman, and Lenat, 1983)

How then may one develop a Knowledge Base based on heuristics? According to Duce and Ringland (1988) this task may be accomplished by the use of Logic, Semantic Networks, Frames, and Rule Based Systems. The use of mathematical logic and its symbols are used by many Expert Systems that make use of a symbolic programming language. The Knowledge Base is arranged into a series of IF-AND statements. These statements are preceded by a condition which will be true given the IF-AND statement which follows it. For example:

You may write personal checks
IF you have a checking account
AND have money in a checking account
AND have checks

The condition statement will not be true if any of the criterion of the IF-AND statements is not met. Rule based systems are closely related to the Logic method, but the knowledge is represented by a series of IF-THEN rules. In using this method of knowledge representation, an example the would be structured in the following way:
IF you have a checking account
AND have money in a checking account
AND have checks
THEN You may write personal checks

If the conditions of the IF/AND antecedents are met, then the consequent or THEN statement is then executed by the Expert System.

Semantic Networks attempt to describe the concepts behind words and the way in which these meanings interact. The terms nodes and links are used to describe the Knowledge Base of such a system. The nodes in a semantic network describe concepts or meanings (e.g. University, LSU), while links describe relationships. The most common link used in semantic networks is the IS-A link. A simple semantic network could be LSU IS-A University. Frames are used to make particular distinctions within the Knowledge Base. Frames could describe universities as sea grant, land grant, public, or private. The frames provide more specific descriptions of universities. Using the previous example of LSU, it meets some of the criterion specified by the frames. Therefore, more specific information is available to accurately describe LSU, since it is a sea grant, land grant, and public institution of higher learning.

Once the Knowledge Base has been compiled into one of the four knowledge representation methods, one is now ready to search the Knowledge Base for answers to particular questions.

A number of approaches to knowledge acquisition may be utilized in the development of the Knowledge Base. Parsaye
and Chingnell (1988) offer three ways in which this task may be accomplished: (1) Interviewing; (2) Learning by Interaction; and (3) Learning by Induction. The interview process has been the most prevalent method of knowledge acquisition. In this process a Knowledge Engineer and expert work together in the development of the Knowledge Base. The Knowledge Engineer's role in the process is to integrate the information supplied by the expert into a form which can be utilized by the Expert System. In many cases the expert will have had little or no exposure to the capabilities of Expert Systems; and thus, could not develop the Knowledge Base without assistance. The Knowledge Engineer must have a thorough knowledge of the particular Expert System software and its capabilities; as well as, some knowledge of the heuristics of the Knowledge Base. These responsibilities emphasize the critical role of the Knowledge Engineer in the Expert System development process.

On the other hand, Parsaye and Chingnell contend that the development of user-friendly Expert Systems has increased the usage of the "learning by interaction" approach. In this method, the role of the Knowledge Engineer is diminished to a great extent or completely eliminated. The expert interacts with the User Interface of the system to achieve the desired results.

The "learning by induction" method eliminates both parties and is done by the Expert System itself. Induction on
the basis of specified characteristics and/or attributes may be conducted on large amounts of raw data to provide generalizations for utilization by the user.

Once the Knowledge Base is completed it should be evaluated to assess its accuracy. Graham and Jones (1988) offer the following dimensions in which knowledge should be evaluated as shown in Table 2.

Table 2.

<table>
<thead>
<tr>
<th>Dimensions of Knowledge Base Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scope</td>
</tr>
<tr>
<td>Granularity</td>
</tr>
<tr>
<td>Uncertainty</td>
</tr>
<tr>
<td>Completeness</td>
</tr>
<tr>
<td>Consistency</td>
</tr>
<tr>
<td>Modality</td>
</tr>
</tbody>
</table>

What does the knowledge cover?
How detailed is the knowledge?
To what degree is the knowledge factual?
Is the knowledge complete?
Are the results consistent?
Do we need this knowledge?

(Graham and Jones, 1988, p. 22-23)

In order to develop a sufficient Knowledge Base for an Expert System these six dimensions of knowledge must be considered by the developer. The elements of scope and granularity are essential in order to understand the content of the Knowledge Base itself. The scope of knowledge needed to perform one task may be much greater in depth, breath, and granularity than the knowledge needed to perform another task; although the utility of these Knowledge Bases may be of equal value to the users.
The degree to which the Knowledge Base is complete may never be known due to the rapid growth of knowledge. The Knowledge Base must reflect any quantitative or qualitative changes in the general knowledge of the subject area. In addition, the Expert System developer must take great care to assure the consistency of the Knowledge Base for its results to comply with generally accepted facts. Once accomplished, the degree of uncertainty of the Knowledge Base will be kept to a minimum.

Finally, the Expert System developer must constantly consider the necessity (modality) of the knowledge throughout the Knowledge Base development process. This may not be a task for one individual to perform. In some cases, many individual experts in a given field may assist in the development of a Knowledge Base.

Once the Knowledge Base is in place some means must be available for the user to gain access to the information. Attention to the next major component of Expert Systems, the Inference Engine, is now warranted.

The Inference Engine

According to Townsend and Feucht (1986) the Inference Engine (or rule interpreter) performs two basic tasks. The first task is to examine the Knowledge Base rule structure. The second task determines the order in which the rules are executed during the consultation. The authors refer to these
two components of the Inference Engine as inference and control.

Townsend and Feucht (1986) state that the inference component operates under the following premise: If a rule is false, then the conclusion must be false and vice versa. This would seem overly simplistic explanation of the system, but one must realize that Expert Systems do not come close to having the reasoning capacity of human beings. Consider the following rule statement: IF Test score is < 60, THEN Student grade is F. The logical conclusion that the Expert System would draw from this rule is that the student's grade is an F because his or her test score was less than 60. Perhaps there are other extenuating circumstances that may cause a student to score less than 60 on the test. On the other hand, if the rule statement was constructed in the following manner:

\[
\begin{align*}
\text{IF} & \quad \text{Test score is } < 60 \\
\text{AND} & \quad \text{Student's level of test preparation} \\
& \quad \text{is LOW} \\
\text{AND} & \quad \text{Student is TARDY} \\
\text{AND} & \quad \text{Student's test anxiety level is HIGH} \\
\text{AND} & \quad \text{Student did not complete test} \\
\text{THEN} & \quad \text{Student grade is F}
\end{align*}
\]

This particular rule statement provides much more information on the possible causes of the low test score. The Inference Engine can now query the user for additional information before drawing a conclusion. The Inference Engine must also be able to deal with incomplete or missing information. Information on the student level of test preparation and anxiety may not be readily available to the teacher, but the
Expert System should be able to reach a conclusion based on the information that is available to the system.

Townsend and Feucht (1986) go on to explain that the Inference Engine should also possess a control component. The control component determines the order in which the rules are scanned and determines if information in the Knowledge Base can be changed during the consultation. The control component, in their estimation, has four components: (1) Matching, (2) Selection, (3) Firing, and (4) Action. (pp. 34-35)

The matching function seeks to fit the pattern of the rules against the pattern of the known facts. In the example of the student test grade, there was only one rule with the following information: IF Test score is < 60. If a complete Knowledge Base was developed for this Expert System, there may be many rules which begin with a similar IF statement. The control module would then search the Knowledge Base in cycles, matching the appropriate rule as more information is provided by the user. This is the selection function.

The firing (execution) function occurs once the appropriate rule is accessed, given the criterion of the rule set. The conclusion can then be added, if desired, to the Knowledge Base. This action constitutes the action function of the Inference Engine. In general, the path that the Inference Engine takes in examining the rules within the
Knowledge Base is data-dependent or non-deterministic in nature.

Generally, two reasoning schemes are used within Expert Systems. According to Sauers (1988) these schemes are forward chaining and backward chaining. In forward chaining systems, the rule interpreter (Inference Engine) begins with an initial set of facts which are then matched to the rule antecedents (IF statements). The rules are executed in a forward fashion from antecedent to consequence (Then statement). This process will continue until a conclusion is reached or the rule interpreter can find no new antecedents to match the last consequence.

Backward chaining systems begin the process with a set of facts which represent the solution to the problem. The consequent of a rule is matched with the antecedents which are intended to show the reasoning behind the given consequent. This closely resembles the method of inductive vs. deductive reasoning utilized by humans in problem solving.

The User Interface

The User Interface is a term used to describe the extent of the interaction between the individual user and the Expert System. The Expert System "...is a tool which is designed to support the user in his or her task and not act as a human substitute." (Beerel, p. 139) According to Vickery, Vickery, and Brooks (1986) the best mode of communication between the user and machine would be a natural language interface. This
natural language interface would reflect the language of the Knowledge Base and should be familiar to the user. This would provide a "common ground" for the user and machine to interact.

The User Interface can include explanation facilities, a graphical display of the reasoning process, or on-line help systems. A second type of User Interface is used by the system developer to modify, de-bug, and expand the Knowledge Base. Some Expert System shell programs allow the developer to trace lines of reasoning, view the reasoning process of the software, and provide graphical views of the Knowledge Base. (Harmon & King 1985) This interaction could also take the form of keyword responses on the part of the user to prompts from the system. (Sommerville & Wood 1986)

Rich (1986) uses the term "User Model" in addressing the User Interface problem and offers some techniques to achieve this goal. The first is to identify the vocabulary and concepts employed by the user and then gauge the response with which the user seems satisfied. This could be accomplished by examining the way the client uses the Expert System. If the client seems comfortable and confident with the system, then it would be logical to assume that he or she had a firm grasp of the vocabulary and concepts within the Knowledge Base, as well as some experience in the use of computers. On the other hand, if the user is having problems deriving information from the Expert System, that person may be a novice and may need
help. This help could be offered in a variety of ways, such as pull down help menus, a dictionary system of commands, or on-line help commands. Ingwersen (1986) uses the term "information retrieval" in his discussion of the User Interface. There are two cognitive structures involved in the information retrieval process. The first structure is Information Retrieval Knowledge, which consists of knowledge about the system setting, the information retrieval process, or search procedures. The second structure consists of Conceptual Knowledge, which is knowledge of the concepts, terminology, goals, and expectations of the topic. Expert System users will certainly possess differing levels of expertise in each of these cognitive structures. Figure 1 illustrates Ingwersen's classification of these searcher groups.
Ingwersen's paradigm is useful in the identification of the level of competency which individuals possess in the use of computers and Expert Systems. The knowledge engineer must be cognizant of the level of computer literacy possessed by users of the Expert System. A high degree of expertise concerning the information present in the Knowledge Base does not necessarily mean a high degree of computer literacy on the part of the user. In order to develop the Expert System proposed herein, a base assumption will be that the users of the system will be under the End User and Layman categories.
Expert System Shell Programs

An Expert System shell program consists of the Inference Engine and User Interface. These two components have been developed by computer programmers using any one of a number of computer languages, i.e. Prolog, Turbo-Prolog, LISP, etc.. A thorough knowledge of these computer languages would normally be a prerequisite for the developer of an Expert System. The level of expertise in these computer languages may intimidate potential users and developers of Expert Systems. Although an individual is lacking the proper computer programming expertise necessary to develop an Expert System, he or she may be able to adapt the Knowledge Base to meet the operational constraints of the Expert System shell program.

Bratko (1986) describes the Expert System shell as being domain independent, which simply means that the Expert System shell may be used in a variety of settings. As long as the Knowledge Base is designed using the constraints of the shell program, the operation of the shell program will be unaffected by the Knowledge Base domain. It is imperative that the Knowledge Engineer understand the design constraints of the particular Expert System shell program that he or she is using. In addition, a determination must be made as to the compatibility of the information with respect to the Expert System shell program. Failure to do so will lead to incompatibility on the part of the systems and thus, result in
a waste of time and effort on the part of everyone involved in
the development of the Expert System.

Applications of Expert System Technology

Expert System technology has been applied in a variety of
fields of study. What follows is a general overview of the
different commercial Expert Systems that are currently in use.
The information will include: 1) Area of Application, 2) Program Name, and 3) Description of the program.

MEDICINE

MYCIN
Designed to consult with physicians on infectious disease
diagnosis and treatment.

(Davis, 1986)

CADUCEUS
Designed for use in internal medicine. The Knowledge Base has
been in development for the past fifteen years and comprises
approximately 80% of the knowledge in internal medicine.

(Davis, 1986)

PUFF
Interprets measurements from respiratory tests conducted in a
pulmonary function laboratory.

(Harmon and King, 1985)

MATHEMATICS

MACSYMA
One of the earliest Expert Systems, designed to perform a wide
variety of mathematical operations in symbolic mathematics.

(Davis, 1986)

CHEMISTRY

DENDRAL
Interprets data from a mass spectrometer in order to determine
the molecular structure of compounds.

(Davis, 1986)
AEROSPACE

NAVEX
Interprets navigational data during space shuttle flights.

(Davis, 1986)

ELECTRONICS

ACE (Automated Cable Expert)
Provides an analysis of trouble reports from residential phone customers to repair technicians.

(Davis, 1986)

XCON
Configures Digital Equipment Corporation's VAX-11/780 computer systems as per customer specifications.

(Harmon and King, 1985)

GEOLOGY

PROSPECTOR
Aids geologists in mineral exploration, regional resource evaluation, ore deposit identification, and drilling site selection.

(Davis, 1986)

DIPMETER ADVISOR
Interprets log data from oil wells concerning the inclination (dip) of formations.

(Davis, 1986)

DRILLING ADVISOR
Assists oil rig drilling supervisors in resolving and avoiding drilling related problems.

(Harmon and King, 1985)

AGRICULTURE

DAIRY EXPERT
Aids in the analysis and diagnosis of the reproductive status of dairy herds.

(Levins and Brown, 1988)

COMAX (Crop Management Expert)
Determines the correct rate and timing of irrigation and fertilizer applications to crops.

(Buriak, 1988)
BUSINESS

AUDITOR
Developed to make diagnostic judgments about the adequacy of a firm's allowance for bad debts.

(O'Leary, 1987)

TAXMAN
A model of the facts of certain corporate cases and Internal Revenue Service information that produced the tax consequences of corporate reorganizations.

(O'Leary, 1987)

EDP AUDITOR
Developed to assist individuals in the audit of computerized accounting systems.

(O'Leary, 1987)

The preceding list only represents a sample of the many commercial Expert Systems that are currently in use worldwide.

The reader should also note the job specific nature of many of these Expert Systems. For example, ACE and EXCON were developed by private companies in order to address or solve a specific problem within the organization. On the other hand, systems such as DENDRAL, DRILLING ADVISOR, and MYCIN adapt themselves to a wider range of user needs. The prototype Expert System that has resulted from this research will specifically assist local vocational educators in Louisiana in applying for Carl D. Perkins vocational education funds.

Educational Applications of Expert Systems.

Since education by its very nature is multi-disciplinary and draws on expertise from many varied sources, it seems that Expert Systems would be an appropriate technology for utilization by teachers and administrators. Some present applications of Expert Systems in education can be found, yet,
the potential of these systems has not been fully realized or recorded.

According to Hofmeister and Ferrara (Ferrara, Prater, Baer, 1987) special education is one educational area which has applied this technology. Sarkees and Scott (1986) state that the Education for All Handicapped Students Act of 1975 (P.L. 94-142) has as one of its mandates the guarantee of non-discriminatory testing in the placement of potential special education students. One handicapping classification in which a student may be placed is that of Learning-Disabled. Public Law 94-142 defines this condition as follows:

Specific learning disability means a disorder in one or more of the basic psychological process involved in understanding or in using language, spoken or written, which may manifest itself in an imperfect ability to listen, think, speak, read, write, spell, or do mathematical calculations. The term includes such conditions as perceptual handicaps, brain injury, minimal brain dysfunction, dyslexia, and developmental aphasia.

(Sarkees and Scott, 1986, p. 46)

Hofmeister and Ferrara (Ferrara, Prater, Baer, 1987) developed an Expert System to assist in this assessment process. The authors estimated that assessment experts would need to determine the following as valid criteria for placement of students in the learning-disabled category: 1) A discrepancy
between the student's expected and actual academic performance; 2) The student's learning disability must not be caused by some other handicapping condition, such as mental retardation; and, 3) The lack of academic achievement must not result from cultural, economic, or environmental factors. The system was given the name CLASS.LD2 by its developers.

The Knowledge Base of CLASS.LD2 is based on the opinions of several nationally recognized authorities on learning disabilities, as well as the Utah and federal regulations regarding P.L. 94-142. The user utilizes the student assessment data in response to a series of questions posed by CLASS.LD2. The system was designed to provide a second opinion regarding student placement in lieu of a professional. Hofmeister and Ferrara (1986, p. 237) state that this software is also being used as part of the training of graduate students in the development of their diagnostic and classification skills.

Juell and Wasson (1988) developed an Expert System to diagnose learning problems in elementary mathematics using "MicroExpert", a commercial shell program. MicroExpert Ver. 1.0 (Thompson and Thompson, 1985) is an inexpensive "backward chaining" or "goal-driven inference" Expert System shell.

The data on student math ability is derived from the KeyMath Diagnostic Arithmetic Test. This instrument consists of fourteen subtests and is designed to provide data in the areas of content, operations, and applications. A numerical
value of student achievement is derived from each of the fourteen subtests. An analysis of the data from the arithmetic test will determine the student's ability to perform mathematical functions using whole numbers. The user can then input the student scores into the Expert System and receive information on the most appropriate course of action for student remediation. (Juell and Wasson, 1988)

The two previous Expert Systems discussed have been used to aid in the diagnosis of student behaviors. Haynes, Pilato, and Malouf (1987) assert that Expert Systems can make a significant impact in the area of educational decision-making. One Expert System, CAPER (Computer-Assisted Planning for Educational Resources), is now being developed to address the problem of over-referral for special education services in schools that have a large number of students that have been identified as being "at risk" by their teachers. Using a Knowledge Base consisting of effective classroom intervention measures, the system will recommend the best instructional strategy for a student prior to their placement in a special education program.

Ragan and McFarland (1987) list four areas, which in their opinion, hold promise to educators in the application of Expert Systems technology. These areas are:

1. Knowledge clarification
2. Computer consultants
3. Decision support systems
4. Content modules for intelligent tutoring systems

(Ragan and McFarland, 1987 p. 33-36)
The knowledge clarification component deals with the development of the Knowledge Base for Expert Systems. Computer consultation is a function of the User Interface, and as the authors suggest, should follow the same process that one would use in gathering expertise from a human expert. Educational Expert Systems can provide users with information on the opinions available to the user in solving a problem. Expert Systems would serve as the Knowledge Base for intelligent tutoring systems. These tutoring systems would consist of very large databases on various specific topics within a curricular area. The development of such databases would be a complex task, but the results of this effort would yield great benefits in the individual instruction of students.

Applications of Expert Systems in Vocational Education.

After a thorough review of education literature, little information on the use of Expert Systems in education was found. This condition, according to Roth and McEwing (1986), will change with the development of better and less expensive Expert System shell programs. They observe a great deal of potential in the use of Expert Systems in Computer Aided Instruction applications within vocational education. They further assert the value of these systems in teaching students problem solving, information handling, and communication skills. Roth and McEwing (1986) issue an implied warning to
vocational educators to be prepared to integrate this new technology into the classroom.

Buriak (1988) stresses the importance of agricultural related Expert Systems in enhancing the vocational agricultural curriculum. A commercially available Expert System such as Crop Management Expert (COMAX), with its GOSSYM cotton growth simulation model would provide students with a wealth of information in order to increase the productivity of their cotton crops. This Expert System would also allow students to run simulations with varying moisture, soil fertility, and crop disease situations in order to predict cotton productivity.

Levins and Brown (1988) also see similar applications for an Expert System called "Dairy Expert", which is designed to help vocational agriculture students learn about reproductive management of dairy herds.

**The Carl D. Perkins Vocational Educational Act of 1984**

The federal government's investment in vocational education had a significant beginning with the passage of the Smith-Hughes Act of 1917. This act and subsequent amendments provided for a continual appropriation of federal funds in the areas of agriculture, home economics, and trades and industry until 1963. The Vocational Education Act of 1963 was enacted by Congress to provide comprehensive legislation for the development of new vocational programs, maintenance and improvement of existing programs, encourage research, and
provide work-study programs for disadvantaged youth. (Roberts 1971, pp. 114-115)

The Carl D. Perkins Vocational Act of 1984 constitutes the most comprehensive rewrite to federal aid to vocational education since the Vocational Education Act of 1963. According to Hopkins, Thomas, and Zdorkowski (1985) this legislation stresses "...(1) new programs, (2) program expansion, improvement, and modernization, and (3) special populations..." (p. 4). Table 3 illustrates the major elements of the Carl Perkins Act:
Table 3

Elements of the Carl D. Perkins Vocational Education Act

TITLE I VOCATIONAL EDUCATION ASSISTANCE TO THE STATES

PART A ALLOTMENT AND ALLOCATION
PART B STATE ORGANIZATIONAL AND PLANNING RESPONSIBILITIES

TITLE II BASIC STATE GRANTS FOR VOCATIONAL EDUCATION

PART A VOCATIONAL EDUCATION OPPORTUNITIES
PART B VOCATIONAL EDUCATION PROGRAM IMPROVEMENT, INNOVATION, AND EXPANSION

TITLE III SPECIAL PROGRAMS

PART A STATE ASSISTANCE FOR VOCATIONAL EDUCATION SUPPORT PROGRAMS BY COMMUNITY BASED ORGANIZATIONS
PART B CONSUMER AND HOMEMAKER EDUCATION
PART C ADULT TRAINING, RETRAINING, AND EMPLOYMENT DEVELOPMENT
PART D COMPREHENSIVE CAREER GUIDANCE AND COUNSELING PROGRAMS
PART E INDUSTRY-EDUCATION PARTNERSHIP FOR TRAINING IN HIGH-TECHNOLOGY OCCUPATIONS

TITLE IV NATIONAL PROGRAMS

PART A RESEARCH
PART B DEMONSTRATION PROGRAMS
PART C VOCATIONAL EDUCATION AND OCCUPATIONAL INFORMATION DATA SYSTEMS
PART D NATIONAL COUNCIL ON VOCATIONAL EDUCATION
PART E BILINGUAL VOCATIONAL TRAINING
PART F GENERAL PROVISIONS

TITLE V GENERAL PROVISIONS

PART A FEDERAL ADMINISTRATIVE PROVISIONS

(Carl D. Perkins Act, 1984, pp. 1-2)

In Louisiana, the State Board of Elementary and Secondary Education acts as the State Board of Vocational Education, and is responsible for the administration of Carl D. Perkins
vocational funds. The Division of Vocational Education of the State Department of Education is specifically responsible for monitoring the application for Carl D. Perkins funds at the local level and the development of the State Plan which outlines the state expenditures of federal funds.

Generally, local education agencies apply for Carl Perkins funds during the first few months of the new year. These applications are in the form of a Local Plan for the Application of Vocational Education Funds. These Local Plans are then forwarded to the State Department of Education for review by the Division of Vocational Education. Local applicants are provided with manuals detailing the federal and state guidelines for the Local Plan. These manuals have been developed for local parish and city school systems, state technical institutes, and state colleges and universities. The manuals are similar in content, the difference being the number of titled programs available to secondary and post-secondary applicants.

The information required to complete the Local Plan application can be classified into two areas; demographic and ancillary information. Demographic information is basically numerical in nature; for example this information could include census data of Title II A student enrollments during a specific school year, the amount of local and state matching funds, or specific information concerning the number of students to be served by a Community-Based Organization. On
the other hand, ancillary information includes the written data used to describe the student outcomes of various vocational programs, a justification of the supplemental services that may be needed for a particular program, or a description of the vocational assessment process used by a local educational agency.

Finally, supervisory personnel from the Division of Vocational Education evaluate each application based on a set of objective and subjective criteria. Subjective evaluations are made concerning program objectives, student outreach, and the quality of the student assessment process. However, objective evaluations are made on the procedural organization of the Local Plan. A checklist of specific items to be included in the Local Plan such as a 50-50 match, a certificate of assurances, or program summary is included in the Evaluation Sheet. These and other items are either included or missing from the Local Plan application, and thus duly noted by the evaluator. It is in the area of objective evaluation in which an Expert System would serve as a source of information concerning the procedural aspects of the Local Plan. Interpretative information, on the other hand, would still need to be addressed by trained supervisory personnel.
CHAPTER III
Methodology

Introduction

The purpose of this chapter is to provide information on the methodology utilized in the development of the prototype Expert System. The prototype expert system resulting from this research was specifically designed to assist Louisiana vocational educators in the preparation of the Local Plan required under the Carl D. Perkins Vocational Education Act.

Some form of federal, state, and local linkage has existed in vocational education since 1917 and the passage of the Smith-Hughes Act. This pattern of linked support by the federal, state, and local governments for vocational education is expected to continue. An Expert System designed to integrate the regulations and policies of each of the three governmental levels would be of value now and into the future.

The methodology utilized in this study was derived from procedures commonly used by Expert System designers. A six-stage development process created by Wolfgram, Dear, and Galbraith (1987) was utilized for this research project. This model effectively embraces characteristics common to other recognized development schemes. The stages of development in this model are:
Table 4

Six Stage Expert System Development Process

STAGE 1 IDENTIFICATION AND DEFINITION OF THE PROBLEM

STAGE 2 DEVELOPMENT OF THE PROTOTYPE

STAGE 3 CONSTRUCTION OF THE EXPERT SYSTEM

STAGE 4 TESTING AND EVALUATION OF THE EXPERT SYSTEM

STAGE 5 INTEGRATION AND IMPLEMENTATION

STAGE 6 MAINTENANCE OF THE EXPERT SYSTEM

(Wolfgram, Dear, and Galbraith, 1987 pp. 16-20)

Stages one through four of Wolfgram's (et.al) model are utilized in this study. Stages five and six depend on adoption of the prototype by the Louisiana Department of Education for further development.

The prototypical expert system developed in this study was based on the Carl D. Perkins Vocational Education Act of 1984. During the development of this expert system the Carl D. Perkins Act of 1984 was in the process of reauthorization. The Act, as revised, is expected to be signed into law during 1990. Once the reauthorization becomes law new federal, state, and local regulations will be developed. Since the Knowledge Base of Expert Systems should be continually updated to enhance their utility, any changes in the Carl D. Perkins Act, or the Local Plan can be integrated into the existing expert system.
Once these stages have been accomplished, the end result of this research project will produce a prototype expert system; designed to provide vocational educators with accurate and up-to-date information concerning the Carl D. Perkins Act of 1984, as well as, the development of the Local Plan application.

Stage 1 Identification and Definition of the Problem

Given the complexity of the Carl D. Perkins Act, the logical organization of an expert system to assist vocational educators in the Local Application process was of primary importance. The application process could be accomplished in a number of ways, but given the lack of experience on the part of many vocational educators with expert system technology, a decision was made to design the User Interface and Knowledge Base of the prototype reflect the existing organization and appearance of the Act, and current Local Plan Application documents.

As a result of design decision the Knowledge Base of the expert system was divided into two parts. The first part of the system provided the user with a means of searching for specific information within the Carl D. Perkins Act. The second part of the system was designed to assist the user in the development of the Local Plan Application itself. A comprehensive explanation of the elements to be included in these two Knowledge Bases is included in Chapter 4.
A variety of PC based expert system Shell programs were available for potential use. The shell program selected was 1st Class Fusion by Programs in Motion, Inc. of Wayland, Massachusetts. 1st Class Fusion does not utilize the typical "IF/THEN" rule structure utilized by most expert system shells. Instead, with 1st Class Fusion the Knowledge Engineer specifies an outcome for a situation, i.e. PASS/FAIL, ACCEPT/REJECT. Once the outcome is specified, the knowledge engineer establishes a set of conditions which govern the specified outcome. When these conditions are established, 1st Class Fusion will "write" the rule thus resulting in a considerable savings in time on the part of the knowledge engineer. Additionally, 1st Class Fusion is one of a few expert system shell programs capable of rule induction. This feature will allow 1st Class Fusion to generate a "rule tree" without the aid of the knowledge engineer using information within the Knowledge Base. The combination of user or machine generated rules provides the knowledge engineer with a great deal of flexibility in the development of a Knowledge Base.

Stage 2 Development of the Prototype

Wolfgram et.al (1987) defines stage two of the development as the phase of the process "... which represents finding the basic concepts which represent knowledge via key metarules, relations, and identifying the flow of information needed to describe the problem-solving process" (p. 17). The Carl D. Perkins Act of 1984 and the State Department of
Education's Local Plan for the Application of Vocational Education Funds Fiscal Year 1989-1990 for Parish and City School Systems served as the primary sources of information for the knowledge base of the expert system developed by this researcher.

The State Department of Education's Local Plan for the Application of Vocational Education Funds Fiscal Year 1989-1990 is one of a number of manuals that have been developed for use by secondary schools, vocational-technical schools, and universities for the purpose of applying for vocational funds under the Carl D. Perkins Act. These manuals provide the policies and procedures to be followed by local education agencies to apply for funding under each of the entitlement programs of the Carl D. Perkins Act.

Another source of expertise utilized in the development of the Knowledge Base was personnel within the Research Coordinating Unit of the Division of Vocational Education in the Louisiana Department of Education. These individuals represented a rich source of information concerning the problems encountered in the Carl D. Perkins Act and the Local Plan application process.

Stage 3 Construction of the expert system

Phase three of the development process was concerned with the actual construction of the expert system. During this stage, the knowledge base and the user interface were developed. The structure derived in Stage 2 was integrated
into a knowledge base using the rule editor in 1st Class Fusion. During this process, the user interface was also developed to complement the knowledge base. At this point the final design of a user interface was undertaken. 1st Class Fusion allows the use of either menu selection, fill-in-the-blank forms, or a combination of both methods. A series of HELP screens were also simultaneously developed to provide the user with any specialized supplemental information concerning the Carl D. Perkins Act or the Local Plan application process.

**Stage 4 Testing and Evaluation of the Expert System**

During phase four of the development process the prototypical expert system was tested and evaluated to determine the accuracy of the knowledge base, the reliability of the expert system, and to determine the ease of interface with the user. This stage represents the final integration and testing which is needed to ascertain the accuracy of the Knowledge Base, "rule tree", and user interface.

Within the limits of the current PC based technology, the prototype was deemed functional and complete. Anticipated mathematical and printer routine enhancements to 1st Class Fusion should enable the prototype, at a later point, where it can print entire local application forms. The mathematical enhancements will enable the expert system to monitor dollar allocations as the user proceeds through the expert system.
Stage 5

Integration and Implementation

Stage five dealt with the integration of the expert system into the public realm. Once the prototypical expert system was completed, an administrative decision will need to be made as to the integration of this expert system into vocational education agencies across the state. In-service education will be necessary to acquaint vocational supervisors and educators with the use of the prototype expert system. This and other implementation decisions will rest with the Louisiana Department of Education, not this researcher; however, the researcher will be available for consultant services.

Stage 6

Maintenance of the expert system

Finally, it will be necessary to periodically update the knowledge base of the expert system to reflect any changes in enabling legislation or Local Plan Application procedure. In addition, feedback on the part of users of the expert system will serve as a basis for any additional changes that may be needed in the user interface of the system. The rule editor in 1st Class Fusion will simplify this process.
CHAPTER IV
Expert System Organization and Development

Introduction

The chapter is divided into four parts. Section one consists of an overview of the 1st Class Fusion expert system shell program and its capabilities. Section two covers the initial planning and purpose for the system. Section three discusses the development of the knowledge base and the use the 1st Class Fusion expert system shell program to achieve this phase of the project, and Section four covers the final integration of the system into its present form.

Section One

An expert system consists of a knowledge base, inference engine, and user interface. The knowledge base consists of a data base containing specific information usually in the form of a series of IF/THEN statements. The inference engine and user interface provide the means of access to this information. The knowledge engineer has the responsibility of integrating these three components into a useful program of value to the audience for which it was designed. 1st Class Fusion provides the knowledge engineer with a considerable amount of flexibility to achieve this goal.

1st Class Fusion was developed by Programs in Motion of Wayland, Massachusetts, and is an updated version of the company's 1st Class expert system shell program. The program is designed for use in IBM compatible personal computers. The
program costs approximately $1,300.00 and requires at least 512K of RAM memory for proper operation. Programs in Motion provides its clients with comprehensive program documentation, technical support, sample knowledge bases, and periodic software updates. The program is written in Microsoft Pascal and Macro Assembler.

The Knowledge Base data utilized by 1st Class Fusion may be in the form of numerical, text, or logical factors. The information (examples) contained in the knowledge base may be represented by the use of "Examples Screens" and "Rule Trees" as shown in Figure 2.

![Figure 2. Examples Screen](image)

The "Examples Screen" in Figure 2 is a spreadsheet display of the IF/THEN rule statements. It is used to present a graphic representation of the IF/THEN rule statements represented in the knowledge base of the expert system. 1st Class Fusion
uses the terms FACTOR/RESULT to refer to the IF/THEN conditions. The items listed across the top of Figure 2 are the factors within the rule. The result is the last item on the right-hand side of the figure. 1st Class Fusion will allow the use of 38 separate factors, 128 results, and 255 examples (rules) in a knowledge base.

The "Rule Tree" in Figure 3 is an example of one of the sample knowledge bases in 1st Class Fusion. The "Rule Tree" is a graphical representation of the information in the knowledge base.
Rule for knowledge base FEATURES 8:30 pm 10/10/1989

---- start of rule ----
1: FEATURES??
2: |TechSpecs:SPECS??
3: | |again:——— #FEATURES
4: | |start:——— #DEMO
5: | quit:——— #QUIT
6: |General:GENERAL??
7: | |again:——— #FEATURES
8: | |start:——— #DEMO
9: | quit:——— #QUIT
10: |KE-int-face:KE-INT-FACE??
11: | |again:——— #FEATURES
12: | |start:——— #DEMO
13: | quit:——— #QUIT
14: | Algorithms:ALGORITHMS??
15: | |again:——— #FEATURES
16: | |start:——— #DEMO
17: | quit:——— #QUIT
18: |Uncertainty:UNCERTAINTY??
19: | |again:——— #FEATURES
20: | |start:——— #DEMO
21: | quit:——— #QUIT
22: |LargeSystem:LARGESYSTEM??
23: | |again:——— #FEATURES
24: | |start:——— #DEMO
25: | quit:——— #QUIT
26: | Compatibility:COMPATIBILITY??
27: | |again:——— #FEATURES
28: | |start:——— #DEMO
29: | quit:——— #QUIT
30: |LogicEngine:LOGICENGINE??
31: | |again:——— #FEATURES
32: | |start:——— #DEMO
33: | quit:——— #QUIT

---- end of rule ----

Figure 3. 1st Class Fusion Rule Tree

This form of data representation affords the knowledge engineer the ability to trace the inference path of each item in the knowledge base. This option is useful in the debugging phase of the development of an expert system. In addition, the knowledge engineer has the ability to make modifications to the knowledge base while in the operating mode.
One feature of 1st Class Fusion which sets this expert system shell program apart from others is its ability to perform inferences within knowledge base data. This process involves the analysis of the specific "characteristics" of information contained within the knowledge base and the relative importance of these "characteristics" to the user. Examples of "characteristics" may include such demographic data as gender, height, weight, or educational level. Suppose the variables of weight, educational level, and gender are important to the user; height is included in the knowledge base data, but should have no impact on the final results given by the expert system. Given this information, the inferencing mechanism within 1st Class Fusion would not include height when it generates the rule tree since this variable has no effect on the results generated by the expert system. This procedure can provide the knowledge engineer with new insights on the relative importance of data within the knowledge base; a standard by which one reflects on the decision-making process associated with the knowledge base, and a means of reducing the number of conditions required for a correct response in large and complex knowledge bases.

1st Class Fusion will allow forward and backward chaining, both within and between knowledge bases. The developers of 1st Class Fusion advocate the use of small, specific knowledge bases when developing an expert system. This procedure will allow faster access to the information and
expedite debugging of the knowledge base; while allowing for the development of extremely large knowledge bases.

1st Class Fusion provides the knowledge engineer with the opportunity to assign "confidence factors" to the RESULTS in the knowledge base. Given the nature of the knowledge base, there may be instances in which 100% certainty in the RESULTS may not be appropriate. In these cases, 1st Class Fusion will allow the knowledge engineer to assign percentages of confidence to the "confidence factor" for each result. Thus, allowing the inference mechanism to select among the different "confidence factor" values. This will offer more than one alternative, allow query of the user for more information, present a result, or provide no advice at all.

From a developmental standpoint 1st Class Fusion provides editorial power over the complete knowledge base. In addition, the knowledge engineer may also access spreadsheet or database information located outside the expert system, as well as external programs. Online help is also provided to the knowledge engineer by the use of "hot keys", which have been designated for this specific purpose. Another option of great value is the Report Generation function; this command will provide the user a detailed description of the knowledge base session in printed form.

Finally, 1st Class Fusion allows the knowledge engineer considerable freedom in the development of the user interface. Default or customized screens may be utilized in the
presentation of the data, as well as menu selection or typed responses on the part of the user. These screens may be developed in full color or monochrome depending on the hardware available to the population to be served. Customized help screens, specifically for the expert system, may also be developed and utilized by specific "hot keys". The user may also employ the "instant replay" feature of 1st Class Fusion in order to replay the knowledge base session and modify a response if so desired. Lastly, the security of an expert system is maintained by the encoding of the data by 1st Class Fusion. An unlimited number of run-time versions of an expert system may be copied and executed using a run-time program provided with the system. (Programs in Motion, 1989)

To provide further insight into the development process, the following explanation will step through the development of a simple expert system. This will include a step-by-step account of the procedures and commands used to develop a knowledge base using 1st Class Fusion. Unless otherwise specified, the procedure(s) presented were used to develop the majority of the knowledge bases in Carl Perkins Advisor.

There are five major screens that are utilized by the knowledge engineer, these are presented in Figure 4.
Files

Definitions

Examples

Methods

Rule

Advisor

Figure 4. 1st Class Fusion Menu Screens

These six menu screens are the heart of this shell program. An overview of the function of each of these screens and some related commands will be necessary in order to understand how expert systems are developed using this program.

The Files Menu

Figure 5 is a graphic representation of the Files screen and is the first screen to be viewed upon the execution of this program. The Files screen provides a listing and a method of selection of knowledge bases that have been developed for retrieval and editing. This screen also provides access to other programs while running 1st Class Fusion.
The Get command is used to select an existing knowledge base, by means of the Up and Down arrow keys on the keyboard, for review and/or editing. The Save command is initiated to save a knowledge base file. The files have a "KBM" extension which identifies the file as a knowledge base. 1st Class Fusion tags the files with this extension to differentiate these from text or report files which also may be generated by 1st Class Fusion. The Print/export command allows the user to print or export the contents of a knowledge base to a printer for examination, or to a file for later use with other programs. The DOS command is used to exit 1st Class Fusion while in use and initiate another program and then return to 1st Class Fusion. Finally, the Map command is used to initialize the RoadMap feature in 1st Class Fusion. This feature allows the user to view the forward and backward chains of each of the
knowledge bases within an expert system. This feature is useful in the debugging process.

The Definitions Menu

1st Class Fusion utilizes a spreadsheet format to develop knowledge bases that are similar in structure to that of LOTUS 123. As mentioned in Chapter Two, the knowledge base of an expert system consists of a series of IF/THEN statements. 1st Class Fusion utilizes a similar format but refers to these statements as FACTORS and RESULTS. In order to illustrate this method consider, the construction of the knowledge base BEGIN.

The first step in the development of this knowledge base is to utilize the DEFINITIONS function of 1st Class Fusion. The DEFINITIONS screen will look similar to Figure 6.

![Figure 6. 1st Class Fusion Definition Screen](image-url)
The information on line one is utilized for the identification of the command statements available in the DEFINITIONS menu. The term FACTOR refers to the "IF" conditions of the knowledge base. 1st Class Fusion will support a definition of up to 31 factors and one result column, or 30 factors, one memo, and one result column. Each factor may be assigned up to 128 values per factor.

In the example, there are two FACTORS, a MEMO factor which is a title screen, and a CHOICE factor, which allows the user to choose between the knowledge bases CARLPERK and CARLPK2. A FACTOR may be active or inactive in the development of a knowledge base. In this case, the Factor MEMO is inactive, since this factor is only a title screen it has no impact on the final results. The variable CHOICE is an active factor, which means that it is used as a condition in the knowledge base. In this case there are two values associated with this factor; 1 and 2. 1st Class Fusion defines these factor variables as VALUES.

There are four VALUES in this knowledge base, two under CHOICE and two under RESULTS. The two values under RESULTS represent the two knowledge bases which will provide the means of access to the Local Plan Advisor and the Legislative Advisor. 1st Class Fusion utilizes a "#" symbol followed by a name to refer to a knowledge base. The other two variables were given the names 1 and 2; this does not mean that they are numerical values in this particular case. Choice 1 allows the
user to access the CARLPKR knowledge base and choice 2 will provide access to the CARLPK2 knowledge base.

1st Class Fusion provides the developer with a considerable amount of flexibility in the utilization of VALUES. These values may be logical (yes, no), conditional, or numeric. Specific or nonspecific numeric values may be utilized by the use of <, >, ≤, or ≥ symbols to address ranges in values.

The TEXT function allows the developer to input text data into FACTOR, VALUE, RESULT, or MEMO variables. The information may be typed in directly using the text editor or imported from another file. In order to import this information, the data must be in an ASCII text file format. The procedure used throughout the development of this expert system was to break down the large ASCII files into smaller files and then import these files as necessary. In order to keep track of these smaller files, they were given names corresponding to the outline format of the Carl Perkins Act and the Local Plan.

The CHANGE function allows the developer to change the names, or values, of any of the variables on the screen by highlighting the item to be changed and selecting this function. The developer may delete any of the information by selecting DELETE and change the position of any variable with the MOVE function. Finally, the ACTIVATE function will render any FACTOR active or inactive.
The Examples Menu

The DEFINITIONS function as mentioned earlier is used to set up the IF/THEN conditions of the knowledge base. The EXAMPLES function forces the developer to specify the outcomes of the variables selected in the DEFINITIONS menu. The EXAMPLES menu consists of a series of cells in which this information is entered as shown in Figure 7.

| Example, Replicate, Change, Activate, Move, Delete |
| Files Definitions | Examples | Methods | Rule Advisor |
| (F1=Help) | 12 Examples in APHASIA | (F5=Definitions) | (F6=Methods) |

| 1: | normal | abnormal | abnormal | abnormal | Broca's |
| 2: | abnormal | abnormal | normal | abnormal | Pure_w_deaf |
| 3: | abnormal | abnormal | abnormal | normal | Wernicke's |
| 4: | abnormal | abnormal | normal | abnormal | Global |
| 5: | abnormal | abnormal | normal | normal | Conduction |
| 6: | normal | normal | abnormal | abnormal | Trans_c_n |
| 7: | abnormal | normal | abnormal | abnormal | Trans_c_s |
| 8: | abnormal | normal | abnormal | abnormal | Trans_c_r |
| 9: | normal | normal | normal | abnormal | Anomic |
| 10: | normal | normal | abnormal | normal | Alex_wo_fgr |
| 11: | normal | normal | abnormal | normal | Alex_u_Agr |
| 12: | normal | normal | normal | normal | normal |

Figure 7. 1st Class Fusion Examples Screen

The Examples screen uses a similar structure as that of the DEFINITIONS screen. The developer selects EXAMPLE and is first given a list of the values to be included into the knowledge base. The developer has complete control over the sequencing of the values within a factor. In this case, choice 1 and its associated text is used to select the CARLPERK knowledge base. To build the first example, the developer would select EXAMPLE and the cell under MEMO on row
one would be highlighted. Since MEMO has no value variables associated with this factor, it would be necessary to move to the next column which would be the CHOICE factor.

Once CHOICE is selected the values for this factor will appear in a pop-up menu near the top of the menu screen. The developer will select the appropriate value. The RESULT will appear as an entry in the specific cell in the EXAMPLES editor. The same procedure is used over again regardless of the number of FACTORS and RESULTS within the knowledge base.

1st Class Fusion can accommodate approximately 900 rows of data. If required, a knowledge base of that size would be difficult to debug and edit, so the developer should strive to keep a knowledge base to a manageable size. If that much information is necessary, it would be advisable to break the knowledge base down into a series of smaller knowledge bases and chain forward or backward to access these knowledge bases.

The REPLICATE command is used to copy a row of data in another position in the EXAMPLES list. This function is useful in reproducing a particular row of data a number of times. Once this is done the developer may change one or more values of the data by using the CHANGE command. This shortcut saves a considerable amount of time in data input. Finally, the ACTIVATE, MOVE, and DELETE commands serve the same function as in the DEFINITIONS menu.
The Methods Menu

The next major development function is contained in the METHODS menu, as shown in Figure 8. Up to this point the knowledge base of the expert system has been developed by defining the FACTORS and RESULTS of the knowledge base. Next, the EXAMPLES menu provided the opportunity to organize the interaction of the FACTORS and RESULTS and thus set the limits under which these conditions exist. The METHODS menu provides the mechanism for inferencing these conditions and the framework for either forward or backward chaining to related knowledge bases. This menu is the heart of the 1st Class Fusion program and provides the developer with six different options on which to build the rule base that will run the system.

![Methods Menu](image-url)

**Figure 8. 1st Class Fusion Methods Menu**
The first, and easiest, method of developing a rule is to utilize the OPTIMIZE method. In this mode the 1st Class Fusion shell program builds the rule in such a fashion as to ask for the fewest number of possible responses. The program disregards irrelevant and redundant factors in its search for the optimum rule. Unfortunately, this method may overlook relevant data since the program seeks to organize the knowledge base into the smallest Rule Tree which will still provide an accurate response. In this mode of operation a FACTOR must make an impact on the final outcome of the Rule. If the FACTOR does not make an impact it is considered to be unimportant, and is omitted from the rule.

In order to extract a response from the user for each factor in the knowledge base, the LEFT-RIGHT method may be utilized. 1st Class Fusion will build the rule in the left-right order that the FACTORS appear in the DEFINITIONS screen. If a response is not necessary on the part of the user, the PROGRESSIVE method is useful to sequentially link factors to yield a final result or answer.

The EXHAUSTIVE method is used in order to generate a rule in which all the factors appear on every path through the rule. This method seeks to generate every possible combination of each factor within the rule. 1st Class Fusion also allows the developer the option of personally building the rule via the CUSTOMIZE method. In this mode the developer
has complete control over the sequencing of the factors and the responses to be elicited by the user.

The final method for building an expert system with 1st Class Fusion does not utilize rules. Instead, the MATCH method asks for a response to a particular factor on the part of the user and then searches the database for an appropriate response. For example, if the answer to a question is "YES", then 1st Class Fusion will search the knowledge base for the conditions for the "YES" response to that particular question. There may be a number of "YES" responses which are associated with the question. At this point, 1st Class Fusion will infer another condition associated with these positive responses and prompt the user for additional responses to this new condition. This procedure continues until a final result is obtained. This mode of operation does not use a formal rule tree to organize the knowledge base.

The Rule and Advisor Menus

The final two commands available to the developer are the RULE and ADVISOR commands. The RULE command graphically displays the rule and its structure for examination and editing if needed, as shown in Figure 9.
The ADVISOR command allows the developer to run the expert system and see exactly what the user will see during the session as shown in Figure 10.
The ADVISOR command also allows the developer to return back to the DEFINITIONS, METHODS, and EXAMPLES screens for debugging and editing.

**SECTION TWO**

The first phase of the development of the system consisted of an in-depth study of the Carl D. Perkins Act of 1984 and the "1st Class Fusion" expert system shell program. The Carl Perkins Act is divided into a very short introductory section and five major title programs. Each title is subdivided into major sections and a outline form is used to identify each sub-part under each section. For example:

"Sec. 113. (a)(1)(A) Any State desiring to receive funds from its allotment for any fiscal year shall submit to the Secretary a State plan for a three-year period in the case of the initial plan and a 2-year period thereafter, together with such annual revisions as the State board determines to be necessary.

"(B) The planning periods required by paragraph (1) of this subsection shall be coterminous with the planning program periods required under section 104(a) of the Job Training Partnership Act.

(Carl D. Perkins Vocational Education Act, 1984, pp.13-14)
The text above was taken from Section 113, sub-section (a), paragraph 1A of the Carl D. Perkins Act. This outline form provided a natural structure for locating specific information and cross-referencing related information within the Act.

The Division of Vocational Education of the Louisiana Department of Education provides a guide to the Application of Carl D. Perkins Funds to local education agencies. There are three Guides that are available to eligible recipients. One is for secondary vocational programs in Parish and City school systems. A second guide has been developed for postsecondary Technical Institutes; and a third guide for Colleges and Universities. These local guides provide guidelines regarding the specific information required for inclusion into the Local Plan Application by each eligible recipient. The guides also provide specific information to local applicants on state policy guidelines concerning each of the specific title programs of the Carl D. Perkins Act itself. The guide to be used in this study will be the one developed for Parish and City School systems. This guide is the most comprehensive of the three guides with regard to the Title programs within the Carl D. Perkins Act.

The current Guide for Parish and City School systems is divided into 12 different sections which correspond to specific program areas contained in the Carl D. Perkins Act. These sections contain the information needed by local applicants in order to apply for vocational funds and must be
completed and returned to the Division of Vocational Education for evaluation on an annual basis.

To be of maximum benefit, an expert system should incorporate information from both the Carl Perkins Act and state policy. It is assumed that the Federal legislation will not undergo major changes over a period of time, although state and local policies may vary over the fifty states. One way to gain broader national acceptance of this system would be to develop two separate knowledge bases and provide the user with access to both sources of information. This method would allow the separate modification of each of the two major knowledge bases and the modification of the Local Plan Advisor to meet the specific local and state policies of states across the nation.

The initial conversion of the printed matter mentioned above into a form which could be utilized by 1st Class Fusion was accomplished by the use of a word processor. The Carl D. Perkins Act was initially typed in Wordperfect 5.0. Once this task was completed, the whole Act was then compiled into one document and checked for accuracy. The text files were converted into ASCII format for import by the text editor of 1st Class Fusion.

The Local Plan guide was obtained on diskette from the Division of Vocational Education of the Louisiana Department of Education in WordStar format. This data was converted to ASCII format by the use of Word for Word.
Section 3

Carl Perkins Legislative Advisor

The development of the expert system relied heavily on an extensive knowledge of the 1st Class Fusion Expert System Shell Program. One of the first decisions that needed to be addressed was to find a suitable name for the expert system. The title "CARL PERKINS ADVISOR" was assigned to the expert system and will be used in reference to this expert system from this point forward.

Each knowledge base contains a term identical to the name of the knowledge base. The addition of this term allows the user to loop back to the beginning of the knowledge base in order to replay the selection or make another selection from the menu. Every effort was made to abbreviate each name to closely match the terminology used within the Carl Perkins Act. This method of identification was used in order to enhance the debugging process.

The first knowledge base to be developed was one which would provide a bridge between the information contained in the Carl D. Perkins Act and the information specific to the Local Plan. The contents of the knowledge base BEGIN is presented in Figure 11.

![Figure 11. Map of Knowledge Base BEGIN](image)
This knowledge base contains the initial screens of the system and provides the user the opportunity to enter the CARLPERK knowledge base providing specific information in the Carl D. Perkins Act, Figure 12 illustrates the structure of this knowledge base. The CARLPK2 knowledge base covers the local application process and will be examined in more detail later in this chapter.

```
CARLPERK
   └── CP
       ├── TITLE1
       │    └── TITLE2
       └── TITLE3
            └── TITLE4
                 └── TITLE5
```

Figure 12. Map of Knowledge Base CARLPERK

The CARLPERK knowledge base serves as a bridge to provide access to each of the five title programs contained within the Carl Perkins Act. Information screens are included in this knowledge base to guide the user in the selection of one of the knowledge bases, as well as for the selection itself.

The information included in the CP knowledge base in Figure 13 deals with the Statement of Purpose and the Authorization of Appropriations of the Carl Perkins Act. This information is included in the CPA and AUTHOR sections of the knowledge base. The CP section provides the user with the opportunity to loop back to the beginning of this knowledge base in order to make another selection. The CARLPERK section
allows the user to loop back to the beginning of the expert system and the QUIT section exits the program and returns to DOS.

![Diagram](image)

**Figure 13. Map of Knowledge Base CP**

The TITLE 1 knowledge base, as shown in Figure 14, is used as a bridge to provide the user with access to the following knowledge bases:

- **AA** Allotment and Allocation
- **IND** Indian and Hawaiian Native Programs
- **SA** State Administration
- **COUNCIL** State Council on Vocational Education
- **SP** State Plans

![Diagram](image)

**Figure 14. Map of Knowledge Base TITLE1**

Knowledge base AA provides information on the allotment and allocation formulas that are used to calculate the amount of
money each state and United States territories will receive from the Carl D. Perkins Act. The IND knowledge base contains information on the authorization and administration of the Indian and Hawaiian Natives Programs covered under this Act. State Administration policies and procedures are covered under the SA knowledge base. Figure 15 shows the structure of each of these individual knowledge bases.

![Diagram of knowledge bases]

Figure 15. MAPS OF KNOWLEDGE BASES AA, IND, and SA

The next knowledge base provides information on the State Council on Vocational Education. The knowledge base COUNCIL is divided into four parts. COUNCIL provides general information concerning the State Council, MEMBER deals with the rules concerning the membership of the State Council, RESP
contains specific information on the responsibilities of the State Council, and UOF describes the guidelines pursuant to the use of funds by the State Council. Figure 16 illustrates the structure of this knowledge base.

\[ \text{COUNCIL} \rightarrow \text{MEMBER} \rightarrow \text{RESP} \rightarrow \text{UOF} \]

**Figure 16. Map of Knowledge Base COUNCIL**

The knowledge base SP provides information on the formulation of the State Plan for vocational education. Due to the significant amount of data associated with this section of the Act, it was necessary to divide this knowledge base into two sections. The first knowledge base SP contains procedural information related to the development of the State Plan. Secondly, knowledge base CONTENT provides specific information on seventeen components that must be addressed by the State Plan. Figure 17 contains the structure of each of these two knowledge bases.
Title II of the Carl D. Perkins Act contains guidelines concerning Basic State Grants for Vocational Education. The information related to this section of the Carl D. Perkins Act was divided into four separate knowledge bases. The knowledge base TITLE2 serves as a bridge to access information stored within the other four knowledge bases. Figure 18 illustrates the structure of this knowledge base.

Figure 17. MAPS OF KNOWLEDGE BASES SP and CONTENT

Figure 18. Map of Knowledge Base TITLE2
The knowledge base TITLE2 provides the user with a selection of topics within Title II of the Act, and the ability to loop back to the TITLE2 menu screen for additional information if necessary. CARLPERK allows access to the main menu screen of the advisor. The USEOFF knowledge base contains information specific to the uses of funds associated with this section of the Act. WSA provides the user with information on the Within State Allocation of Title II. Details on the Criteria for Services and Activities for the Handicapped and Disadvantaged is located in the CRIT knowledge base. Finally, data regarding Part B of Title II, Vocational Education Program Improvement, Innovation, and Expansion may be found in the IMP knowledge base.

Title III of the Carl D. Perkins Act provides general information concerning the implementation and administration of Special Programs in vocational education. This section of the Act is divided into the following five parts:

- **Part A** State Assistance for Vocational Education Support Programs by Community-Based Organizations
- **Part B** Consumer and Homemaker Education
- **Part C** Adult Training, Retraining, and Employment Development
- **Part D** Comprehensive Career Guidance and Counseling Programs
- **Part E** Industry-Education Partnership for Training in High-Technology Occupations

Since this part of the Act provides information on five separate funded programs, it was necessary to develop five
knowledge bases to coincide with each section of Title III. The knowledge base TITLE3 serves as a bridge to access the five knowledge bases within this section of the Act. Figure 19 displays the structure of the TITLE3 knowledge base.

```
  CCG
 /    \
ADT /     \
---  PART
  \\
  CHE
   \\
STAST
```

**Figure 19.** Map of Knowledge Base TITLE3

The STAST knowledge base provides information concerning State Assistance for Vocational Education Support Programs by Community-Based Organizations. Data pertaining to Consumer and Homemaker Education is located in the CHE knowledge base. Adult Training, Retraining, and Employment Development is dealt with in the ADT knowledge base. Programs in Comprehensive Career Guidance and Counseling are located in the CCG knowledge base. Finally, information dealing with Industry-Education Partnerships for Training in High-Technology Occupations can be found in the PART knowledge base.

Title IV of the Carl D. Perkins Act contains six sections which focus on the maintenance and development of National Programs. These sections are divided as follows:
Part A Research

Part B Demonstration Programs

Part C Vocational Education and Occupational Information Data Systems

Part D National Council on Vocational Education

Part E Bilingual Vocational Training

Part F General Provisions

Part A is designed to stimulate research within the area of vocational education. This section establishes the National Center for Research in Vocational Education, provides for a National Assessment of vocational programs, and provides guidelines for the Research Activities to be conducted under this Act. Due to the large amount of data associated with this Part of Title IV, it was necessary to develop a separate knowledge base in which to locate this information. Figure 20 illustrates the structure of knowledge base 4PARTA.
The structure of the remaining knowledge bases within TITLE4 are shown in Figure 21 below:

```
<table>
<thead>
<tr>
<th>4PARTA</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEMO</td>
</tr>
<tr>
<td>PARTC</td>
</tr>
<tr>
<td>PARTD</td>
</tr>
<tr>
<td>PARTE</td>
</tr>
<tr>
<td>PARTF</td>
</tr>
</tbody>
</table>
```

**Figure 21.** Map of Knowledge Base TITLE4

The knowledge base DEMO contains information related to Demonstration Programs authorized under this Act. Data associated with Vocational Education and Occupational Information Data Systems is contained in the PARTC knowledge base. PARTD includes information pertaining to the National Council on Vocational Education. Authorization for programs for Bilingual Vocational Training is contained in the PARTE knowledge base. Finally, PARTF contains the General Provisions related to the Distribution of Assistance concerning the programs covered in TITLE IV.

The final section of the Carl D. Perkins Act, TITLE V, contains the General Provisions of the Act. This section of the Act is divided into two parts, the first part covers information regarding the Federal Administrative Provisions of the Carl D. Perkins Act. The second part provides specific definitions concerning terminology used within the Act, as well as conforming amendments which were added during the
legislative process. Figure 22 illustrates the structure of the knowledge base TITLE5.

Figure 22. Map of Knowledge Base TITLE5

The development of this knowledge base required the creation of two forward chaining knowledge bases. All of the information pertaining to Title V, with the exceptions of Definitions and Withholding Judicial Review, are located within the TITLE5 knowledge base. Information concerning the Judicial Review of State Plans and the state administration of the Carl D. Perkins Act is contained within the knowledge base WITH. Figure 23 illustrates the structure of the knowledge base WITH.

Figure 23. Map of Knowledge Base WITH

Information related to the definitions of the various terms used throughout the Act are included in the DEF knowledge base. Due to the large number of definitions in the Carl D. Perkins Act, it was necessary to divide the number of definitions into two separate knowledge bases. The DEF
knowledge base provides a means of forward-chaining to the DEF1A and DEF2A knowledge bases as shown in Figure 24.

Figure 24. Map of Knowledge Bases DEF, DEF1A, and DEF2A

This concludes the description of the structure of the knowledge bases utilized in the Legislative Advisor of this Expert System.

How does one use the Legislative Advisor to find specific information within the Carl D. Perkins Act? The procedure is fairly straightforward once the user selects the Legislative Advisor as shown in Figure 25.
In this example the Carl Perkins Legislative Advisor is highlighted. Once <ENTER> is pressed, the user has the opportunity to select the Introduction, Titles I through V, or exit to the Carl Perkins Financial Advisor, as shown in Figure 26.
Please select the appropriate Title of the Carl Perkins Vocational Education Act in which you need advice.

<table>
<thead>
<tr>
<th>Introduction</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Title I — Vocational Education Assistance to the States</td>
<td></td>
</tr>
<tr>
<td>Title II — Basic Grants For Vocational Education</td>
<td></td>
</tr>
<tr>
<td>Title III — Special Programs</td>
<td></td>
</tr>
<tr>
<td>Title IV — National Programs</td>
<td></td>
</tr>
<tr>
<td>Title V — General Provisions</td>
<td></td>
</tr>
<tr>
<td>Local Application Advisor</td>
<td></td>
</tr>
</tbody>
</table>

**Figure 26.** Carl Perkins Legislative Advisor Selection Screen

The user may select a choice by using the Up or Down Arrows on the Numeric Keypad or by pressing the Space Bar. In this case, TITLE III - SPECIAL PROGRAMS is highlighted and once <ENTER> is pressed the following screen appears as shown in Figure 27:

**Figure 27.** Title III Selection Screen
This screen is the title screen for Title III, its purpose is to provide the user with a general outline on the contents within Title III. Once the user presses <ENTER> to continue, the next screen, as shown in Figure 28, provides the user with the means for finding specific information within this title program.

![Figure 28. Title III Selection Menu](image)

In this example information on Part B - Consumer and Homemaker Education has been selected, and this selection will yield the results shown in Figure 29.
Please select the topic in which you desire information concerning Part B

<table>
<thead>
<tr>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consumer and Homemaker Grants</td>
</tr>
<tr>
<td>Information Dissemination and Leadership</td>
</tr>
<tr>
<td>Program Development</td>
</tr>
<tr>
<td>Support Services and Activities</td>
</tr>
<tr>
<td>Use of Funds</td>
</tr>
</tbody>
</table>

Figure 29. Consumer and Homemaker Selections

This screen offers the user five selections under this subpart of Title V, Part B - Consumer and Homemaking Education. In this case Consumer and Homemaking Grants has been selected, and will display the screen in Figure 30.
"Consumer and Homemaker Education Grants

"Sec. 311. From the portion of the allotment of each State under section 101 available for this part, the Secretary is authorized to make grants to States to assist them in conducting consumer and homemaker education programs. Such programs may include (1) instructional programs, services, and activities that prepare youth and adults for the occupation of homemaking, and (2) instruction in the areas of food and nutrition, consumer education, family living and parenthood education, child development and guidance, housing, home management (including resource management), and clothing and textiles.

Figure 30. Consumer and Homemaking Text

This screen contains the text associated with this section of the Carl Perkins Act. The user has the opportunity to examine this screen, or in other cases multiple screens of selected text. Below the textual data are options for the user to select additional information under this sub-section, additional information under Title III, return to the Carl Perkins Legislative Advisor, or Exit the Expert System entirely.

Subsequent sessions using the Carl Perkins Legislative Advisor will follow a similar format to that stated above. Specific information within the Carl D. Perkins Act can be accessed in about four steps. Now the Local Plan Advisor will be explained in detail.
Local Plan Advisor

The Local Plan Advisor is designed to assist local vocational educators in the preparation of the Local Plan for the Application of Vocational Education Funds. There are 13 different title programs that are included in the Parish and Secondary School Systems version of the manual. In order to access this section of Carl Perkins Advisor it was necessary to develop a knowledge base to serve as a bridge to each of the 13 major knowledge bases associated with the title programs. Figure 31 illustrates the structure of the knowledge base CARKPK2 which performs this function:
Figure 31. Map of Knowledge Base CARLPK2

The CARLPK2 and CARLPERK knowledge bases provide the opportunity for the user to loop back to the CARLPK2 knowledge base or to access the Legislative Advisor respectively. The remaining knowledge bases are associated with each of the thirteen title programs in this version of the Local Plan.

In order to provide the users of this Expert System with an efficient method for information gathering and data input, most of these knowledge bases consist of two parts. The knowledge base names which end in an "A" designation are knowledge bases which require the user to respond in either an
affirmative or negative way to whether certain kinds of information have been included in their narrative during the development of the Local Plan Application. This type of information would include specific information concerning the goals and objectives for students enrolled in a title program, vocational assessment methods and results, and program evaluation methods.

Knowledge bases without an 'A' designation serve as the financial advisor programs for each title program. In these knowledge bases the user would be required to enter data concerning student enrollments, the amount of local matching funds, or the amount of state funds available for matching purposes. Upon the completion of this section of the Advisor the user would have an estimate of the amount of local, state, and federal vocational funds available within their local parish.

In order to link these two knowledge bases together so they may function together as a unit, 1st Class Fusion provided a means to forward and backward chain the two knowledge bases into essentially one knowledge base. In essence the user follows a forward chaining procedure to access a particular knowledge base and once in that knowledge base a backward chaining procedure is used to access the financial advisor knowledge base. This is a programming procedure accomplished by 1st Class Fusion and is not evident to the user during a session with the Advisor. Figure 32
illustrates this structure using the two knowledge bases associated with the application for Handicapped funds.

![Diagram of Knowledge Bases HAND and HANDA]

**Figure 32.** Map of Knowledge Bases HAND and HANDA

The HANDA knowledge base contains information concerning the procedural process for the application of Handicapped funds. The user may forward chain to the HAND knowledge base which contains the Financial Advisor, the BEGIN knowledge base which returns to the Main Menu of the Advisor, the CARLPK2 knowledge base which contains the Main Menu for the Local Plan Advisor, and the CARLPERK knowledge base which contains the Main Menu for the Legislative Advisor. The HAND knowledge base on the left-hand side of the HANDA knowledge base represents a backward chaining process from the Financial Advisor back to the HANDA knowledge base. A similar structure was utilized for most of the knowledge bases within the Local Plan Advisor.

Figure 33 shows the structure of the knowledge bases associated with the information needed to apply for Disadvantaged funds under the Carl D. Perkins Act.
Figure 33. Map of Knowledge Base DISADVA
Information on funds available for vocational education programs for individuals with Limited English Proficiency are illustrated in Figure 34.

Figure 34. Map of Knowledge Base LEPA
Vocational education programs for Adult Training and Retraining are located in the following knowledge bases, as shown in Figure 35.

Figure 35. Map of Knowledge Base ADULTA
In order to complete the Advisor for Single Parent/Homemaker programs it was necessary to utilize a variation of the structure of the previous knowledge bases listed above. The Financial Advisor had to be modified to contain nine separate data entry cells for Agriculture/Agribusiness, Business
Education, General Cooperative Education, Health Occupations, Home Economics Consumer/Homemaking, Home Economics Wage Earning, Industrial Arts/Technology Education, Marketing Education, and Trade and Industrial Education programs. Individual financial knowledge bases were developed for each one of the program areas and were backward chained to a Financial Advisor knowledge base which was modified to link the nine knowledge bases together. The user will enter financial data concerning each of the program areas and totals will be displayed by the Financial Advisor. Single Parent/Homemaker programs may also be administered by local educational agencies and Community-Based Organizations; this fact necessitated the development of two knowledge bases to provide specific procedural information on the development of the Local Plan for these two organizations. The structure of this knowledge base is depicted in Figure 36.

Figure 36. Map of Knowledge Base SPHC
Information dealing with Sex Bias/Stereotyping funds can be located in the SEXBA and SEXB knowledge bases, as shown in Figure 37.

![Diagram of Knowledge Bases]

**Figure 37.** Map of Knowledge Base SEXBA

Funding for the Improvement, Innovation, and Expansion of existing vocational programs is provided by the Carl D. Perkins Act and details may be found in the knowledge bases presented in Figure 38.

![Diagram of Knowledge Bases]

**Figure 38.** Map of Knowledge Base IIEXPA

The Carl D. Perkins Act of 1984 included provisions for State assistance for vocational education Support Programs by Community-Based Organizations. The provisions for this type of vocational education delivery system may be found in the knowledge bases shown in Figure 39.
Figure 39. Map of Knowledge Base CBOA

Vocational education programs for Consumer and Homemaking Education are included in the following knowledge bases located in Figure 40.

Figure 40. Map of Knowledge Base CONHOMA

The procedures for applying for funding in the areas of Research Activities and Curriculum Development are almost identical, thus the knowledge bases for these sections of the Local Plan Advisor followed a similar structure as shown in Figure 41.
Finally, two other knowledge bases remain that are associated with the Vocational Guidance aspects of the Carl D. Perkins Act. These two knowledge bases should be consulted by the user only after the Handicapped, Disadvantaged, Limited English Proficiency, Adult Training and Retraining, Single Parent/Homemaker, Sex Bias, and Improvement, Innovation, and Expansion knowledge bases have been utilized and the information within the respective financial advisors is complete. Formulas programmed within the knowledge bases calculate a percentage of the total funds in each of the Title II-Part A and Title II-Part B knowledge bases to yield a total amount of funding available for Vocational Guidance. In addition these two knowledge bases did not require the development of a backward chaining knowledge base as shown in Figure 42.
Finally, two other knowledge bases remain that are associated with the Vocational Guidance aspects of the Carl D. Perkins Act. These two knowledge bases should be consulted by the user only after the Handicapped, Disadvantaged, Limited English Proficiency, Adult Training and Retraining, Single Parent/Homemaker, Sex Bias, and Improvement, Innovation, and Expansion knowledge bases have been utilized and the information within the respective financial advisors is complete. Formulas programmed within the knowledge bases calculate a percentage of the total funds in each of the Title II-Part A and Title II-Part B knowledge bases to yield a total amount of funding available for Vocational Guidance. In addition these two knowledge bases did not require the development of a backward chaining knowledge base as shown in Figure 42.

![Figure 42. Map of Knowledge Bases VGPT1A and VGPT2A](image)
The following session using the Handicapped Advisor will illustrate the general structure and procedures in utilizing this section of the Advisor. Access to the Local Application Advisor is accomplished by highlighting the Local Application Advisor selection as shown in Figure 43.

Figure 43. Carl Perkins Advisor Selection Menu

Figure 44 shows the Financial Advisor screen which lists each of the thirteen programs covered in the Local Plan.
Please select the area in which you would like to develop a local application:

<table>
<thead>
<tr>
<th>Handicapped</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disadvantaged</td>
</tr>
<tr>
<td>Limited English Proficiency</td>
</tr>
<tr>
<td>Adult Training and Retraining</td>
</tr>
<tr>
<td>Single Parent/Homemaker</td>
</tr>
<tr>
<td>Sex Bias/Stereotyping</td>
</tr>
<tr>
<td>Improvement, Innovation, and Expansion</td>
</tr>
<tr>
<td>Community-Based Organizations</td>
</tr>
<tr>
<td>Consumer and Homemaking Education</td>
</tr>
<tr>
<td>Research Activities</td>
</tr>
<tr>
<td>Curriculum Development</td>
</tr>
<tr>
<td>Vocational Guidance: Title II Part A</td>
</tr>
<tr>
<td>Vocational Guidance: Title II Part B</td>
</tr>
</tbody>
</table>

Figure 44. Financial Advisor Selection Screen

In this example the Handicapped Advisor is highlighted by either pressing the Space Bar or Arrows located on the Numeric Keypad. Once the user presses the Enter key as shown in Figure 45 will appear.
This section of the Carl Perkins Advisor is designed to assist you in the development of your local application for HANDICAPPED FUNDS. The advisor will ask questions concerning whether or not certain specific items of information have been included in your Local Plan.

The advisor will also assist you in the estimation of the amount of local, state, and federal money available for your parish.

Remember the deadline for the submission of Local Plans is March 27, 1989.

Press <F1> for information concerning the Directions for Submitting Application(s).

Press <F2> for information concerning the Evaluation of Applications.

Press <F4> for information concerning the GUIDELINES for this program.

This initial Message Screen is used to orient the user to the information contained in this particular section of the Advisor. Information is presented concerning the Function keys, which are used to provide the user with additional detailed information concerning various topics. These "hot keys", as they are referred to in 1st Class Fusion are developed using a subroutine called HelpWindow. HelpWindow commands are developed by the knowledge engineer by the identification of the Function Key, the execution of HelpWindow, the name of the ASCII text file, the location of the text within the text file, and the size of the Window in which the information is to be displayed. A typical programming command would look like this: (2:call helpw handi 3 1 15 72 25). Reading left to right, the command initializes the F2 key and the HelpWindow program. The ASCII file which
contains the text is called HANDI and the number three identifies the paragraph identification number of the text in use. The final four numbers designate the window size to be used by this Help screen. Since all of the information included in the Message Screen cannot be displayed on one screen, the message "PgDn" is displayed on the bottom of the screen. This command prompts the user to press the "PgDn" key to go on to the next screen as shown in Figure 46.

Figure 46. Handicapped Advisor Memo Screen

The message in the "box" is used to remind the user of the extent of the fiscal year and that approved programs will receive reimbursement during that fiscal year. Once the user presses the RETURN key the screen in Figure 47 appears on the screen.
This section of the Local Plan Advisor is built into the majority of the knowledge bases in order to provide the user with the option of accessing procedural data, developing financial data, or a combination of both. As stated earlier, most of the knowledge bases consist of pairs which contain either procedural and financial information. This screen provides the opportunity to branch to each of the knowledge bases or to utilize both. For the purpose of this demonstration the complete Handicapped Advisor will be utilized, as shown in the highlighted bar in Figure 47.

When the complete Advisor is utilized by the user, procedural information associated with the particular Title program is presented first. Then the Financial Advisor is initialized. Each of the screens is designed to include the
same questions that are posed to the user by the Local Plan Manual.

In Figure 48 the first question concerns the identification of needs of handicapped students as determined by the local needs assessment. In this case, a positive or negative response is required on each of the five items below question A.

![Figure 48. Handicapped Advisor Question A](image)

1st Class Fusion provides the option for the Knowledge Engineer to develop data entry cells within an expert system. The following data entry cell is written in the 1st Class Fusion command language: ??NAME&&&&. The question marks identify the variable NAME as an unknown, the "&" symbols provide space for data entry in the expert system itself.

Once all of the information is completed, the user is prompted for a response as to whether the information for this
specific part of the Handicapped Advisor has been completed. The default value is always YES in order for the user to proceed rapidly through the Advisor. Each of the screens dealing with procedural information throughout the Local Plan Advisor follow a similar format.

Many times all of the information that is needed by the user cannot be shown on one complete screen. If this is the case, then HelpWindows are used to present the additional information. Figure 49 illustrates the form of a typical Help Screen.

![Figure 49. Typical Help Screen](image)

The commands PgUp and PgDn allow the user to access more information within the Help Screen. The RETURN symbol allows the user to exit the Help Screen. Print will send the information within the Help Screen to the printer so a hard copy of the information may be obtained by the user.
In the event that specific information may not have been completed for inclusion into the Local Plan and the user provides a negative response to the prompt. A Warning Message is shown to remind the user that the approval of the Local Plan is in jeopardy. These warnings shown in Figures 50 and 51 were developed using 1st Class Fusion's Window program. Window provides the Knowledge Engineer the opportunity to interrupt the operation of the expert system in order to present information that may be of importance to the user. This function is similar to the HelpWindow command but does not access information from a text file. Window provides the option of entering one line of text directly into the Window command.

Figure 50. Warning Screen 1
C. Did you identify and justify the supplemental equipment needed to modify the vocational program(s) based on the needs assessment and objective(s)? Provide details for requested services unique to a particular program, as needed. (Submit an equipment list with the budget).

Press <F1> for General Information on this topic.
Press <F2> for information on Supplemental Equipment.

If this information is unavailable select YES to continue
press a key to continue...

**Figure 51. Warning Screen 2**

Figures 52 and 53 present further examples of the use of data entry fields. Yes or NO responses are required in Figure 52 for the identification of program areas for Supplemental Training. In the case of Figure 53, another screen is included to allow the user to input a total of ten high schools.
5. Supplemental Training (Complete if Applicable)

Press <F1> for General Information on this topic.
Press <F2> for more information on Supplemental Training.

A. Identify appropriate program area(s).
Type yes or no as a response.

- [ ] Business
- [ ] GCE
- [ ] Industrial Arts/Technology Education
- [ ] Health Occupations
- [ ] Home Economics (Consumer and Homemaking)
- [ ] Home Economics (Wage Earning)

Figure 52. Data Entry Screen

C. List the school(s), program area(s), and exact date(s) for requested supplemental training.

<table>
<thead>
<tr>
<th>SCHOOL</th>
<th>PROGRAM AREA</th>
<th>DATES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crowley High School</td>
<td>Agriculture Education</td>
<td>Aug. 1989 to May 1998</td>
</tr>
<tr>
<td>Church Point High</td>
<td>Business Education</td>
<td>Aug. 1989 to May 1998</td>
</tr>
</tbody>
</table>

Figure 53. High School Data Entry Screen

The rest of the screens containing the procedural information associated with the development of the Handicapped section of the Local Plan Advisor follow a similar format.
The structures of the Financial Advisor and Carl Perkins Legislative Advisor are similar, but the main difference between the two knowledge bases is the use of numerical data in the Financial Advisor. 1st Class Fusion provides the Knowledge Engineer with the opportunity to program formulas into the expert system to manipulate data entered by the user. Figure 54 shows the initial display in the Handicapped Financial Advisor. Data entry fields are included for the date and the name of the user, but the parish name was programmed into the Carl Perkins Advisor as a global variable. 1st Class Fusion treats a global variable as one that does not change over the course of a session. In other words, when the expert system finds the variable "PARISH" anywhere in the program the word Acadia will be substituted as the value of that variable.

![Figure 54. Initial Handicapped Financial Advisor Screen](image)

Press (f2) for more information on state and local matching funds.

HANDICAPED ADVISOR

This section is designed to assist you in the preparation of an application for Handicapped Set-Aside Funds.

Date: 04/30/88
Name: Brady LeVrier
Parish: Acadia

Press 1 to continue
Figures 55 and 56 are examples of data entry fields generated by the Definitions function of the 1st Class Fusion Shell program. In this case, the variable is given a name and it is identified as a numerical variable, and the user enters a value at the prompt developed by 1st Class Fusion.

![Financial Advisor Data Entry Screen]

Figure 55. Financial Advisor Data Entry Screen
Figure 55 prompts the user to enter demographic data concerning the number of handicapped students that were enrolled in the parish during the 1987-88 school year. Figure 56 asks the user to supply data related to the amount of local matching funds available on the part of the local parish.

Figure 57 is an example of a method of summarizing data using the 1st Class Fusion Expert System Shell program. The user would have the opportunity to print a hardcopy of the information presented below by either pressing the Shift and PrtSc keys or by utilizing the Print feature of 1st Class Fusion which will be explained later in this section.
Based on the information you supplied:

Handicapped Set-Aside Report for Acadia Parish

04/30/90

Prepared by: Brady LeVrier

Number of Handicapped Students in Acadia Parish: 23.

Local Funds Available for Match: 2000.00

State Funds Available for Match: 19166.67

Federal Funds Requested: 21166.67

Total Funds Requested: 42333.34

Figure 57. Handicapped Financial Advisor Summary

Figure 58 shows the same screen but in a format which shows all of the commands that are built into the program. This screen would be seen using the Definitions and Methods functions of 1st Class Fusion, but invisible to users using run-time versions of the Advisor.
Figure 58. Formula Screen

According to Brustein (1985) the Handicapped Set-Aside is calculated as follows:

1. Seven percent of the total handicapped setaside must be subtracted and used for Administration.

2. One-half of the remainder is then used for handicapped programs within the state.

3. The amount of handicapped funds available to a local education agency is a function of the ratio of the number of handicapped students enrolled in local area programs to the total number of handicapped students enrolled in vocational programs across the state.

4. This ratio is then multiplied by the amount of state funds for the handicapped, and the product yields the amount of handicapped funds available to the local education agency. (pp. 126-127)

The text and numbers surrounded by ( ) are formulas which are used to calculate the amount of local, state, and federal monies which will be available to the local educational agency. In this case, the term sthand = 1200 means that there
are 1200 handicapped students enrolled in the state. The formula \( \text{stf} = \frac{\text{hand}}{\text{sthand}} \times 1000000 \) calculates the ratio of local handicapped students to the state total.

The ratio \( \frac{\text{hand}}{\text{sthand}} \) is then multiplied by the fifty percent set-aside for handicapped students \( (1000000) \). This amount is then identified as the amount of state funds \( \text{stf} \) available to the local education agency. The local funds available for matching and the state funds are then added together in the formula \( \text{fed} = \text{stf} + \text{locfunds} \) to yield the amount of federal matching funds. These three variables are then added together to provide a total of the funds requested by the local educational agency.

Set-aside information could also take the form of a specific amount of state assistance due the local educational agency. Future versions of this expert system could incorporate this information to provide the user a vehicle to make overall planning decisions concerning the local allocation of vocational funds.

The procedure for the calculation of local, state, and federal funds are similar in format for the rest of the Title Programs in the Local Plan Advisor, with the exceptions of the Vocational Guidance Title II Part A and B Advisors. These two expert systems use 10 percent of the funds allocated to each of the programs in Title II Part A and B and then yield a total amount of local, state, and federal funds available for Guidance purposes. Due to the nature of the Guidance
knowledge bases, the Local Advisors for each of the programs in Title II Part A and B must be completed before these two knowledge bases will yield any meaningful results.

The final section of this chapter will describe various utility functions which have been built into the Carl Perkins Advisor. Figure 30 illustrated the method for exiting the Legislative Advisor and Figures 59, 60, and 61 will graphically present the procedure for accessing the various knowledge bases located in the Local Plan Advisor.

![IFi=Help3 . [Esc=Stop]

At this point you may continue and exit the program and/or print a report of the information you supplied during the session.

You may wish to utilize the Local Plan Advisor to help you complete the development of this section of the Local Plan.

<table>
<thead>
<tr>
<th>Yes, I wish to continue.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes, I wish to use the Local Plan Advisor.</td>
</tr>
</tbody>
</table>

Figure 59. Continuation/Advisor Screen

Figure 59 is a screen that was built into the Local Plan Advisor knowledge base to provide the user who chose to use only the Financial Advisor the opportunity to access the procedural information in the Local Plan Advisor, or exit the program entirely.
Figure 60 serves a similar function to the screen shown in Figure 30 of the Legislative Advisor. Here the user has the opportunity to access another knowledge base in the Local Plan Advisor, escape to the Legislative Advisor, return to the Main Menu, or Exit and Print a report of the session.

Figure 60. Local Plan Escape Menu

Once the user selects Escape and Print the following screen appears with the commands illustrated in Figure 61.
Thank you for using Carl Perkins Advisor. At this point select and press the letter corresponding to the following commands:

M New Session: This command will allow you to begin a new session with this advisor.

R Replay Session: This command will replay the session in order to allow you to change any of the responses you made during the session.

P Print Report: This command will print a record of the session.

Q Quit: This command will terminate the session and return to DOS.

Please make your selection.

The screen in Figure 61 provides one more opportunity for the user to begin a New Session or Replay the session in order to modify some data in the knowledge base. The Print command will send the information to the printer to provide a hard copy of the information generated during the session. The Quit command terminates the session and returns the user to the DOS prompt.

Up in the top right hand corner of each of the illustrations which have been presented in this chapter are the letters ESC. If the user presses the ESC (Escape) key during the course of a session the following screen appears as shown in Figure 62.
This screen is a default escape screen which is generated by 1st Class Fusion and is very similar to the escape screen mentioned earlier. The Fast - Forward feature speeds up the replay of the session up to the next to last answer provided during the session. If for some reason the user chooses to Exit the program then begins a new session using the Advisor, the screen, shown in Figure 63, will appear.
The last session of this advisor was interrupted.
Do you want to replay and continue that session? [y/n]
[Tab = Fast Forward to next-to-last answer]

Figure 63. 1st Class Fusion Interrupt Screen

A negative response will initiate the start of a new session of the Advisor, an affirmative response will prompt the user to select the Fast - Forward function to return to the next to last answer given the during the previous session.
CHAPTER V

Conclusions and Recommendations

Introduction

This chapter provides conclusions and recommendations concerning the development of this prototypical Expert System, and the implications of this project for further research.

Conclusions

The primary objective of this study was to determine the feasibility of Expert Systems to assist vocational educators in the development of Local Plan Applications for Vocational Education funding. This objective was achieved through the development of the prototype described in Chapter 4. The procedural and legislative information associated with the Carl D. Perkins Act and Local Plan guidelines proved well suited for inclusion into a rule-based knowledge based system. 1st Class Fusion's expert system shell program provided the environment for development of the framework of the system and while meeting the goal of a non-threatening user interface.

A series of five technical upgrades in the 1st Class Fusion software occurred during the course of this study. Three of the upgrades represented a fundamental change in the nature of the software and could not be addressed in this prototype. Recommendations concerning the implications of these upgrades for later versions of this expert system are addressed in the recommendations that follow.
Recommendations

Recommendations for Practice

The Carl D. Perkins Act of 1984 is in the process of reauthorization. The reauthorization process, common to such enabling legislation, underscores the need for a knowledge base that can be edited to reflect changes in the Act itself. The 1st Class Fusion Text Editor will allow for entering and editing of textual data. This information may then be merged into the existing structure of the Expert System. Changes in the Title programs under the present Act may necessitate the development of additional knowledge bases, the deletion of existing knowledge bases, or the modification of existing knowledge bases. Changes will also be necessitated in the Local Plan for the Application of Vocational Education Funds developed by the Louisiana Department of Education. In light of these conditions, the author offers the following recommendations for practice:

Recommendation One.

The prototypical expert system model presented here speaks to the feasibility of using this technology to assist in the preparation of local vocational plan applications. The Louisiana State Department of Education should, based on the results presented here, seriously consider adopting this system as a means of assisting eligible recipients in the preparation of local applications. It is recommended that anticipated system enhancements be incorporated into further
refinements of the prototype and that the knowledge base of Carl Perkins Advisor be modified to reflect the changes made under the reauthorization. In order to expedite the adoption of this expert system, an advisory committee, reflective of constituent users, should be organized by the Louisiana Department of Education to assist in further development. The utilization of this type of technology might require minor modifications in the Division of Vocational Education's existing local plan application administrative procedure.

Upon the completion of internal evaluation, the expert system should be field tested to further evaluate its content and degree of user interface. The results of the field test should serve as the basis for final modification(s) to the system. In-service training for vocational educators concerning the use of the expert system would be necessary prior to dissemination to the local educational agencies.

**Recommendation Two.**

The Legislative Advisor should be modified to utilize 1st Class Hypertext for the purpose of searching textual data. This particular expert system development program by Programs in Motion was not available at the outset of this project.

1st Class Hypertext uses a card file format for the storage of textual data. The information is organized similarly to a filing system and printed on "cards" as shown in Figure 64.
Here's your first hypertext screen of choices. Think of the four choices below as buttons which you can press. Press one with ↓:

**Description of hypertext**

Hypertext is text which is organized in a special way. While a novel is organized linearly, and a service manual may be organized topically in an outline fashion, a hypertext document connects key words to parts of the document that explain the key word in some way.

For example, some of the terms you will use while working with hypertext are: cards, buttons, stacks, and threads. Using the cursor keys (or a mouse), move the highlight to one of these words and press ↓ (or click the left mouse button). After reading an explanation of the word you selected you can press Esc and be right back on this screen, ready to explore another topic.

(When you see PgDn in the lower right, Press [PgDn] for more...)

---

**Figure 64. 1st Class Hypertext Screen**

Key words or phrases are highlighted and then used as the inference mechanism to conduct a forward search for specific information. These "cards" may be stacked as shown in Figure 65, and accessed by the use of a mouse or keypad.

---

**Figure 65. Hypertext Card Stacks**
This method of data storage provides a user friendly interface and should be incorporated into any revisions to the Legislative Advisor.

**Recommendation Three.**

This prototype represents the initial attempt to develop a expert system for this particular application. In retrospect, a different approach to the development of the Local Plan Advisor might be in order. Each page of the Local Plan for the Application of Vocational Education Funds could be stored graphically and retrieved into the Advisor. Data entry cells could then be integrated into the existing text, and thus provide a similar data entry format to past Local Plan Application manuals. Unfortunately, the data entry option of 1st Class Fusion is currently limited to one line of text. It has been recommended to Programs in Motion that future versions of 1st Class Fusion provide for paragraphs or pages of data to be entered and stored into data files for later editing or final assimilation into the knowledge base and retrieval by the user. Programs in Motion has indicated interest in this recommendation and will include it into their development agenda.

In addition, further modifications should be made in the financial advisor to enhance the input of baseline data into the knowledge base. Information on the specific level of state assistance available to local recipients could be contained in the knowledge base; then accessed to assist in
the overall extent of the level of local monies for matching purposes and the amount of federal funds available to the local educational agency. Long and short range goals could then be developed by the local recipients to aid in the efficient use of Carl Perkins Vocational funds.

**Recommendation 4.**

Further research and development should continue which would ultimately yield an expert system capable of producing a completed the Local Plan. This system would complete all of the financial calculations for the user, and also function as a word processor for the inclusion of textual data. The submission of the Local Plan might be done via modem directly to the Louisiana Department of Education for review by supervisory personnel.

**Recommendations for Further Research**

Expert System technology is still in its infancy in the area of vocational education. Figure 66 provides a graphic representation of the possible areas of application within vocational education; followed by a brief description of each of the recommended areas of application.
1. **School Finance/Inventory:** Expert Systems could be designed to assist vocational educators in the management of financial and inventory data. 1st Class Fusion provides users with the capability of accessing information within external database or spreadsheet programs. For example, if a school used a spreadsheet program such as Lotus 123 for financial data and a database program like dBASE IV for inventory data; an expert system could be programmed to access specific information within files for use within the expert system. This data
could then be manipulated by the expert system and user in planning and coordinating the use of these limited resources.

2. **Vocational Assessment:** Since Vocational Assessment is an integral part of vocational programs, an expert system similar in design to CLASS.LD, could be used to assist in the interpretation of vocational assessment results. Thus, providing additional support in the proper placement of students into more appropriate vocational learning environments could be realized.

3. **Program Evaluation:** The periodic evaluation of vocational programs would be enhanced by the use of expert system technology. An Evaluation Advisor equipped with the standards which must be met by local vocational agencies could assist these agencies in the preparation for such evaluations. On the other hand, a similar system could be designed for the evaluators and thus contribute to the objectivity of vocational evaluations.

4. **Student Admissions:** The post-secondary Technical School System of Louisiana operates under an open entry, open exit policy. Most schools conduct weekly admission tests and placement for new and reentry students. The number of students present may vary a great deal from week to week for these
sessions. Student Personnel Officers must know how many students are currently enrolled in vocational programs so as to apprise new students of vacancies in these programs, and the minimum level of achievement on admissions tests by these students for placement into specific vocational programs.

An expert system could be designed to assist Student Personnel Officers in this task. The knowledge base would contain the current enrollment of students in vocational courses in the school. The Student Personnel Officer could then enter the admissions data directly and receive information as to whether the student meets the admission requirements of the specific vocational program and ascertain if there are vacancies within the program. In addition, an expert system of this type could be modified to offer diagnostic recommendations for students which may need enhancements offered through Special Needs programs.

5. Program Guide: Recently the School of Vocational Education at LSU developed a Graduate Student Handbook for use by present and prospective graduate students. The handbook provides background information about the faculty, staff, and school. In addition, procedural information is
presented concerning the graduate programs, Graduate School policies, and financial aid. An expert system would be a novel way of presenting this information to prospective students that have access to personal computers. Once this information was processed electronically it could be placed into commercial or private electronic bulletin boards or mailed directly to prospective students on floppy disks. Students currently enrolled in the School could take advantage of the system to provide up to date information on policies within the School of Vocational Education and the LSU Graduate School.

6. **Computer Aided Instruction/Intelligent Tutoring Systems:** Expert Systems could be developed by vocational educators using expert system shell programs like 1st Class Fusion to present specific information to students in a programmed learning environment. Specific lessons could then be linked together in a "blackboard" arrangement to provide access to a series of lessons on one or more topics. An expert system could also serve as a part of a multi-media intelligent tutoring system which would take advantage of programmed learning lessons by expert systems. Also, it could provide
additional information via audio, videotape, hypertext, or compact disk media.

7. **Statistics Advisor:** Many commercial statistics software packages are on the market at this time. Most provide for the statistical analysis of data; but leave the application of a statistical procedure to the imagination of the user. An expert system could be designed to assist researchers in the search for the proper statistical procedure for the analysis of data.

8. **Research Methodology:** Expert Systems could also help researchers develop sound methodologies in the conduct of research. A deductive or backward chaining expert system could define a specific outcome of the research and then provide the appropriate research design needed to proceed to that outcome. This expert system could then be combined with a statistical applications expert system to provide a comprehensive expert system to aid researchers.

9. **School Law:** The judicial decisions of the courts have made a tremendous impact on the educational system in this country. These decisions have a direct impact on the actions of local school administrators and teachers. An expert system designed to provide these individuals with a source
of legal interpretations of the law would be a valuable commodity. This system could assist administrators in the examination of the legal consequences of their decisions, and thus influence the quality of their decisions.

10. **Curriculum Development:** The development and modification of vocational curricula is a never ending process. An expert system based on a specific curriculum model could assure the completion of the process of the development or modification of the specific curriculum, was accomplished in the proper sequence under the constraints of the particular curriculum model. This comprehensive system could serve a diagnostic, design, planning, and monitoring function to assure the specific outcome of the curriculum development process.

In conclusion, these ten recommendations for possible future applications of expert systems within vocational education are not exhaustive. The application of expert system technology into vocational education will be limited only by the imagination of vocational educators, and their desire to utilize this new and innovative technology.


APPENDIX

Carl Perkins Advisor

INSTRUCTIONS

**NOTE** YOU WILL NEED A PERSONAL COMPUTER EQUIPPED WITH A HARD DISK DRIVE TO OPERATE THIS EXPERT SYSTEM.

LOADING CARL PERKINS ADVISOR ON THE HARD DRIVE:

In order to successfully load Carl Perkins Advisor on to the hard drive of your computer, please follow the following steps:

1) Check your computer disks and make sure that you have three disks: C P Utilities, Carl Perkins Advisor Files #1, and Carl Perkins Advisor Files #2.

2) Set up a subdirectory under the root directory C:\ called CPEXPERT. To do this type:

   C:\>MD CPEXPERT <ENTER>
   C:\>CD\CPEXPERT <ENTER>

   The first command tells the computer to make a directory called CPEXPERT and once you press the <ENTER> key the light on the hard drive should light up momentarily and then go off. This signifies that the subdirectory CPEXPERT has been created on the hard drive. If the light does not come on; retype the command. If you are still not successful in creating a subdirectory; refer to your owner's manual or DOS manual for assistance in creating a subdirectory.

3) The second command CD\CPEXPERT is used to change directory from the root directory to the CPEXPERT subdirectory. Once this command is executed, type DIR and press <ENTER>. You should see a message that No Files are present.

4) Take the C P Utilities Disk and slip it into the floppy disk drive. Now type COPY A:*.* and press <ENTER>. This will copy all of the files on the Utilities Disk onto the hard drive. You should see the names of the files come up on the screen once they have successfully been copied.
5) Press the F3 key and COPY A:\*.* will appear, slip the Carl Perkins Advisor Files #1 disk into the floppy disk drive and press <ENTER> to copy the files onto the hard disk.

6) Follow the same procedure for the Carl Perkins Advisor #2 disk.

Once all of the files for the Advisor have been copied into the CPEXPERT subdirectory, type CP at the DOS prompt and press <ENTER>. The following Title screen should appear:

Figure 1. 1st Class Fusion Advisor Screen

Carl Perkins Advisor is divided into two major parts: Part One allows you to find specific information within the Carl D. Perkins Act of 1984. Part Two is designed to assist local vocational educators in the development of the Local Plan for the Use of Carl Perkins Vocational Education Funds. Carl Perkins Advisor was developed using an Expert System Shell program called 1st Class Fusion, by Programs in Motion of Wayland, Massachusetts.

Once these procedures have been completed you are now ready to utilize the Expert System. See Section 2 for information on how to use Carl Perkins Legislative Advisor, and Section 3 for information on the Local Plan Advisor.
SECTION TWO

Press <ENTER> and the next screen you will see after the Carl Perkins Advisor Title Screen is the screen shown below. Figure 2. Carl Perkins Advisor Screen

This screen allows you to access to either the Legislative Advisor or the Local Plan Advisor of the Expert System.
HOW TO USE THE CARL PERKINS LEGISLATIVE ADVISOR

The Carl Perkins Advisor is divided into six parts which cover the five major Titles within the Act and the Introduction. The system is designed to forward chain from the Title program to specific information contained within the Title itself. A thorough knowledge of the Carl D. Perkins Act of 1984 is not necessary since most information can be accessed in about four steps or less. Figure 3 shows the selection screen for this section of the Legislative Advisor.

Figure 3. Carl Perkins Legislative Advisor Selection Screen

At this point, you have the opportunity to select the Introduction, Titles I through V, or exit to the Carl Perkins Financial Advisor. You may select a choice by using the Up or Down Arrows on the Numeric Keypad or by pressing the Space Bar. In this case TITLE III - SPECIAL PROGRAMS is highlighted and once <ENTER> is pressed the following screen appears:
This screen is the title screen for Title III, its purpose is to provide you with a general outline of the contents within Title III. Once you press <ENTER> to continue, the next screen provides you with the means for finding specific information within this title program.

In this case information on Part B - Consumer and Homemaker Education has been selected, and this selection will yield the following results:
This screen offers you five selections under this subpart of Title V, Part B - Consumer and Homemaking Education. In this case Consumer and Homemaking Grants has been selected, and will display the following screen:

Figure 7. Consumer and Homemaking Text

This screen contains the text associated with this section of the Carl Perkins Act. You have the opportunity to examine this screen, or in other cases multiple screens of selected text. Below the textual data are options for you to select additional information under this sub-section, additional
information under Title III, return to the Carl Perkins Legislative Advisor, or Exit the Expert System entirely.
SECTION THREE

This section gives a brief description of the parts of the Financial Advisor. The figure below shows the Financial Advisor screen which lists each of the thirteen programs covered in the Local Plan.

Figure 8. Financial Advisor Selection Screen

In this example the Handicapped Advisor is highlighted by either pressing the Space Bar or Arrows located on the Numeric Keypad. Once you press the <ENTER> key the following screen will appear, as shown in Figure 9.

Figure 9. Handicapped Advisor Message Screen
This initial Message Screen is used to orient you to the information contained in this particular section of the Advisor. Information is presented concerning the Function keys, which are used to provide you with additional detailed information concerning various topics. Since all of the additional information may not be contained on one screen, the message "PgDn" is displayed on the bottom of the screen. This command prompts you to press the "PgDn" key to go on to the next screen as shown in Figure 10.

Figure 10. Handicapped Advisor Memo Screen (Continued)

The message in the "box" is used to remind you of the extent of the fiscal year and that approved programs will receive reimbursement during that fiscal year. Once you press the <ENTER> key the screen in Figure 11 appears on the screen.
For your convenience, please select the operation you wish to utilize in this knowledge base.

- I want to use the complete advisor.
- I want to use the Financial Advisor.
- I want to use the Local Plan Advisor.

This section of the Local Plan Advisor is built into the majority of the knowledge bases in order to provide you with the option of accessing procedural data, developing financial data, or a combination of both.

When the complete Advisor is utilized; procedural information associated with the particular Title program is presented first, then the Financial Advisor is initialized. Each of the screens is designed to include the same questions that are posed to you by the Local Plan Manual.

Figure 12. Handicapped Advisor Question A

A. Have you identified needs based on your local assessment of vocational handicapped students. (Respond with Yes or No in the block provided.)

- YES  Reinforcement of basic mathematics skills
- YES  Reinforcement of basic language arts skills
- YES  Reinforcement of vocational program(s) skills
- YES  Reinforcement of employability skills
- NO   Other: (Press F2 for more information on this topic.)

Press <F1> for General Information on this topic.

Yes, this section has been completed.
No, this information has not been completed.

In Figure 12 the first question concerns the identification of needs of handicapped students as determined by the local needs
assessment. In this case, a positive or negative response is required on each of the five items below question A.

Once all of the information is completed, you are prompted for a response as to whether the information for this specific part of the Handicapped Advisor has been completed. The default value is always YES in order for you to proceed rapidly through the Advisor. Each of the screens dealing with procedural information throughout the Local Plan Advisor follow a similar format.

Many times all of the information that is needed cannot be shown on one complete screen; if this is the case, then Help Screens are used to present the additional information. Figure 13 illustrates the form of a typical Help Screen.

Figure 13. Typical Help Screen

The commands PgUp and PgDn allow you to access more information within the Help Screen. The <ENTER> symbol allows you to exit the Help Screen. Print will send the information within the Help Screen to the printer so you may obtain a hard copy of the information.

In the event that specific information may not have been completed for inclusion into the Local Plan and you provide a negative response to the prompt; then a Warning Message is shown to remind you that the approval of the Local Plan is in jeopardy. These warnings shown in Figures 14 and 15 were developed using 1st Class Fusion's Window program.
C. Did you identify and justify the supplemental equipment needed to modify the vocational program(s) based on the needs assessment and objective(s). Provide details for requested services unique to a particular program, as needed. (Submit an equipment list with the budget).

Press <F1> for General Information on this topic.
Press <F2> for information on Supplemental Equipment.

Yes, this section has been completed.
No, this information has not been completed.

YOUR APPLICATION MUST CONTAIN THIS INFORMATION TO BE APPROVED
press a key to continue...

Yes, this section has been completed.
No, this information has not been completed.

If this information is unavailable select YES to continue
press a key to continue...

Figures 16 and 17 present further examples of the use of data entry fields. In the case of Figure 17, another screen is included to allow you to input a total of ten high schools.
Figure 16. Data Entry Screen

5. Supplemental Training (Complete if Applicable)

Press <F1> for General Information on this topic.
Press <F2> for more information on Supplemental Training.

A. Identify appropriate program area(s).
Type yes or no as a response.

- Business
- GCE
- Industrial Arts/Technology Education
- Health Occupations
- Home Economics (Consumer and Homemaking)
- Home Economics (Wage Earning)

Fgh to continue

Figure 17. High School Data Entry Screen

5. Supplemental Training (Complete if Applicable)

Press <F1> for General Information on this topic.

C. List the school(s), program area(s), and exact date(s) for requested supplemental training.

<table>
<thead>
<tr>
<th>SCHOOL</th>
<th>PROGRAM AREA</th>
<th>DATES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crowley High School</td>
<td>Agriculture Education</td>
<td>Aug. 1989 to May 1998</td>
</tr>
<tr>
<td>Church Point High</td>
<td>Business Education</td>
<td>Aug. 1989 to May 1998</td>
</tr>
</tbody>
</table>

The rest of the screens associated with the procedural information associated with the development of the Handicapped section of the Local Plan Advisor follow a similar format. Figure 18 shows the initial display in the Handicapped Financial Advisor. Data entry fields are included for the date and your name, but the parish name was programmed into the Carl Perkins Advisor as a global variable.
Figure 18. Initial Handicapped Financial Advisor Screen

Press <F2> for more information on state and local matching funds.

HANDICAPPED ADVISOR

This section is designed to assist you in the preparation of an application for Handicapped Set-Aside Funds.

Date: 4/30/88
Name: Brady LeVrier
Parish: Acadia

Press <F2> for more information on this topic.

Figures 19 and 20 are examples of data entry fields generated by the Definitions function of the 1st Class Fusion Shell program. In this case the variable is given a name and it is identified as a numerical variable, and you enter a value at the prompt developed by 1st Class Fusion.

Figure 19. Financial Advisor Data Entry Screen

Please enter the number of Handicapped Students in your parish during fiscal year 1987-88.

Press <F2> for more information on this topic.

Enter a number:22
Figure 20. Financial Advisor Data Entry Screen 2

Figure 20 prompts you to enter the dollar amount of local funds available for matching purposes.

Figure 19 prompts you to enter demographic data concerning the number of handicapped students that were enrolled in the parish during the 1987-88 school year. Figure 20 asks you to supply data related to the amount of local matching funds available on the part of the local parish.

Figure 21 is an example of a method of summarizing data using the 1st Class Fusion Expert System Shell program. You would have the opportunity to print a hardcopy of the information presented below by either pressing the Shift and PrtSc keys or by utilizing the Print feature of 1st Class Fusion which will be explained later in this section.

Figure 21. Handicapped Financial Advisor Summary

Based on the information you supplied:

Handicapped Set-Aside Report for Acadia Parish

Prepared by: Brady LeVrier

Number of Handicapped Students in Acadia Parish: 23.
Local Funds Available for Match: 2000.00
State Funds Available for Match: 19166.67
Federal Funds Requested: 21166.67
Total Funds Requested: 42333.34
Figure 22 is a screen that was built into the Local Plan Advisor knowledge base to provide a choice to use the Financial Advisor the opportunity; access the procedural information in the Local Plan Advisor, or exit the program entirely.

In Figure 23 you have the opportunity to access another knowledge base in the Local Plan Advisor, escape to the Legislative Advisor, return to the Main Menu, or Exit and Print a report of the session.

Figure 22. Continuation/Advisor Screen

**[F1=Help] [Esc=Stop]**

At this point you may continue and exit the program and/or print a report of the information you supplied during the session.

You may wish to utilize the Local Plan Advisor to help you complete the development of this section of the Local Plan.

Yes, I wish to continue.

Yes, I wish to use the Local Plan Advisor.

Figure 23. Local Plan Escape Menu

**[F1=Help] [Esc=Stop]**

Congratulations!! You have completed this phase of the Local Application of the Carl Perkins Act. Please use this information for your final draft to be sent to the State Department of Education.

Yes, I would like to return to the Local Applications Menu.

Yes, I would like to return to the Main Menu.

Yes, I would like some specific information concerning the Carl Perkins Act.

Yes, I would like to QUIT and PRINT a record of this session.
Once you selects Escape and Print the following screen appears with the commands illustrated below in Figure 24. Figure 24. Escape/Print Screen

This screen provides one more opportunity for you to begin a New Session or Replay the session in order to modify some data in the knowledge base. The Print command will send the information to the printer to provide a hard copy of the information generated during the session. The Quit command terminates the session and returns you to the DOS prompt.

Up in the top right hand corner of each of the illustrations which have been presented in this chapter are the letters ESC. If you press the ESC (Escape) key during the course of a session the following screen appears in Figure 25.
This screen is a default escape screen which is generated by 1st Class Fusion and is very similar to the escape screen mentioned earlier. The Fast - Forward feature speeds up the replay of the session up to the next to last answer provided during the session. If for some reason you choose to Exit the program then begins a new session using the Advisor, the following screen will appear, as shown in Figure 26.

A negative response will initiate the start of a new session of the Advisor, an affirmative response will prompt you to select the Fast - Forward function to return to the next to last answer given the during the previous session.
VITA

Brady Keith LeVrier was born May 4, 1954, in Raceland, Louisiana to Leona Mae Miller and Grady Welborne LeVrier. He graduated from Iota High School in 1972. Upon graduation from high school he attended Louisiana State University, Eunice; later he transferred to the Main Campus in Baton Rouge in 1976. In December 1978 he received a B.S. in Industrial Arts Education and began teaching Drafting at Baker High School, Baker, Louisiana.

He was hired in 1980 as a Drafting Instructor at Southwest Louisiana Vocational-Technical School in Crowley, Louisiana. During this time he enrolled in graduate school at Louisiana State University, Baton Rouge, Louisiana and received a M.S. in Industrial Education in August, 1983.

As a result of a reduction-in-force in 1987 within the Vocational-Technical School System he sought enrollment and received acceptance into the Doctoral Program of the School of Vocational Education. During this time he served as a Graduate Assistant and taught one undergraduate estimating course. He assisted in a national Trade and Industrial Certification Study conducted by the department and has helped to monitor and set-up equipment in the School's telelearning program.
DOCTORAL EXAMINATION AND DISSERTATION REPORT

Candidate: Brady Keith LeVrier

Major Field: Vocational Education

Title of Dissertation: The Development of a Prototype Knowledge-Based Expert System to Assist Vocational Educators in the Development of the Local Plan Application for Vocational Education Funds.

Approved:

[Signature]
Major Professor and Chairman

[Signature]
Dean of the Graduate School

EXAMINING COMMITTEE:

[Signatures]

Date of Examination:

April 26, 1990