PRODUCTIVITY CONSIDERATIONS FOR ONLINE HELP SYSTEMS

DISSERTATION

Presented to the Graduate Council of the University of North Texas in Partial Fulfillment of the Requirements For the Degree of

DOCTOR OF PHILOSOPHY

by

Charles R. Shultz, Jr., B.B.A., M.B.A.

Denton, Texas

May, 1994
Shultz, Jr., Charles R., Productivity Considerations for Online Help Systems, Doctor of Philosophy (Business Computer Information Systems), May, 1994, 186 pp., 7 tables, 7 figures, 10 appendixes, bibliography, 74 titles.

The purpose of this study was to determine if task type, task complexity, and search mechanism would have a significant affect on task performance. The problem motivating this study is the potential for systems online help designers to construct systems that can improve the performance of computer users when they need help. Task type (mathematical and verbal) and task complexity (high complexity, low complexity) and search mechanism (keyword, semantic) were the independent variables. The dependent variable was task performance. The surrogate was task accomplishment measured by the score the subject received for the task set assigned.

The researcher conducted a protocol analysis to determine the words and phrases users expect when searching for help information. From the results of the protocol analysis, the researcher constructed a semantic online help
This research compared the traditional keyword based online help with the semantic system by assigning tasks to users where the users had to use the online help systems to accomplish the tasks. The researcher graded the users on performance. This study compared the two performance levels to identify any significant differences.

The results of the research support the hypothesis that the type of online help search mechanism made a significant difference in the performance of the subjects. Task complexity was not a significant factor in affecting performance. Task type was also a significant variable in performance.

Researchers will benefit by using the framework developed in this experiment. End users will benefit from the higher level of productivity provided through the use of the newer online help systems.
PRODUCTIVITY CONSIDERATIONS FOR ONLINE HELP SYSTEMS

DISSERTATION

Presented to the Graduate Council of the University of North Texas in Partial Fulfillment of the Requirements For the Degree of DOCTOR OF PHILOSOPHY

by

Charles R. Shultz, Jr., B.B.A., M.B.A.

Denton, Texas

May, 1994
Copyright

Charles R. Shultz, Jr.

1993

Dr. V.,

To the only teacher who would accept nothing but my best.

Respectfully,

Charles R. Shultz, Jr. Ph.D.
ACKNOWLEDGEMENTS

I would like to thank Dr. Vanecek for his patience and understanding during this dissertation. I would also like to thank my parents because without their help, I would have been unable to finish.
# TABLE OF CONTENTS

## LIST OF TABLES

| ix |

## LIST OF FIGURES

| x |

## Chapter

### I. THE INADEQUACY OF ONLINE HELP

<table>
<thead>
<tr>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Statement of the Problem</td>
</tr>
<tr>
<td>Purpose of the Study</td>
</tr>
<tr>
<td>Significance of the Study</td>
</tr>
<tr>
<td>General Help Considerations</td>
</tr>
<tr>
<td>Keyword Help System</td>
</tr>
<tr>
<td>Semantic Help System</td>
</tr>
<tr>
<td>Context Sensitive Help</td>
</tr>
<tr>
<td>Methodology Overview</td>
</tr>
<tr>
<td>Data Collection Overview</td>
</tr>
<tr>
<td>Analysis of the Data</td>
</tr>
<tr>
<td>Limitations of the Study</td>
</tr>
<tr>
<td>Summary</td>
</tr>
</tbody>
</table>

### II. BACKGROUND

<table>
<thead>
<tr>
<th>20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
</tr>
<tr>
<td>Help Systems Literature</td>
</tr>
<tr>
<td>Help Systems Research Literature</td>
</tr>
<tr>
<td>Designing Help Systems Literature</td>
</tr>
<tr>
<td>Related Literature</td>
</tr>
<tr>
<td>Task Type Literature</td>
</tr>
<tr>
<td>Task Complexity Literature</td>
</tr>
<tr>
<td>Adaptive User Interface</td>
</tr>
<tr>
<td>Conclusions</td>
</tr>
</tbody>
</table>

### III. THEORETICAL AND OPERATIONAL DEVELOPMENT

<table>
<thead>
<tr>
<th>43</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research Model Overview</td>
</tr>
<tr>
<td>Independent Variables</td>
</tr>
<tr>
<td>Search Mechanism</td>
</tr>
</tbody>
</table>
Task Complexity ........................................ 48
Task Type .............................................. 50
Dependent Variable ...................................... 50
Demographic Variables .................................. 53
Hypotheses ............................................. 53

IV. RESEARCH DESIGN .................................. 59
Experimental Design .................................... 59
Research Design ........................................ 61
Operational Model ...................................... 61
Operationalization of the Variables .................... 63
Measurement of the Variables ........................... 66
Demographic Data ....................................... 67
Subjects and Population .................................. 68
Pre-experimental Procedures ........................... 69
  Protocol Analysis ...................................... 70
  Semantic Help Design ................................ 73
  Expert Panel ......................................... 75
  Task Set Design ..................................... 76
Experimental Data Collection ........................... 78
Key Assumptions ........................................ 81

V. DATA COLLECTION .................................. 83
Pre-Experimental Preparation ........................... 84
  Pre-protocol Investigation ............................ 85
  Protocol Task Sets .................................... 86
  Protocol Data ......................................... 86
Expert Panel Feedback On Proposed
  Pilot I Data and Semantic
    Help System ....................................... 88
  Pilot I Test Data .................................... 90
Expert Panel Feedback On Proposed
  Pilot II Data and Task Sets ......................... 90
  Pilot II Test Data ................................... 91
Experimental Test Data .................................. 92

VI. DATA ANALYSIS .................................... 93
Pre-experimental Data Analysis ........................ 94
  Analyze and Develop Protocol Task Sets ............. 94
  Analysis of the Protocol Data ........................ 95
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analysis of Pilot I Data</td>
<td>98</td>
</tr>
<tr>
<td>Analysis of Feedback On Proposed Pilot II Task Sets</td>
<td>99</td>
</tr>
<tr>
<td>Analysis of Pilot II Data</td>
<td>100</td>
</tr>
<tr>
<td>Conclusions From The Pilot Studies</td>
<td>100</td>
</tr>
<tr>
<td>Experimental Data Analysis</td>
<td>101</td>
</tr>
<tr>
<td>General Demographics</td>
<td>102</td>
</tr>
<tr>
<td>Linear Regression Model</td>
<td>105</td>
</tr>
<tr>
<td>Individual Cell Data</td>
<td>108</td>
</tr>
<tr>
<td>Interaction Effects</td>
<td>108</td>
</tr>
<tr>
<td>Results by Hypotheses</td>
<td>109</td>
</tr>
<tr>
<td>VII. CONCLUSIONS</td>
<td>111</td>
</tr>
<tr>
<td>Conclusions For Each Hypothesis</td>
<td>112</td>
</tr>
<tr>
<td>Research Conclusions and Recommendations</td>
<td>120</td>
</tr>
<tr>
<td>Limitations of the Research</td>
<td>122</td>
</tr>
<tr>
<td>Direction for Future Research</td>
<td>123</td>
</tr>
<tr>
<td>Summary</td>
<td>124</td>
</tr>
<tr>
<td>APPENDIXES</td>
<td></td>
</tr>
<tr>
<td>A. List of Definitions</td>
<td>126</td>
</tr>
<tr>
<td>B. An Informed Consent Document</td>
<td>130</td>
</tr>
<tr>
<td>C. Pre-experimental Protocol Task List</td>
<td>132</td>
</tr>
<tr>
<td>D. Expert Panel Rankings</td>
<td>140</td>
</tr>
<tr>
<td>E. Semantic Help System Interfaces</td>
<td>146</td>
</tr>
<tr>
<td>F. Standard Help System Interfaces</td>
<td>149</td>
</tr>
<tr>
<td>G. Pilot 1 Pre-experimental Task List</td>
<td>152</td>
</tr>
<tr>
<td>H. Example Help Scripts for Semantic System</td>
<td>163</td>
</tr>
<tr>
<td>I. Pilot II and Experimental Data Collection Task List</td>
<td>166</td>
</tr>
<tr>
<td>Table</td>
<td>page</td>
</tr>
<tr>
<td>----------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>1. Relevant Online Help Research</td>
<td>21</td>
</tr>
<tr>
<td>2. Pilot II Data</td>
<td>101</td>
</tr>
<tr>
<td>3. Demographic Data</td>
<td>104</td>
</tr>
<tr>
<td>4. Experimental Cell Sizes</td>
<td>105</td>
</tr>
<tr>
<td>5. Results from the Linear Analysis</td>
<td>107</td>
</tr>
<tr>
<td>7. Results For Each Hypothesis</td>
<td>110</td>
</tr>
</tbody>
</table>
# LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Ives, Hamilton, and Davis Research Model</td>
<td>44</td>
</tr>
<tr>
<td>2.</td>
<td>Research Model Used For This Study</td>
<td>45</td>
</tr>
<tr>
<td>3.</td>
<td>Help Systems Variables List</td>
<td>46</td>
</tr>
<tr>
<td>4.</td>
<td>Relationships of the Variables</td>
<td>62</td>
</tr>
<tr>
<td>5.</td>
<td>Operational Model</td>
<td>63</td>
</tr>
<tr>
<td>6.</td>
<td>Experimental Design</td>
<td>79</td>
</tr>
<tr>
<td>7.</td>
<td>Task Complexity Gradient</td>
<td>121</td>
</tr>
<tr>
<td>Section Description</td>
<td>Page</td>
<td></td>
</tr>
<tr>
<td>----------------------------------------------------------</td>
<td>------</td>
<td></td>
</tr>
<tr>
<td>Research Model Overview</td>
<td>43</td>
<td></td>
</tr>
<tr>
<td>Independent Variables</td>
<td>47</td>
<td></td>
</tr>
<tr>
<td>Search Mechanism</td>
<td>47</td>
<td></td>
</tr>
<tr>
<td>Task Complexity</td>
<td>48</td>
<td></td>
</tr>
<tr>
<td>Task Type</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>Dependent Variable</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>Demographic Variables</td>
<td>53</td>
<td></td>
</tr>
<tr>
<td>Hypotheses</td>
<td>53</td>
<td></td>
</tr>
<tr>
<td>IV. RESEARCH DESIGN</td>
<td>59</td>
<td></td>
</tr>
<tr>
<td>Experimental Design</td>
<td>59</td>
<td></td>
</tr>
<tr>
<td>Research Design</td>
<td>61</td>
<td></td>
</tr>
<tr>
<td>Operational Model</td>
<td>61</td>
<td></td>
</tr>
<tr>
<td>Operationalization of the Variables</td>
<td>63</td>
<td></td>
</tr>
<tr>
<td>Measurement of the Variables</td>
<td>66</td>
<td></td>
</tr>
<tr>
<td>Demographic Data</td>
<td>67</td>
<td></td>
</tr>
<tr>
<td>Subjects and Population</td>
<td>68</td>
<td></td>
</tr>
<tr>
<td>Pre-experimental Procedures</td>
<td>69</td>
<td></td>
</tr>
<tr>
<td>Protocol Analysis</td>
<td>70</td>
<td></td>
</tr>
<tr>
<td>Semantic Help Design</td>
<td>73</td>
<td></td>
</tr>
<tr>
<td>Expert Panel</td>
<td>75</td>
<td></td>
</tr>
<tr>
<td>Task Set Design</td>
<td>76</td>
<td></td>
</tr>
<tr>
<td>Experimental Data Collection</td>
<td>78</td>
<td></td>
</tr>
<tr>
<td>Key Assumptions</td>
<td>81</td>
<td></td>
</tr>
<tr>
<td>V. DATA COLLECTION</td>
<td>83</td>
<td></td>
</tr>
<tr>
<td>Pre-Experimental Preparation</td>
<td>84</td>
<td></td>
</tr>
<tr>
<td>Pre-protocol Investigation</td>
<td>85</td>
<td></td>
</tr>
<tr>
<td>Protocol Task Sets</td>
<td>86</td>
<td></td>
</tr>
<tr>
<td>Protocol Data</td>
<td>86</td>
<td></td>
</tr>
<tr>
<td>Pilot I Test Data</td>
<td>90</td>
<td></td>
</tr>
<tr>
<td>Expert Panel Feedback On Proposed Pilot II Data and Task Sets</td>
<td>90</td>
<td></td>
</tr>
<tr>
<td>Pilot II Test Data</td>
<td>91</td>
<td></td>
</tr>
<tr>
<td>Experimental Test Data</td>
<td>92</td>
<td></td>
</tr>
</tbody>
</table>

iv
VI. DATA ANALYSIS

Pre-experimental Data Analysis
Analyze and Develop Protocol Task Sets
Analysis of the Protocol Data
Expert Panel Feedback On Proposed Pilot I Data and Semantic System
Analysis of Pilot I Data
Analysis of Feedback On Proposed Pilot II Task Sets
Analysis of Pilot II Data
Conclusions From The Pilot Studies
Experimental Data Analysis
General Demographics
Linear Regression Model
Individual Cell Data
Interaction Effects
Results by Hypotheses

VII. CONCLUSIONS

Conclusions For Each Hypothesis
Research Conclusions and Recommendations
Limitations of the Research
Direction for Future Research
Summary

APPENDIXES

A. List of Definitions
B. An Informed Consent Document
C. Pre-experimental Protocol Task List
D. Expert Panel Rankings
E. Semantic Help System Interfaces
F. Standard Help System Interfaces
LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Relevant Online Help Research</td>
<td>21</td>
</tr>
<tr>
<td>2. Pilot II Data</td>
<td>101</td>
</tr>
<tr>
<td>3. Demographic Data</td>
<td>104</td>
</tr>
<tr>
<td>4. Experimental Cell Sizes</td>
<td>105</td>
</tr>
<tr>
<td>5. Results from the Linear Analysis</td>
<td>107</td>
</tr>
<tr>
<td>7. Results For Each Hypothesis</td>
<td>110</td>
</tr>
</tbody>
</table>
LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Ives, Hamilton, and Davis Research Model</td>
<td>44</td>
</tr>
<tr>
<td>2. Research Model Used For This Study</td>
<td>45</td>
</tr>
<tr>
<td>3. Help Systems Variables List</td>
<td>46</td>
</tr>
<tr>
<td>4. Relationships of the Variables</td>
<td>62</td>
</tr>
<tr>
<td>5. Operational Model</td>
<td>63</td>
</tr>
<tr>
<td>6. Experimental Design</td>
<td>79</td>
</tr>
<tr>
<td>7. Task Complexity Gradient</td>
<td>121</td>
</tr>
</tbody>
</table>
CHAPTER I

THE INADEQUACY OF ONLINE HELP

Advanced development tools related to online help systems have not been available until recent times. Most of the traditional online help systems have used a keyword based method where the user accepts a word from a list of help words and subjects. After a keyword is chosen, the help system provides the user with a more specific word list on the topic in question. Finally, the keyword based online help system provides a script that contains the relevant help information.

Recently many tools have become available that allow online help systems builders to construct many different search mechanisms of help information. In Windows® from Microsoft, a mouse click presents the user with several possible choices for obtaining information. One method provides a list of the contents in the help system. A second method lets the user see information about the keyboard. A third method presents the prompt "How do I" to
the user. Once the user clicks on the "How do I" choice with a mouse, a list of activities is presented. A fourth method presents a list of the letters in the alphabet. If the user knows the word of the function in question, the user can click on a letter and jump to a list of words that start with the letter. From there, the user scrolls down the keyword list until the user finds the word he/she seeks. After clicking on that word, he/she is provided the requested information by the help system. A fifth method of using the online help system is to click on an icon about using the help system. After the user clicks on the help icon, information is presented to the user on how to use the help system. A sixth method of obtaining help is by using the "What is" icon. If the user clicks on the icon, the cursor becomes a question mark. At that point, if the user clicks on anything, the help system will tell the user all about the item identified.

Another example of recent help systems improvements includes the integration of online help systems in a windowing environment as described by R. Duncan (1993) in the article "Integrating Windows Help: A Strategic Review."
The author discusses the implementation methodologies that can be used in building a help system in Windows®. It is possible to design a context sensitive help system by implementing a "MAP". The map contains hooks that can be used to enter the help system at different points, thereby producing the context sensitive information.

Another example of one of the newer help type interfaces is the "wizard". Once the user calls up the wizard, the computer presents a step-by-step instruction list of how to accomplish a given task. The user learns how to do a given task by stepping through it with the wizard. Quattro® Pro from Borland has the new wizard feature. Borland presented many of its new products and their features during a seminar called "The Borland Productivity Series" in Chicago on September 13, 1993.

Meyer (1991) points out that there is an important trend emerging. The trend of the use of end-user information retrieval systems is on the increase. The end-user information retrieval phenomenon is on the rise because it is easier and less expensive for companies to provide documentation on CD-ROM's than to publish paper-based
manuals for end-users. One method the user may use to learn how to employ the searching facilities to obtain information from the CD-ROM is through the online help system. Since the help system is an important tool in guiding end-users toward needed information, end-users will need correctly designed searching mechanisms to the help information.

**Statement of the Problem**

There are several problems related to online help systems research. The first problem is a lack of a comprehensive model relative to online help systems research and productivity. The second is a lack of linkage between productivity and the help function in general. The third is a lack of understanding of how beginners think and relate when searching for help type information.

An issue that has been a concern of many researchers in the past is that online help does not adequately meet the informational needs of the user. When the lack of understanding occurs, the user may be unable to obtain the needed information, or the user may not understand the information presented. Frustration and non-task
accomplishment are the usual outcomes. Frustration and non-task accomplishment have been identified in earlier studies. For example, according to Rockart and Flannery (1983), help methods, as described by Maguire (1982), do not adequately meet the needs of beginning, non-programming end user computer users. Cohill and Williges (1985), in another earlier study, suggest that many help facilities are difficult to use and often contain too much jargon. Today's help systems are still difficult to use and still contain too much jargon. As a result, help information may confuse rather than help users. Help systems should not hinder users. Also, Carroll and Carrithers (1984) concluded that new users of complex systems are often frustrated and confused by errors they make in the early stages of learning. These new learners are unable to obtain information from the system to accomplish a given task, and the failure in task accomplishment causes frustration on the part of the user. The difficulties of learning to use a computer is an ongoing historic problem. According to Mack, Lewis and Carroll (1983), persons learning to use new computer systems often have great difficulty because they do
not understand how to use the help system effectively. In their efforts to correct these difficulties, new users often take side tracks and get into error tangles. This is a state in which the user has been given an error code and is provided with information, but is unable to decipher it and can not make any progress. As a result, recovery, or even diagnosis, is difficult or impossible. Such learning difficulties can be costly if tutorial help is required from trained personnel (Seybold 1981). The same condition is still true today.

Recent writers have reported that online help systems are still ineffective. According to Slack (1991), recent research has shown that in many cases online help is not effective. The user is unable to get the information that is needed for task accomplishment. The consequence of the lack of information and subsequent inability to accomplish a task is the loss of productivity for computer users.

**Purpose of the Study**

The study had several purposes. The main purpose of this study was to determine if different search techniques
used by non-programming end users, as described by Rockart and Flannery (1983), affect their productivity. This investigation is a significant step in the contribution to the advancement of research on online help systems. Also, if it is true that search mechanism to help information significantly impacts on task performance, then it is possible to design help systems that help people perform tasks faster. The result would be that help system design could be changed to maximize end user productivity.

Another purpose of the study was to determine if task type had a significant impact on task performance. Not all tasks have the same set of characteristics. The reason this purpose is included in this research is to extend the research concerning online help systems on this topic. Most of the research to date has categorized all tasks into one generic type. If task type is a significant variable, this finding would be important.

Another purpose of this research is to determine if task complexity has a significant impact on task performance. Task complexity has been used in other research areas as an important variable. On line help
systems research has not included this type of variable in the past.

Many activities had to be undertaken so that the purposes of this study could be accomplished. One of the activities was to learn what information is needed for the completion of a given task by a novice user. If a novice user does not have that information and subsequently obtains the information from the computer, then the novice user can accomplish the given task. The help system should be able to provide the needed information. A second activity was to identify the words and phrases the novice user might employ or expect to see in searching for information. If the help system contains the words and phrases familiar to the novice user, finding the needed information will be faster. To accomplish the first purposes of this research a protocol analysis was conducted. The protocol analysis research methodology was used to identify what the user needs to know to accomplish a given task. The information concerning task accomplishment is included in the help system. Protocol analysis was also used to determine what words and phrases the novice might use to search for the information. The
words and phrases identified during the protocol analysis were incorporated into the semantic help system. All the information gathered was used to construct a semantic online help system. By comparing the outcomes from using the custom online help system with the traditional keyword based system, a performance analysis was done.

To accomplish the second purpose of determining if task type had a significant impact, tasks given the subjects were classified into two types. The first type was mathematical. The second type was verbal.

**Significance of the Study**

The primary benefit of this research is the extension of human-computer interface theory in the context of online help systems. An important aspect of this study is the identification of basic informational pieces which are needed by users for the completion of their computer based tasks. The identification of specific information necessary for task completion makes it possible to construct specific help systems which provide the needed pieces of information. Information identification research is basic to the
construction of online help systems. Both what users need to know and how to search for information are addressed. By using the information on task accomplishment and words associated with the task, one can construct online help systems which allow the user to search and retrieve information more efficiently and effectively.

As technology and time have progressed, computer human interfaces, specifically online help systems, have become adaptable to the user. The adaptation process could be accomplished in two ways: (1) users could change the interface to suit their likes and dislikes, or (2) the system could change to address the usage patterns of the users. The lack of information about the process is why basic research is still needed.

In addition, the results of this research will help future information system designers construct efficient help facilities as part of the larger scope of the user interface. Future researchers can also use the theoretical framework to guide their research in online help systems.
This study uses terminology having specific and important meaning relative to understanding the study. A terminology and concept list is located in Appendix A.

General Help Considerations

Help information can be obtained by many different methods. This research focuses on computer generated help after the user starts looking for help information. Specifically, help is sought when subjects have difficulty completing tasks and need additional information. Subjects then generate a request, usually by command, whether by a function key or a mouse click, to obtain that needed information.

This research is a study of search mechanisms once a help system is invoked. Whether the help system is called by a function key, a mouse click or by some other mechanism is not addressed here.

Keyword Help System

Many help systems use a keyword search mechanism. An example is shown in Appendix F. When invoking the help system, it is called up by clicking the mouse or hitting a
function key and a set of words is displayed. The user then
chooses a word or phrase in order to display information or
a more detailed set of key words and phrases from which to
choose. The use of the function key to enter the help
system has no relationship to the search mechanism once the
help system is functioning. The traditional spreadsheet and
word processing help systems are constructed using the
function key access approach.

Windowing type interfaces have become a de facto
standard in the micro-computer world. If the beginner is
using a program that covers the entire screen, such as a DOS
type program, or if the program is running in a window,
these two different scenarios have no impact on the help
system search mechanism. In either environment, multiple
screens may be implemented. The help system search
mechanism once the help system is activated was
investigated.

Semantic Help System

The semantic help system is similar to the keyword help
system except that the semantic help system allows a user to
build a sentence that should have more meaning to the user than one or more abstract words. An example is shown in Appendix E. The semantic help system and the keyword help system may both be invoked by a function key or a mouse click or another activity but the difference between the two systems occurs when both are called into action. With the semantic system, users can choose phrases from a list until a complete sentence is constructed. The semantic help system is more grammatical and "English-like" in nature.

Context Sensitive Help

Another type of help system characteristic is context sensitivity. With a context sensitive type help system, the user is attempting to do an activity but can not complete it. If the help system is invoked in the middle of the procedure, the help system is "intelligent enough" to retrieve information about the task being attempted.

Methodology Overview

A research model was constructed by including significant variables from past research. The operational
model was developed from the research model and used to construct the testable hypotheses.

The objective of the research was to study what the impact task type, task complexity, and help search mechanisms have on task performance. The following activities were conducted to help accomplish this research objective.

The first research activity was to identify computer based mathematically and verbally oriented tasks and the information needed to complete those tasks. Protocol analysis was conducted to identify the tasks and the information needed by a person to complete the tasks. Protocol analysis was the most appropriate research tool available to accomplish the identification of information relevant to the task.

Another research activity was to identify the words and phrases beginners may expect to see when trying to find needed information. Again, protocol analysis was used to identify those words and phrases.

The first research objective was to determine if a significant difference exists between levels of task
performance when using a keyword driven help system or a semantic help system for a given task type and level of task complexity. A semantic online help system was constructed from the information obtained in the second phase of the protocol analysis. An expert panel of judges was used to validate the words and phrases, the information needed for task accomplishment and design of the semantic online help system. The semantic help system was tested in pilot studies. The results from the pilot test dictated a change in the tasks developed initially. The results were taken back to the expert panel and re-verified. A new task set was designed and the second pilot study was done. The results from the second pilot suggested the research design was acceptable. The process of collecting the experimental data was conducted.

The keyword online help system was used in the comparison against the semantic online help system which was already implemented in commercial products used as test instruments. The study used an off-the-shelf word processor and a spreadsheet package as implementational tools. The test subjects used either the keyword help features supplied
by the commercial package or the constructed semantic help system. The beginners were told how to invoke the help system before the main data collection phase. If the beginners were in the keyword help group they were instructed to access the help function in one way. If the beginners were in the semantic based help system, they were told to access the help system using a different set of key strokes.

In addition to access mechanism grouping, subjects were also assigned either to verbal or to mathematical task types of varying complexity. A single measurement instrument was used to measure the level of productivity of all groups.

**Data Collection Overview**

The data were collected in two stages. The first stage consisted of the protocol analysis, the pilot studies, and expert panel reviews. Following the completion of these preliminary research design activities, the second stage which consisted of the controlled experiment was done.

During the first stage, a subject was asked to sit in front of a computer and accomplish a list of tasks. During
that time, he/she was questioned on a variety of items. All of the protocol data was recorded and compiled for later analysis. The later analysis revealed patterns in information that related to the task the user was attempting to accomplish. A custom semantic online help system was constructed using the results from the protocol analysis. This process involved analyzing the words and phrases that were used by the beginners. These words and phrases were included in the semantic system.

Once the semantic online help system was finalized and supported by validation procedures, the experiment was conducted. The experimental design consisted of eight different groups (two task types, two levels of task complexity, and two different search mechanisms). Participation in each group was randomly assigned. Each group had a different set of treatments. Since three different variables were being tested, eight different combinations were possible.
Analysis of the Data

Linear regression and t-tests were used to determine the significance of the results. The major variables of task type, search mechanism and task complexity were all analyzed. The regression models started with all the independent variables. Then a step-wise procedure was used to delete the least significant variable, one at a time. The demographic data were also analyzed to determine if any of the characteristics might significantly impact task performance.

Limitations of the Study

This study has several limitations. A concern is always present when using students to simulate the environment of the business world. The concern is that student characteristics do not match the population in the business environment, and that the presence of characteristics mismatch can affect the inferences that may be drawn about the business community. Typing speed required for the accomplishment of the different tasks during the allotted time frame was kept to a minimum. Task
domain was kept very general so that business knowledge or experience were not a factor. The complexities of actual business use and demands could increase the intensity of the activity. However, the study assumed that underlying fundamentals are not influenced by the environment. Current online help systems have many different methods of obtaining help information. This study limited the search mechanisms to just two different types.

**Summary**

This chapter discussed the development of the problem as it relates to the design of online help systems and its potential linkage with user productivity. Chapter 2 presents a review of the relevant online help systems literature and other literature relevant to this research. Chapter 3 describes the development and application of the literature relevant to the research and operational models. Chapter 4 presents the research design. Chapter 5 contains data collection procedures. Chapter 6 presents the analysis of the data. Finally, Chapter 7 discusses the implications of and provides directions for future research.
CHAPTER II

BACKGROUND

This chapter contains a comprehensive analysis of the research related to online help, including those of historical importance. The literature review documents a pattern of investigation into the help interface prevalent in information systems. An overview of task complexity and task type is also presented. Each topic includes a discussion of the findings of researchers in their respective fields. Table 1 contains a list of the theoretical relationships used by the major researchers. These variables are important in the construction of a research model.

Introduction

The following review of online system research includes several different topics. These topics include: (1) general interface design, (2) adaptive systems, and (3) online help systems interface design.
The variables used in prior help related research are discussed in this chapter. The strengths and weaknesses of those studies are analyzed.

Table 1

Relevant Online Help Research

<table>
<thead>
<tr>
<th>AUTHOR(S)</th>
<th>INDEPENDENT VARIABLES</th>
<th>DEPENDENT VARIABLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Magers (1983)</td>
<td>User Characteristics</td>
<td>Task Performance</td>
</tr>
<tr>
<td></td>
<td>Online Help Implementation</td>
<td>User Satisfactions</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cohill and Williges (1985)</td>
<td>Help Initiator Help Sequence Help Format</td>
<td>Task Performance</td>
</tr>
<tr>
<td>Smith (1988)</td>
<td>Experience Online Help Type Documentation</td>
<td>Task Performance User Satisfaction User Attitudes</td>
</tr>
<tr>
<td></td>
<td>Format User Interface</td>
<td></td>
</tr>
<tr>
<td>Coventry (1991)</td>
<td>User Characteristics</td>
<td>Task Performance</td>
</tr>
</tbody>
</table>
Interest in help systems is growing. The growing interest is evident by the number of articles specifically related to the design and implementation of help systems. There are three types of articles: (1) those that present research on different help systems (2) those that examine how to design help systems and (3) those that present ideas and concepts that can be adapted and used in help systems.

In an experiment with non-programmers in two different help environments, Magers (1983) found that both user characteristics and the implementation of online help documentation affected the subsequent task performance and satisfaction. Mager's experiment had several methodological problems. He used three methods whereby help could be attained: (1) from the computer, (2) from the manuals, and (3) from a human helper. Although the use of all three methods at once could potentially influence the results of the experiment, no explanation was given concerning how the problem of multiple influences was addressed. The crossover
of information flow could have affected the results by
diluting the treatment affect. Also, Magers' subjects were
administered the Learning Style Inventory (Kolb 1976) in
order to classify their cognitive processing abilities. The
classification scheme used in the Learning Style Inventory
may not have been appropriate in the environment of help
systems because learning is not necessarily required.
Learning is "a permanent change in behavior" and using a
help system may only affect the subjects' behavior at the
time the task is completed.

Cohill and Williges (1985) tested several variables:
(1) help initiator (computer versus human) as one variable,
(2) the help sequence chosen (computer versus human
specified) as a second variable and (3) the format used
(online versus hard copy) as a third variable. They
concluded that novices work faster at editing when the
novice users do the requesting. They also concluded that
users work faster at the editing function when a manual is
available and when they can manage the help function. The
only task tested was the editing function.
Several problems were also evident in the Cohill and Williges (1985) study. First, they categorized college students who had fewer than eleven hours of formal class instruction on interactive computer systems as naive. With the beginning widespread use of microcomputers, the classification scheme used to categorize naive users may have been inappropriate. Since subjects were not randomly selected and were paid a fee for their participation in the experiment, it may have affected their motivation and, thus, the results of the study.

Borenstein (1985) conducted an experiment under the UNIX operating system. He wrote a program in LISP and C which defined the screen into five areas: (1) small, to be ignored, (2) help texts, where the help information was to be displayed, (3) keyword list which displayed topics on which help could be obtained, (4) command area where the user could type in commands to get help information, and (5) system response area. He concluded that the most important aspect of a help system was the text produced by the help facility and that search methods were less important.
Borenstein's conclusions were based on the assumption that the users are using a non-intelligent type of help system. If the users had been using an intelligent type help system, the results may have been different. Borenstein also concluded that expert users do not benefit as much from sophisticated help systems as do novice users. This conclusion may be task related. The tasks in his research may not have been difficult or complex enough to require help. The experts may not have needed much help.

Smith (1988) conducted research on the help function. The variables used in his research included experience, online help availability, help type, task performance, and user satisfaction. The lab experiment used a 3 x 2 x 2 full factorial between subjects design varying existence or non-existence of a user interface and media of help documentation (either online or written) while blocking for levels of user experience. Three conclusions from Smith's study were: (1) experience was the most significant influence on productivity, (2) online help had a positive influence on task performance, and (3) the subjects were generally pleased with the online help system.
Palmer, Duffy, Gomoll, K., and Gomoll, T. (1988) found differences in the vocabulary sets of novices, intermediates and experts. The authors found that the vocabulary set was much larger for the experts than for the beginners.

Frankel and Balci (1989) describe the characteristics of a good help system as it relates to a complex model building facility. Good help system characteristics include: (1) consistent availability of assistance, (2) accurate information and (3) reasonable cost for developing and maintaining the help system. The help system they presented, called the Assistance Manager, is one of their tools in their Simulation Model Development Environment (SMDE). No experiment was conducted on the help system.

Granda, Halstead-Nussloch, and Winters (1990) conducted a field study in which they asked 229 computer users to complete questionnaires. Each user was asked to describe a situation where information was required to use a computer. Then the person was asked to specify all the information sources that were consulted, judge the degree to which each met their information needs, and estimate the time required to obtain the information. They found that computer users
generally rate human helpers as most beneficial and online help systems as least useful or helpful. The reasons given why humans were more advantageous than the computer were: (1) humans are interactive speakers and listeners, (2) humans can be selective in the information presented, (3) humans can query at multiple levels during the communication process, and (4) humans can assess the relevance of the information presented by the person. Paper based documentation was rated along with the other two mechanisms of obtaining help. Data for the study were collected for from one to several weeks after the computer experience.

Coventry (1991), in her dissertation on help systems, investigated the relationship of individual differences to the use of computers and online help. The observational study of real users of UNIX showed that subjects used very few commands and that great variability existed among subjects in the use of UNIX. She identified "Field Dependency" as a potential source of the variation between users. She conducted two experiments to assess the effects of Field Dependency, as measured by the Embedded Figures Test (EFT). The researcher assigned subjects a number of
tasks to be carried out with help provided via a human expert or an online help systems. The help system developed was configured to behave either actively or passively. The study covered two different user communities: (1) computer science students and (2) women trainees. Both experiments found Field Dependency to be correlated with the number of commands known by users: the more field-independent a user, the more commands are known. Field dependency did not correlate with the use of the help system as a whole. All the female subjects completed fewer tasks than the male subjects, although they asked for less help. The computer science students did not like the computer generated active help. They preferred the passive help systems. The students preferred to do their own browsing in the help system. On the other hand, the Technology Centre trainees preferred the active help system. This system provided specific help on the tasks to be accomplished by the subjects. Since the information provided was specific in nature and the trainees spent less time with the help system, they tended to be more productive concerning task accomplishment. The subjects accomplished a higher number
of tasks in a given amount of time. A problem with the research could have been cell sizes used in the analysis. The total subject population was 32. Eleven in one group and twenty one in the other. Some subgroups had as few as three in them.

Slack (1991) examined the use of online help while subjects were searching an online library system. Slack then analyzed the transaction logs. The problem areas the subjects addressed included: (1) the general library system interface, (2) inputting of search terms, (3) refining the search strategy, and (4) subject description. Analysis showed that only one third of the subjects used the online help system. Even when the online system was used, the subjects had a difficult time successfully completing subject searches. With a little human help, the subjects easily completed the subject search tasks. A second help system was designed and tested. The newer system was used less frequently but when used, the subjects were more successful.
Another group of literature examines the issues associated with the construction of help systems. For example, Kearsley (1988) in his book about help systems discusses: (1) why help systems are needed, (2) design alternatives, (3) several different examples of online help systems, and (4) how to implement online help systems. Kearsley also proposed the following guidelines in help system design:

1. Make the help system easy to access.
2. Make it easy to return to the entry point.
3. Make helps as specific as possible.
4. Give the user as much control as possible.
5. Different types of users need different types of help.
6. Help messages must be accurate and complete.

Shneiderman (1992) devoted a chapter to help systems in his book *Designing the User Interface Strategies for Effective Human-Computer Interaction*. He presented a list of design strategies related to menu-based systems that are relevant to this study. His list included:
1. Use task semantics to organize menu structure.
2. Give position in organization of help system by graphic design, numbering, and titles.
3. Items become titles in walking down a tree.
4. Make meaningful groupings of items in a menu.
5. Make meaningful sequences of items in a menu.
6. Items should be brief and consistent in grammatical style.
7. Permit type-ahead, jump-ahead, or other short-cuts.
8. Permit jumps to previous and main menu.
9. Use consistent layout and terminology.
11. Consider response time and display rate impact.
12. Consider screen size.

Shneiderman also proposed "Eight Golden Rules of Dialog Design". His rules were:

1. Strive for consistency.
2. Enable frequent users to use shortcuts.
3. Offer informative feedback.
4. Design dialogues to yield closure.
5. Offer simple error handling.
6. Permit easy reversal of actions.
7. Support internal locus of control.

Pilkington (1992) examined the process of specifying a question-answering help facility in the context of UNIX mail. The developer, Pilkington, based the system on expert-user facilitative dialogues. The method he used to
develop the system included analyzing the dialogues with a classification scheme developed for that purpose. The developer used patterns of answers to develop the interface between the machine and the user.

Kirk (1990) believes that users cannot remember all the facilities of a complex system. He developed an online help system to assist people while they are using a large record system called COSTAR (Computer Stored Ambulatory Record System). With the help system in place, the users required less training time individually and in group session.

Related Literature

Literature that identifies, and classifies, and categorizes levels is also relevant to this study. The next section addresses these issues, as related to help systems, and identifies some of the inconsistencies in existing research.

Task Type Literature

Task characteristics and complexity have previously been used to classify tasks. Researchers have studied help facilities, task characteristics and task complexity as
important variables. None of the research has combined all three in one research effort. Bloom (1956) proposed a task classification scheme related to educational objectives that includes, from lowest to highest, knowledge of specifics, comprehension, application, analysis, synthesis and evaluation. Bloom's (Bloom 1959, p15) taxonomy is as follows:

**Evaluation** -- making judgments about the value, for some purpose, of ideas, works, solutions, methods, material, etc.

**Synthesis** -- putting together parts so as to form a whole.

**Analysis** -- breaking down the material into its constituent parts and detecting the relationships of the parts and the way they are organized.

**Application** -- remembering and bringing to bear upon given material the appropriate generalizations or principles.

**Comprehension** -- grasping the meaning and intent of the material.

**Knowledge of Specifics** -- the recall of specific and isolatable bit(s) of information.

Gardner (1986) classified tasks using two dimensions. The first was the perception of core job characteristics
scales from the **Job Diagnostic Survey**. The analysis from the JDS resulted in a motivating potential score (additive formula) which showed the enrichment level as perceived by the subject relating to a specific task. Gardner also developed a second perceived task characteristic measure which he based on activation theory constructs (visual, intensity, complexity, meaningfulness, novelty, and variation of stimulation). Gardner hypothesized that complex tasks required lower levels of activation to achieve maximum performance than simple tasks.

Hearne and Lasley (1985), who used mathematics and verbal ability scales in their research regarding predictions of computer aptitude, used the **Stanford Achievement Test** to obtain ability ratings. An extension of the application of the **Stanford Achievement Test** to computer aptitude is making the assumption that a link exists between task and ability.

DeSanctis and Gallupe (1987) outlined a categorization scheme for the assessment of tasks in a group decision environment. Their task types included planning,
creativity, intellective, preference, cognitive conflict, and mixed-motive.

Hard and Vanecek (1991) conducted an experiment using task performance as the dependent variable and task type and presentation format as the independent variables. The authors chose Bloom's taxonomy to classify the processes of decision making. The groups developed by the authors included: (1) accumulation (2) recognition (3) estimation and (4) projection. Their results showed that presentation format, with respect to the task being performed, did have a relationship to the decision-making process of financial decision makers.

Task Complexity Literature

Jarvenpaa (1989) concluded that graphical presentation format and task complexity were significant in determining the decision quality of where to locate a restaurant. Graphical decision aids was one of the independent variables. The conclusions were inconclusive in the early trials. The reasons given were varied. One was that the subjects did not have sufficient problem identification
skills. Another was the poor design of the graphs being presented to the subjects.

Kozlowski and Hultz (1986) associated task complexity with the job performance of engineers. They investigated task complexity by studying engineers in a research and development organization. These authors measured task complexity using the Job Characteristics Inventory (Sims, Szilagyi and Keller, 1976). Previous research (Dunham, 1976; Roberts and Glick, 1983) suggests that the classification of job characteristics can be done by using a single task complexity construct. The authors suggested that a simple sum is the most appropriate method to use in obtaining task complexity.

It is possible to classify task complexity using different schemes. Wichman and Oyasato (1983) varied the level of complexity in their research by using one-letter numbered pairs versus four-letter numbered pairs in experiments in prospective remembering. They reported that task complexity was a significant contributor to subject performance in regard to remembering the character strings.
Gawron (1982) used still another classification scheme for task complexity. She classified a simple task as one in which the subjects do one task at a time. For the complex task, the subjects do dual tasks. She found that the task complexity factor was significant.

Johnson and Payne (1985) defined task variables as "those associated with general characteristics of the decision problem." An example is the number of alternatives which is not dependent on the particular values of the objects. The results of Johnson and Payne's study suggest that heuristic strategies can be highly accurate. On the other hand, these strategies may substantially reduce the effort required as they relate to the normative procedures. They found that the accuracy and effort of strategies, however, were highly contingent upon characteristics of the choice task.

Kleinmuntz (1985) studied the dynamic decision environment. Characteristics of the dynamic decision environment include the subjects' cognitive abilities as they relate to the problem domain, to computational complexity of the decision task, and to the engagement of probabilistic
behavior by the subjects. The structure of the environment can influence the decision making behavior of subjects (Brunswik, 1952; Postman and Tolman, 1959; Simon, 1981). Two other task characteristics used by Kleinmuntz (1985) were task size and task related information feedback.

Zmud (1984) included task complexity in his study of the management of software groups. His complexity measure was a combination of the percentage of projects that: (1) took longer than six months to develop, (2) required more than twenty-five man-months of effort and (3) cost more than $20,000 to develop. Zmud found a relationship between task complexity and the adoption of innovative technologies.

Most researchers who have used task complexity in the past have not considered task type. However, task complexity may take on different dimensions and elicit different properties in light of the task type being investigated.

Although several researchers such as Magers (1983), Cohill and Willinges (1985), Borenstein (1985), Smith (1988), Slack (1991), and Coventry (1991) have suggested that many constructs may influence performance when using
the help function, none has presented generalized formal theoretical frameworks in their investigations. However, theoretical frameworks may be implied by the variables used. The theoretical framework developed from all the variables used by past researchers includes: user characteristics, task characteristics, information characteristics and user environmental characteristics as the independent variables and task performance as the dependent variable.

A comprehensive literature review was unable to find research in help systems using task type as an independent variable. The lack of inclusion of task type could be a significant oversight. In a research setting that is investigating the help function, it would seem logical to assume that task complexity could play an important role in the outcome. If the task complexity is not high enough, the help system is not needed and if task complexity is too high, no online help systems will be able to assist the user.
Adaptive User Interface

In a concept oriented article written by Trumbly (1990), he proposes that the six design principles of a good human factors program are: (1) supply feedback, (2) be consistent, (3) minimize human memory requirements, (4) keep the program simple, (5) match the program to the user's skill level, and (6) sustain the orientation of the user.

In another article (Kuo, Karimi, Jahangir 1988), the authors present three types of user interfaces: (1) question-answer, (2) menu-form, and (3) command language. They propose that all systems should support all three types of interfaces. In the scenario where all help system types are available, the users choose whichever they wanted. It is possible users could choose a different type of interface for a different situation.

An adaptive interface can be implemented in one of two ways. The first is to let the user choose the interface design. When the users choose their own interface, it would be known as user-directed adaptation. The second method would be for the computer to adapt to users as they use the system. The computer directed adaptation process would
require some form of intelligence on the part of the computer system. This intelligence could be implemented in the form of a rule base. Then the rules could be developed either by using protocol analysis or by gleaning information from a group of experts.

Conclusions

Traditionally, help systems research has not included some variables that may have a significant impact on the findings. Task complexity needs to be included to determine if it may be a significant variable. Another variable that has been untested is task type. Help related research usually tests different providers of information and how to obtain information from the viewpoint of the subject, but none has included a research effort that included different task types in the same research effort.

Although several studies suggest that the overriding variable is experience in relation to performance of a task, many problems exist concerning past research. Since the research has not been framework based, definite conclusions are suspect. Because no foundation was laid, any
assumptions that arise from this line of research may be questionable. In addition, many researchers used multiple treatments at the same time, compounding the problem of determining impact. It is difficult to isolate causes from multiple sources. None of the researchers used a task classification scheme. This may, in itself, be enough to invalidate the research, because help research may be significantly effected by task type.
CHAPTER III

THEORETICAL AND OPERATIONAL DEVELOPMENT

This chapter presents the development of the research and the operational models. All of the variables were derived from previous literature. The hypotheses were a direct result of the variables used in the operational model.

Research Model Overview

Several frameworks have been proposed and developed by management information systems researchers in the past (Chervany, Dickson, and Kozar, 1971; Gorry and Scott-Morton, 1971; Ives, Hamilton, and Davis, 1980; Lucas, 1973; Mason and Mitroff, 1973; Mock, 1973). These frameworks were used as a foundation for the development of the theoretical framework for this study. Figure 1 shows the Ives, Hamilton, and Davis model. The study used an adaptation of the Ives, Hamilton, and Davis (1980) model (Figure 1). The
adaptation process resulted in the research model used in this study (Figure 2).

![Diagram of Ives, Hamilton, and Davis IS Research Model]

Figure 1. Ives, Hamilton, and Davis IS Research Model.

The main difference between the Ives, Hamilton, and Davis Model and the research model used in this study is the addition of the task performance variable. The operation
variable does not specifically include the performance dimension.

![Research Model](image)

Figure 2. Research Model used for this study.

The categories of variables chosen for this research were user characteristics, task characteristics, process characteristics, and task performance. Task type and complexity were both independent variables selected from the task characteristics category. The search mechanism to information was the independent variable selected from the
process characteristics category. The user characteristics category included experience, age and gender. Quantity of output was the dependent variable selected from the task performance category.

![Diagram of Help Systems Variables List]

**Figure 3. Help Systems Variables List.**

A list of the variables used in the model follows. The reasons for including these variables are also presented.
Independent Variables

This study used task type, task complexity and access mechanism to information as primary independent variables. These variables were chosen because prior researchers believed that task characteristics are a prime determinant of human decision making. (Einhorn and Hogarth 1981, Newell and Simon 1972, Sage 1981). These variables were chosen because of their demonstrated importance as variables by Magers (1983). Hearne and Lasley (1985) used mathematics and verbal ability variables in their research. Their categorization scheme was adapted and included in this research because those variables may be important in affecting task performance.

Search Mechanism

Smith (1988) conducted research on help systems. He concluded that the presence of a help system improved the performance of the user. This study takes help systems research one step farther. This research categorizes the type of search mechanism the user may use in obtaining help from the computer.
Search mechanisms to information can be easy or difficult to use, especially for beginners. Since this research concerns beginners, a logical assumption and proposed hypothesis is that the easier it is to acquire the needed information, the faster the person will be in completing the task set.

The level of complexity for a beginner may involve a situation where the beginner does not know the meanings of the words that are on the screen. If the beginner does not understand, the beginner cannot appropriately use the words to search for the help information. If the words on the screen are familiar to the beginner, it is more likely that the beginner can use those words and phrases effectively in getting the system to generate the needed help information.

The surrogate variable of search mechanism was keyword driven versus a semantically based help system. Help systems have traditionally been keyword driven.

Task Complexity

Task complexity was found to be a significant variable in the Jarvenpaa, Dickson and DeSanctis (1985) research.
They tested the effect of task complexity on decision performance and on decision confidence. They found that by lowering the complexity of the decision environment, the subjects detected a higher percentage of the problems.

Simon (1981) proposed that a complex system is "one made up of a large number of parts that interact in a non-simple way." He also stated that "how a system is described" affects the complexity level of that structure.

Since the task complexity variable is affected by task type, the task types used for this study conform to the classification scheme used by Bloom (1956). Bloom describes six different task activities. For this research, subjects were required to function at Bloom's comprehension level.

Task complexity was monitored and tested in this research. None of the research to date has included task complexity. If tasks are very simple for subjects, then the help mechanisms are not tested at all. On the reverse side, if tasks are too complex, no amount of generic help can enable users to complete the task. In the case where the task is very complex, specific information related to the task of the subject was needed. Most implementations of the
help function do not provide a very detailed level of support.

Task Type

The surrogates for task type were mathematical and verbal task types. Jarvenpaa, Dickson and DeSanctis (1985) proposed that task type may be a significant variable in the information systems research. Hearne and Lasley (1985) used mathematics and verbal ability scales in their research regarding predictions of computer aptitude and they used the Stanford Achievement Test to obtain ability ratings. Hard and Vanecek (1991) found that task type can be a significant variable in affecting task performance. The potential impact of task type needs to be studied.

Dependent Variable

The one major dependent variable in the model, task performance, is defined as the quantity of output. In the business world, there are degrees of completion with regard to tasks. It is logical that the degree of completion be taken into consideration when conducting research that will be applied to a business setting.
Another dimension to task performance is quality. Quality is also important when considering task performance. Vasilash (1992) investigated the automation process concerning the conversion of design concepts all the way through to actual appliances. Productivity was the main concern, but another issue was that the assurance the number of mistakes in the process would not increase and lower quality. This study assumes constancy of the quality level. The tasks are either accomplished or they are not.

A major goal of this research is the identification of the important factors that may affect task performance. Productivity is an important consideration in a business environment. Task accomplishment is related to that concept. The more tasks that can be accomplished in a given amount of time, the more productive the person, given a constant level of quality. Surynt and Augustine (1993) discussed the issues surrounding resource allocation and end-user productivity in an educational environment. The goal of resource allocation was to help maximize end-user productivity and minimize waste of the institutional resources. The desired effect on the students was to
provide an adequate resource level so they could effectively learn.

The dependent variable of task performance was chosen for the purpose of evaluating the effects of access mechanism, task type and task complexity. Magers (1983) found that both user characteristics and the implementation of online help documentation affected the subsequent task performance. Cohill and Williges (1985) concluded that users worked faster when the help system was not the initiator. If the user did the requesting, the user tended to work faster. If the system prompted the user to see if he/she needed help, the user tended to work slower. Smith (1988) concluded online help had a positive influence on task performance. Coventry (1991) in her dissertation on help systems investigated the relationship of individual differences to the use of computers and online help. She found that individual differences had an effect on usage rates of the computer. Slack (1991) examined the use made of online help during subject searching. She found that when the help system was redesigned even though the usage rate dropped, the accomplishment of successful searches
increased. From the literature, task performance has been used as a dependent variable. This study uses task performance also as a dependent variable.

Demographic Variables

Demographic data about the subjects could be an important consideration since past research has found that one characteristic such as experience level was a significant determination in task performance (Smith 1988). Data collected concerning demographics include age, gender, experience in general and experience with the test instrument (either the spreadsheet or the word processor). This was done to determine prior knowledge of the test instruments.

Hypotheses

The primary hypothesis of this study was that the level of task performance would vary with the access mechanism used. It was then hypothesized that task performance is a function of the search mechanism. Stated in the null form:
HoA1: There will be no difference in task performance between subjects using the keyword and semantic help systems.

This hypothesis is consistent with previous research, such as Borenstein (1985.) He used search mechanism as one of the independent variables in his dissertation.

No prior research on the topic of complexity levels and task performance relative to help systems is known to exist. Jarvenpaa, Dickson and DeSanctis (1985) found that task complexity was a significant variable in their research. This study investigated the application of task complexity and task performance relative to help systems. Hence, stated in the null form:

HoA2: There will be no difference in task performance between subjects performing high complexity tasks and low complexity tasks.

No prior research on the topic of task type relative to help systems is known to exist. Jarvenpaa, Dickson and DeSanctis (1985) proposed that task type may be a significant variable in the information systems research. Hearne and Lasley (1985) who used mathematics and verbal
ability scales in their research regarding predictions of computer aptitude, also used the Stanford Achievement Test to obtain ability ratings. This study investigated the application of task type to help systems. Stated in the null form:

**HoA3:** There will be no difference in task performance between subjects performing verbal and mathematical tasks.

A secondary hypotheses set was developed. Based on prior research, subjects should perform tasks better when using the semantic help system, and they should perform better on the higher level of complexity tasks. Stated in the null form:

**HoB1:** There will be no difference in task performance between subjects using the semantic online help system and subjects using the keyword driven help system when the subjects are given a low complexity level verbal task.

Based on prior research, the subjects should perform better when using the semantic online system when the tasks are complex. Stated in the null form:
HoB2: There will be no difference in task performance between subjects using the semantic online help system and subjects using the keyword driven help system when the subjects are given a high complexity level verbal task.

Another secondary hypothesis is that task performance will be related to the access mechanism given a low complexity mathematical task type. Stated in the null form:

HoC1: There will be no difference in task performance between subjects using the semantic online help system and subjects using the keyword driven help system when the subjects are given a low complexity level mathematical task.

Another secondary hypothesis is that task performance will be related to the access mechanism given a high complexity mathematical task type. Stated in the null form:

HoC2: There will be no difference in task performance between subjects using the semantic online help system and subjects using the keyword driven help system when the subjects are given a high complexity level mathematical task.

Another secondary hypothesis is that task performance will be related to verbal type and task complexity given the semantic online help system. Stated in the null form:
HoD1: There will be no difference in task performance between subjects using the semantic online help system given a verbal task type and varying the task complexity.

And another secondary hypothesis is that task performance will be related to verbal type and task complexity given the menu-driven online help system. Stated in the null form:

HoD2: There will be no difference in task performance between subjects using the keyword driven online help system given a verbal task type and varying the task complexity.

The seventh secondary hypothesis is that task performance will be related to task complexity given the semantic online help system and the mathematical task type. Stated in the null form:

HoE1: There will be no difference in task performance between subjects using the semantic online help system given a mathematical task type and varying the task complexity.

The final secondary hypothesis is that task performance will be related to task complexity given the keyword driven
online help system and the mathematical task type. Stated in the null form:

HoE2: There will be no difference in task performance between subjects using the keyword driven online help system given a mathematical task type and varying the task complexity.
 CHAPTER IV

RESEARCH DESIGN

This chapter discusses the research design used in the study. The chapter covers the following activities: (1) development of experimental design, (2) development of the research design, (3) operational model development, (4) operationalization of the variables, (5) discussion on the measurement of the variables, (6) discussion of demographic data, (7) discussion of subjects and population, (8) pre-experimental procedures development, and (9) a discussion on experimental procedures, and (10) a presentation of the key assumptions.

Experimental Design

A research framework, which was presented in Figure 3 of Chapter III, was developed to identify variables used in prior help systems research. The categories of variables chosen for this research were task performance, task characteristics and process characteristics. The independent variables of task type and of task complexity
were selected from the task characteristics category. The independent variable search mechanism was chosen from the process characteristics category. The user characteristics category included demographics of experience, age and gender. The dependent variable of quantity of output was chosen from the task performance category. The surrogate of quantity of output was score measure by the number of tasks completed by the subjects.

This study used four different experimental instruments. The four instruments were developed to represent two levels of the independent variables: (1) task complexity and (2) task type. Task complexity had two classes: (1) high and (2) low. Task type had two classes: (1) mathematical and (2) verbal.

A laboratory experiment was used to test the hypotheses. The experimental design was a post-test-only control group between groups 2X2X2 factorial design (design 6, Campbell and Stanley, 1963). Subjects were randomly assigned to one of the two search mechanism groups and to one of the two task groups and to one of two complexity levels (eight different treatment groups). The research design is represented in Figure 4. The anonymity of each
subject was maintained. Each subject completed either a high or a low complexity task set using either Lotus or word processor. Subjects were allotted a specific amount of time. Both the spreadsheet and word processor parts had either a high complexity task set or a low complexity task set.

**Research Design**

Figure 4 that follows illustrates the overall research design. It is a pictorial representation of the variables under investigation. The study investigated three factors. Each factor had two levels. Each subject was assigned to one group.

**Operational Model**

The variables listed in Figure 3 of chapter III were used as inputs into the construction of the operational model in Figure 5 of this study. All of the independent variables listed on the left in Figure 3 are assumed to be variables that have a significant impact on the dependent variables.
Figure 4. Relationships of the variables.

The operational model in Figure 5 was developed from the research model. Task performance was included from the dependent variables list. Task type and task complexity were used from the independent variable -- task characteristics. Search mechanism to information was chosen from the list of process characteristics.
$Y_{1,2,3,4,5,6,7,8} = f(x_1 \text{ given } x_2 \text{ given } x_3)$

$Y$ = task performance (SCORE) for eight different task sets

$x_1$ = search mechanism (Semantic versus Keyword)

$x_2$ = task complexity level (high or low)

$x_3$ = task type (mathematical or verbal)

Figure 5. Operational Model

**Operationalization of the Variables**

Task performance in an educational setting usually involves grades. The dependent measure developed in this research was grade achieved on the task set (SCORE). The grading scale was adjusted according to input from a panel of experts. All task sets were graded using a scoring sheet for each task set. Therefore, the surrogate for quantity of output was performance on the task set. Quantity was measured by the number of questions answered correctly on the task set during the timed experiment.

Search mechanism was operationalized into two categories. The first category was the keyword based search mechanism. The second category was the semantic based help system. Subjects using the second semantic
based help system chose words and phrases that were combined into sentences. When the sentences were complete, the help system would display on the screen the requested information.

Task type was operationalized into two categories. The first was the mathematical type. The problems the subjects had to solve included mathematical concepts. The subjects used a spreadsheet to address the mathematical problems. The second was the verbal type. This verbal task type involved the use and manipulation of words, phrases, sentences, paragraphs and a document. The subjects had to use a word processor for the verbal task type.

The surrogate variables used in this experiment were: (1) test scores on the task set of each subject for performance, (2) the spreadsheet and the word processor application programs for task types, (3) a high versus low task complexity level which was validated by the expert panel, and (4) keyword versus semantic help systems for search mechanism. The surrogate for dependent variable task performance was the score students received on the assignment. The score was generated by using a standard
evaluation form which was also validated by the expert panel.

The surrogate for the independent variable search mechanism was determined by whether the subject used the semantic help system or the keyword system provided by the manufactures of the spreadsheet and the word processor programs. The surrogate for the independent variable task complexity was initially measured by the researcher who used a number of elements: (1) the depth required in the command system of the spreadsheet and word processor (the higher number of levels that need to be traversed in the command structure, the higher the level of complexity), (2) the experience and knowledge the researcher had concerning beginners and how they perceive and learn computer concepts, and (3) the number of steps required to accomplish a given task. No mathematical formulas were used to assign the complexity level to any one task. Instead, assignment was based on a combination of personal experiences of the researcher and the observation, over the previous five years, of beginners while they were learning. The classification scheme and the value of the assigned complexity level to each of the tasks were validated by the
expert panel before each of the pilot tests. The expert panel achieved agreement with regard to the scheme used and the values assigned.

Measurement of the Variables

At the beginning of the experiment, all subjects were asked to complete a consent form and a demographic questionnaire. The information gathered from the questionnaire included subjects' age, gender, experience with computers, education, and experience with word processors and spreadsheets in general and experience with the test word processor and the test spreadsheet in particular.

The tasks were graded on an accomplished/not accomplished basis. The files from the computers provided sufficient information so subjects could be given credit for accomplishing tasks that did not require the generation of paper output. Each file and/or paper submitted was graded against the grading scale developed during the pre-experimental phase. All grading was done by the researcher. This was done to prevent the introduction of any grading bias by another individual. Although the
grading criterion was very specific, another person may have inadvertently graded differently.

**Demographic Data**

Demographic data about the subjects were collected including age, gender, experience in general and experience with the test instrument (spreadsheets or wordprocessors). The demographic data were used for several reasons: (1) there had to be a method of rejecting subjects who were not beginners, (2) there needed to be a method of determining if age was a significant influence on the outcome, and (3) the gender variable was investigated to determine if there was a performance difference between them.

Subjects who scored themselves higher than a three for prior knowledge about the software being used or about the software category in general were excluded from the data analysis. Exclusion prevented the data from having a bias with non-novices. The exclusion process was conducted after random assignment; the subjects that were excluded were eliminated from the experiment.
Subjects and Population

Student subjects have been used extensively in research. Gordon, Slade, and Schmitt (1986) showed that student populations were similar in characteristics and demographic data to non-student populations. However, studies of Copeland, Francia, and Strawser (1973) and Soley and Reid (1983) demonstrated significant differences between student populations and business populations. Because the ability to make inferences regarding the work world was a concern in this research, business students were included.

The subjects for this study were obtained from beginning computer classes (BCIS 2610) in the Business Computer Information Systems Department at the University of North Texas in Denton, Texas. Three hundred and twenty students participated during the 1990 fall semester. Most of the participants were classified as sophomores and juniors.

Students who participated in the study were asked to complete a demographic questionnaire which included questions regarding their age, gender, education, computer experience and experience with test spreadsheet and test
word processor in particular. Since the research effort was a class assignment, subjects were given the opportunity to refuse to participate. In retrospect, using a class assignment as part of the research effort was not a problem.

This research was designed to be projected toward a general population of workers in the business world who are inexperienced in the use of computers. There are many individuals in the business world who fit the description of general beginners with regard to computer use.

**Pre-experimental Procedures**

The tasks used in the study were developed with the help and input from a panel of experts. The reason for selecting the particular tasks was that they were the kinds of tasks business people encounter.

The pre-experimental procedures were designed to facilitate the validation of the task sets, the scoring system and the online semantic help system. The pre-experimental procedures included the following nine steps:
1. Development of the initial math and verbal tasks.
2. Conduct the protocol analysis to determine search words and levels of complexity as perceived by the subjects and develop the initial scoring assignments.
3. Validate the data with an expert panel.
4. Develop the semantic help system.
5. Test the task sets and the help systems in the first pilot test.
6. Add tasks to the task sets.
7. Re-validate the task sets, scores and perceived levels of complexity of the two help systems by the expert panel.
8. Conduct the second pilot study.
9. Analyze the results from the pilot study.

The procedures, task sets, and help systems were pilot tested with undergraduate students. The primary purposes of the pilot testing were to validate the semantic online help system, to validate the task sets, and to ensure that a discriminatory condition would exist between the task sets.

Protocol Analysis

This section contains an overview of the research tool protocol analysis. The following chapters on data collection and analysis contain specific details on what occurred during the protocol process stage. The Data Collection chapter presents the method of collection and
the Data Analysis chapter presents the method used to analyze the data obtained.

Data collection about how people search for information and what types of information they seek has been difficult or impossible in the past. It is possible, however, to observe subjects as they use the computer. The limitation of observational methodology is that the researcher can see the activities of the subject, but he cannot determine the underlying motivation of the behavior. Observational research often leaves a void in the kinds of information available to the researcher. It is not enough for the researcher to know, for example, that the subject hit the F3 key; the researcher needs to know why that activity occurred. This reasoning information is vital in designing effective and efficient systems interfaces. Protocol analysis is a tool that can be used to investigate the cognitive processes being used by a subject.

Protocol analysis is the collection of data whereby subjects verbalize their feelings, thoughts and/or information to the researcher. Watson (1920) was the first to use the protocol analysis technique. Newell and Simon (1972) gave protocol analysis a second look. Then Ericsson
and Simon (1984) developed the protocol analysis technique when they developed a framework of the human thought process. This framework could then be used as a guide for interpretation.

This study used protocol analysis to gather data about how beginners, when given a task set, interact with the computer. This provided insight into the thinking patterns of beginners as they attempted their tasks. The semantic help system was constructed using the information collected during the protocol analysis phase of the research. Specifics of the protocol analysis data collection process are given in the Data Collection chapter. The technique of protocol analysis is unique to the research on help systems and provides significant insight into the process.

The subjects for the protocol analysis phase had the same characteristics as the subjects in the full study. By using students in the protocol phase of the research, the researcher ensured consistency of subject population characteristics between the protocol phase and the regular data collection phase.
Semantic Help Design

The semantic online help system was developed during the pre-experimental process. The following is a list of the steps that were taken in the development and testing of the semantic help system.

1. Develop the semantic words and phrases.
2. Develop the information needed for task accomplishment.
3. Code the system.
4. Contact expert panel - validate complexity of the help system, the phrases and the information provided.
5. Test validated semantic system.

An example of how the protocol information was used follows. The first three lines of the protocol data show the discussion on the save process. From the feedback obtained during the protocol analysis phase, the save process was included. The resulting screen that included this concept is shown in Appendix E of the word processor semantic help screen. Another example of a concept that was discussed in the protocol data was how to move the cursor around in a document. An example of the help script created to teach a person how to do that activity is shown in Appendix H of the word processor help scripts.
From the protocol information and feedback from the expert panel, the semantic help system was constructed using Pascal. Pascal was chosen because it was relatively easy to develop the TSR feature of the pop-up help system on a DOS machine. Appendix E contains the example screen used in the semantic help system.

The design specifications of the semantic help system included: (1) the ability to be called up from a function key, (2) windows would be placed on the screen with words and phases in them, (3) a cursor could be moved around which would enable the user to construct a sentence, (4) once the sentence is constructed, the helpful information would be displayed on the screen, (5) if the amount of information will not fit on one screen, a scrolling mechanism must be included, and (6) once the semantic help system is exited, the user should be right back at the point of entry. The example screen used in the semantic help system is shown in Appendix E. The keyword help system interface is shown in Appendix F.

In contrast to the functioning of the semantic help system, the keyword help system functioned differently. When the subject called up the keyword help system, a list
of words was presented on the screen. The user had to choose one of the words to access another list of words that were more specific to a given topic. Depending on the number of levels the user had to traverse, the keyword help system would finally provide the help information requested.

Expert Panel

An expert panel was included in the research process for several reasons. The expert panel provided validation for the following: (1) task categories, (2) task complexity rating system, (3) scoring system and (4) the semantic help system. They may provide insight into unanticipated problems. None was encountered. The word processing experts were consulted about word processing tasks and concepts, and the spreadsheet experts were consulted concerning spreadsheet tasks and concepts.

The panel members consisted of two word processing specialists certified by the word processing corporation and three spreadsheet specialists who received specific training and certification by the spreadsheet corporation.
According to Rockart and Flannery (1983) such experts are classified as functional support personnel.

The expert panelists were chosen from a list provided by the respective companies that developed the word processor and the spreadsheet. Initial contact was made through telephone. During the pre-experimental phase of the research, meetings were used to obtain feedback from these experts. The organizations provided the names of people who had undergone the training sessions and had passed competency tests the organizations provided. Being on the official list allowed the experts to advertise that they were certified by the organizations. All of the experts enlisted on the panel were practicing trainers in the field.

**Task Set Design**

The process of task set design required many steps. The first task set was acquired by the researcher. All of the task sets used were designed by the researcher and validated by the expert panel. The first task set was the homework assigned to the students in the BCIS 2610 class. This task set was acquired before the protocol analysis
occurred. The researcher had 5 years of experience teaching the BCIS 2610 class. A more detailed account of the task set development is presented in the Data Collection and Data Analysis chapters.

Since Hearne and Lasley (1985) used mathematics and verbal ability scales in their research regarding predictions of computer aptitude, their classification scheme was adapted for this research.

A verbal task involves the use of words. A mathematical task involves the use of numbers. An example of a verbal task is shown in Appendix D for the word processing questionnaire. Verbal tasks include the use and manipulation of words, phrases, sentences, paragraphs and documents. One example in the questionnaire is deletion of text in a document which the expert panel classified as a simple task. An example of a complex task as defined by the expert panel in the use of different fonts in a document.

A mathematical task involves the use and manipulation of numbers. A list of mathematical tasks is shown in the spreadsheet questionnaire of Appendix D. An example of a low complexity mathematical task as defined by the expert
panel would be entering a number in a spreadsheet. An example of a high complexity mathematical task is conducting data sorts on numbers.

**Experimental Data Collection**

Once the task sets were finalized through the validation process, collection of the experimental data occurred. A detailed account of the process is presented in the Data Collection chapter.

Before the experimental data were gathered, each of the subjects received a preliminary teaching seminar. The training session ensured that all subjects had the same relative knowledge about how computers worked and how the test spreadsheet and the test word processor functioned. The pre-data collection lecture was written and standardized and given by the researcher.

The experimental process took place over a period of a week for all subjects. Eight different sessions were included. The following is a representation of the research design:
The experiment was administered in eight sessions at the beginning of the semester. The experiment was given early in the semester so the subjects would not learn information that would bias the experiment. Random assignment of the treatments to each session ensured that each subject had an equal probability of receiving either of the two complexity levels, and either of the two task types and either of the two help system types. At each of the experimental sessions, subjects completed a demographic questionnaire and the administrator used a timing device. During the forty five minute timed experiment, the subjects reviewed the task sets and responded to the assigned tasks.

Subjects need only a basic understanding of the keyboard and the hardware, such as the printer, to complete

\[
\begin{align*}
R & \quad X_n & \quad O_n \\
\end{align*}
\]

Where \( R \) = randomization
\( X_n \) = the different treatment conditions
\( O \) = observation
\( n \) = 1...8

Figure 6. Experimental Design: Posttest-only control group, Design 6. Adapted from Campbell and Stanley
the tasks. This information was provided by the researcher in a short presentation given prior to their beginning the experiment. All the presentations were given by the same person from a previously developed list of concepts (keyboard, printer, and accessing the help system). The presentation was given to ensure the same level of knowledge prior to the experiment about the environment of the experiment.

Subjects were instructed to work the list of tasks within the allotted time. At the end of the allotted forty five minutes, all subjects ceased working, and the materials were collected. The subjects were instructed not to talk with any of the other subjects. They were also instructed not to ask any questions. If the subjects needed information, they were instructed to use the help system on the computer.

After the subjects turned in their papers, the researcher saved all the files from the computers. These files were later analyzed for task completion even if the subject produced no output. The activity of grading those files ensured that there would not be a bias in the data based on output production versus no output production.
The scoring system listed in the appendix materials was not present for evaluation by the subjects. The reason for this was to prevent bias in task selection by the subjects. The subject may have had a different analysis of the less complex and more complex tasks as compared with those of the expert panel. The bias may have influenced the results.

**Key Assumptions**

One of the assumptions in this research concerning beginners is that they do not have the critical mass of computer related information on which to make decisions. Another assumption is that all beginners are alike. This assumption is not so. There is a vast difference between a beginner with keyword experience and one without. An experimental training process and the random assignment of subjects were used to alleviate the problem of keyboarding knowledge and skill. To eliminate the impact of keyboarding knowledge, the researcher also designed the tasks so that keyboarding skills would not be a significant factor in the task accomplishment. The other method used to eliminate the impact of different levels of knowledge
was a teaching session just before the task sets were assigned to the subjects. This teaching session was given by the researcher alone and the content was common to all subjects.

Another assumption is that task complexity increases when the number of tasks increase or when the number of interrelationships between/among the tasks increase. By definition, task complexity is the level of elements and the inter-relationships among the elements. If the level of elements increases, then the level of task complexity increases. As a practical matter, adding very simple tasks to the task list will theoretically increase the task complexity component; but, since this increase is so small, the impact is negligible.
CHAPTER V

DATA COLLECTION

The study consisted of pre-experimental and experimental stages. Each stage has a number of steps. The data collection and data analysis processes have many steps in common but there are some steps that are unique to each.

The data collection process had several activities. The first main activity was the data acquisition of data to facilitate the construction of the semantic help system. The second main activity was to provide feedback to facilitate the validation process for the task sets. The third main activity was to provide data for the evaluation of the research objective.

This chapter covers the data collection process. The following activities were associated with this process:
A. Pre-experimental stage.
   1. Pre-expert panel process.
      a. Develop the initial task sets.
      b. Conduct the protocol analysis.
         a1. Obtain information on words and phrases associated with tasks.
         b1. Obtain information on information needed for task accomplishment.
      c. Develop semantic help system.
   2. Expert panel feedback.
      a. Validate the task sets.
      b. Validate the semantic help system.
      c. Validate the scoring system.
   4. Additional expert panel feedback.
      a. Validate the task sets.
      b. Validate the semantic help system.
      c. Validate the scoring system.
   5. Pilot II test.
B. Experimental stage.
   1. Test the task sets and the help systems.

Pre-Experimental Preparation

The pre-experimental stage had several activities. One was to construct a task set that was short enough so beginners could complete all the tasks within the allotted time of forty five minutes. Another was to build a semantic online help system that most beginners understood from the words and phrases which were collected during the protocol analysis process.
Many different sets of data were collected during the pre-experimental phase. The following is a list in sequential order:

1. Protocol task sets, verbal and mathematical.
2. Protocol data.
3. Expert panel data on task sets, help system and scoring.
4. Pilot I results.
5. Expert panel data on Pilot I results of task sets, help system and scoring.
6. Pilot II results.
7. Experimental data.

Pre-Protocol Investigation

The task sets were divided into low and high complexity. The researcher assigned the task sets to their respective groups based on experience and knowledge. The results of this process are listed in Appendix C. The low complexity tasks were activities, such as, editing and inputting text as shown in Appendix C for the word processor tasks. Less complex menu-based tasks did not require the use of the menu command structure more than two levels deep in the spreadsheet. More complex tasks were those which were defined as the special functions in the spreadsheet and the word processor which required the use of the command menu more than two levels deep in the word
processor. The more complex tasks, for example, were similar in difficulty to generating a mail merge list. Examples of the more complex tasks assigned are listed in Appendix C in the high complexity tasks assigned.

Protocol Task Sets

The mathematical and verbal task sets used in the protocol process were developed by acquiring an original assignment sheet for BCIS 2610 students. These two task sets are listed in Appendix C.

Protocol Data

The process of collecting the protocol data involved several steps. These steps were:

1. Post a signup sheet on the wall to enlist volunteers.
2. Schedule times for the volunteers.
3. Attend and record the sessions with a voice recording device.
4. Transcribe the verbal data into a computer file.
5. Print the file for later analysis.

Subject interviews were conducted on a one-to-one basis. The subject would sit in front of a computer. The subject was given the task set. The researcher would start the voice recorder. As the subject attempted to complete
the tasks on the list, the researcher observed the subject. Periodically, the researcher asked the subject questions. Several examples of the questions asked are: (1) "What are you trying to do?", (2) "What are you thinking?", (3) "What information do you want?", (4) "What task are you trying to accomplish?", and (5) "What do you think the assignment wants you to do?". Another form of communication that occurred was the response of the researcher to questions. Most of the subjects were at ease with the tape recorder. Those who were hesitant in the beginning soon settled down and concentrated on the tasks at hand. (Protocol data available on request).

The protocol data collection process was undertaken by ten subjects in a beginning computer class (BCIS 2610 at University of North Texas). Ten subjects were used because that was the number of students who volunteered on the signup sheet. Before the subjects took part in the protocol analysis phase, each was required to sign an informed consent document (Appendix B).
Expert Panel Feedback On Proposed Pilot I Data and Semantic Help System

The data obtained from the protocol sessions and the data concerning the task sets were broken down into concepts. These concepts were listed in a form that was presented to the expert panel in their respective fields. These forms are listed in Appendix D. The semantic help system was designed and constructed after the protocol analysis phase and before the first meeting with the expert panel. The semantic help screens are shown in Appendix E.

When a panelist and the researcher had a meeting they discussed the following issues: (1) would the two help systems have the same perceived level of complexity for a beginner?, (2) was there anything the panelist would change about the semantic help system?, (3) were the search terms appropriate for the tasks?, (4) were the information/help files appropriate for the given tasks?, (5) were the scoring values appropriate for the given tasks assigned by the other panelist(s)?, (6) how would the panelist rate each of the concepts listed in the form (Appendix D)?, (7) was the classification scheme being appropriately applied?, and (8) would the panelist change any of the task
assignments with regard to high or low complexity that had been assigned by the researcher? Answers to these questions were as follows: (1) yes, (2) no, (3) yes, (4) yes, (5) yes, (6) their values are listed in Appendix D, (7) yes, and (8) no. All of the experts agreed with the assignments made and the semantic system developed by the researcher.

The expert panel was given a set of tasks on paper, and each member rated these from 0 to 100 on a task complexity scale. A 0 represented an absence of complexity and 100 represented the greatest complexity possible (Appendix D). Some of the panel members wanted clarification of the term complexity. The feedback given to all the members by the researcher was an example: 0 means the subject needs no help in accomplishing the task and the subject perceives the task as very simple, and 100 means there is no way the subject could solve the task accomplishment problem without some additional human help and perceives the task as very complex.

There was some misunderstanding initially about the term task complexity. All the expert panelists thought the researcher meant task difficulty. Once the term task
complexity was explained to the panelists, they seemed to acknowledge the difference. The expert panelists kept the definition of task complexity in mind when they filled out the forms (Appendix D).

Pilot I Test Data

The scores for the first pilot test were obtained by administering the pre-data collection teaching session. Then the task sets were administered to the subjects on a one-to-one basis. The subjects were placed in front of computers. They were presented the standardized training information by the researcher. They were asked to complete the task set in front of them. No questions were answered by the researcher during the pilot I data collection procedure. Eight subjects were chosen for this pilot study because that was the minimum number needed to fill all of the different combinations of treatments.

Expert Panel Feedback On Proposed Pilot II Data and Task Sets

Because of the result from the first pilot (the result is discussed in the Data Analysis chapter), the expert panel had to be re-contacted for additional feedback. This
feedback was required because the task sets had to be changed. This change process is discussed in the Data Analysis chapter.

The new task sets had to be validated by the expert panel. The resulting feedback was acquired in the same manner as the first process used for the pre-pilot I process.

Pilot II Test Data

The pilot II test data collection process used the same procedures that were used in the pilot I testing process. The first eight student volunteers were chosen for this stage. Each student was administered the task set by the researcher. The researcher saved and graded the file(s) that were used if the printout was not generated by the student. All eight of the students took the pilot II test at different times during a one-to-one session. All eight students were given the same instructional teaching information before starting the process. No questions were answered during the pilot II data collection process.
Experimental Test Data

The process used to collect the experimental test data was the same as used in the previous pilot tests (I and II). The questionnaire in Appendix J was given to all the subjects. The only difference was that each session had many subjects, not just one. Some subjects tried to ask questions at the beginning of the data collection process. When they were referred to the help systems, they seemed resigned to the process. They probably would have preferred getting answers from the researcher. That would have been the "easiest" thing for them to do when they had a problem. The subjects were reluctant to use the search mechanism which they perceived, in the beginning of the session, to be more demanding than asking the researcher.
The study consisted of pre-experimental and experimental stages. Each stage has a number of steps. The data collection process and data analysis process have many steps common to each but there are some steps that are unique to each.

The activities of the data analysis process were to analyze the data obtained and in the pre-experimental phase, to make changes where appropriate in the semantic help system, the scoring assignments, and/or to the task sets. After the experimental data was collected, an analysis was conducted to determine if the research objective had been attained.

This chapter covers the pre-experimental and experimental data analysis process. The following activities were associated with these processes:
A. Pre-experimental data collection.
1. Analyze and develop the initial task sets.
2. Analyze protocol data.
3. Analyze expert panel feedback from protocol.
4. Analyze data from pilot I.
5. Analyze expert panel feedback from pilot I.
6. Analyze the pilot II data.
B. Experimental data collection
7. Analyze experimental data.

Pre-experimental Data Analysis

The following list of activities occurred during the pre-experimental data collection process. They are depicted in chronological order.

Analyze And Develop Protocol Task Sets

The process of acquiring the original task sets was uneventful. The researcher chose the beginning word processing and spreadsheet assignments given to the beginning students of a BCIS 2610 class. The initial goal of the task set design was to keep the expected time of completion of each of the task sets to under forty five minutes. Because of the length of time it took to collect the protocol data from students, the number of tasks was shortened in each of the task sets by the researcher. The modification of the task sets was conducted. The result of
that process is the change in task sets from Appendix C to Appendix G.

Analysis of the Protocol Data

The process of analyzing the protocol data involved searching through the interviews to determine if any common concepts occurred in the discussions. If a concept kept occurring in the questioning process, it was included in the list of concepts implemented in the semantic help system. Another method was a matching process between the assigned tasks and the questions asked by the subjects. Both of these techniques were used to develop the list of words and phrases that were implemented in the semantic help system. Appendix E contains the results of that effort.

An example of how the protocol information was used follows. The first three lines of the protocol data show the discussion on the save process. From the feedback obtained during the protocol analysis phase, the save process was included in the semantic phrasing and a text on saving was included in the textual body.
Expert Panel Feedback On  
Proposed Pilot I Data and Semantic System

The data collected from the first round of the expert panel are shown in Appendix D. The answers to the validation questions are listed in the Data Collection chapter. The conclusion was that everything the researcher had done seemed to be correct and that no changes to the semantic help system, to the task sets or to the preliminary scoring system were needed. The answers validated the task sets and the semantic help system perceived complexity level and appropriateness.

An unanticipated bias seemed to affect the answers of some of the expert panel members as observed by the researcher. The bias was a feeling and not statistically measurable (judgmental) perception. The bias was a feeling the researcher had when asking questions about help systems in general. Since it was the business of all the expert panel members to train beginners and others on how to use these programs, they may have felt threatened by the possibility that a help system would replace/change their jobs. The expert panel members felt that everyone must go through some formal training before using their prospective
packages. In other words, true beginners should not be using the packages; training should come first. The bias seemed to increase the overall complexity scores during the first round of the expert panel input.

When the expert panel was shown the completed semantic help system and asked for advice about the validity of the help system and its completeness, the panel of experts suggested that the help information be kept short and concise. (The semantic help system already exhibited those characteristics.) The reasoning behind these suggestions was in their experience beginners have a more difficult time dealing with situations when there is a higher volume of information in the beginning. The semantic help system was constructed with the same level of visual and apparent complexity (breadth, depth and number of combinations) as the keyword based help system. The implementation of this design goal was to prevent perceived differences of help systems characteristics from affecting the performance of the subjects. If the semantic help system was too "small", then the complexity levels of the help systems themselves might have affected the outcome of the study.
Analysis of Pilot I Data

All of the subjects completed all of the tasks in the allotted time. Every subject made the maximum of 20 points. This was the original goal of the experiment. Because of this goal, there was no differentiation of scores among the groups. As a result of this situation, the researcher added tasks to the task sets in order to make them longer. This was done after the researcher consulted with the research committee. The research committee deemed this action appropriate since no discrimination in scoring was evident. Since there was no differentiation in the scores, there was no way to determine performance differences of the two help systems.

Because task performance can be considered as output over some time interval, the task list for each group was increased. The goal of the lengthened task list was that most subjects would not finish all tasks. The desired result would be that the average number of tasks performed would be higher with the semantic help system after instigating the new time constraints. If lengthening the task list had not been done, then differentiation of the treatments would not have been possible.
The researcher took tasks that were assigned low numbers by the experts in the first round or he modified slightly these tasks that were already in one particular category and re-entered that modified task or new task into the task set.

The task sets from the pilot I test to the pilot II test were modified by the researcher. This difference is shown from Appendix G to Appendix I. For example, three tasks were added to the high complexity word processing task list and six tasks were added to the low complexity word processing list by the researcher.

An example of the one of the tasks that was added to the high complexity spreadsheet set was the assignment of sorting the data in the spreadsheet. The pilot I task sets are shown in Appendix G and the new task sets used in pilot II are shown in Appendix I.

Analysis Of Feedback
On Proposed Pilot II Task Sets

These new task sets were shown to the expert panel. They agreed with the classifications of the new task sets, and they had no recommended changes to make in either the task sets or in the semantic help system.
The scoring system was not fully developed until after the results of the first pilot data was collected. The scoring system was finalized by the researcher before the expert panel was contacted the second time. During the second meeting the experts validated (with agreement) the scoring system that was originally designed by the researcher.

Analysis Of The Pilot II Data

It was evident from the results from pilot II that the scores the subjects received were clearly different between the semantic and the keyword help systems. The decision to conduct the experiment was positive. The results are listed on the following page.

Conclusions From The Pilot Studies

The subjects had very low motivation levels with regard to using computer generated help. The low motivation levels were still true even with a help system that was highly relevant to what the subject was trying to accomplish. The low motivation levels may be attributable to human nature and, thus, future research into the motivational issue may be useful.
Table 2

Pilot II Data

<table>
<thead>
<tr>
<th>System</th>
<th>Complexity</th>
<th>Task</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Semantic</td>
<td>Low</td>
<td>Verbal</td>
<td>18</td>
</tr>
<tr>
<td>Semantic</td>
<td>Low</td>
<td>Math</td>
<td>17</td>
</tr>
<tr>
<td>Semantic</td>
<td>High</td>
<td>Verbal</td>
<td>11</td>
</tr>
<tr>
<td>Semantic</td>
<td>High</td>
<td>Math</td>
<td>12</td>
</tr>
<tr>
<td>Keyword</td>
<td>Low</td>
<td>Verbal</td>
<td>9</td>
</tr>
<tr>
<td>Keyword</td>
<td>Low</td>
<td>Math</td>
<td>7</td>
</tr>
<tr>
<td>Keyword</td>
<td>High</td>
<td>Verbal</td>
<td>3</td>
</tr>
<tr>
<td>Keyword</td>
<td>High</td>
<td>Math</td>
<td>0</td>
</tr>
</tbody>
</table>

Experimental Data Analysis

Linear regression models were used to analyze the differences between the performance levels of each variable. An analysis was done to determine if there were a significant impact from any of the user characteristics. A breakdown was conducted to determine if task type significantly affected performance. A comparison between the two different application programs was conducted to see if the help systems might be application dependent. Demographic data from the demographic data sheet are provided in this chapter. Sections describing the
dependent measure development, interaction effects, and results from the hypotheses are also included. T-tests were done to determine if there were differences between the levels of performance of the paired cells associated with the secondary hypotheses set.

General Demographics

All of the subjects were enrolled in BCIS 2610, which is a required beginning computer course for business majors. The age of the subjects ranged from eighteen to sixty three years, with a mean of 22.5 years. Fifty nine percent of the subjects were male. Ninety four out of three hundred and twenty subjects were eliminated because they had too high a level of computer experience for the assigned task or for the assigned program. Only subjects who ranked their level of computer experience a 3 or less on the Likert-type scale were included in the study (Appendix J). Students who ranked themselves as 4 or higher on a particular application program were excluded from the data analysis. Three hundred twenty students participated in the experiment. The total of 213 acceptable subjects were determined after the advanced
students were removed. One hundred seven students were not eligible for their assigned task set.

Subjects who ranked themselves as high experience with spreadsheet, yet low for word processing and word processor, were still included in the word processor group if they were originally assigned there. The assumption was that knowledge is so different between the concepts of word processors and spreadsheets that the knowledge does not transfer across into the other domain. This still maintains random assignment principles.

The students' mean for knowledge of spreadsheets was 1.4 with a range from 1 to 5. Students' mean for knowledge of word processors in general was 2.2 with a range from 1 to 5. The mean for students' knowledge of the spreadsheet being used in the experiment was 1.3 with a range from 1 to 4. Students' mean for the last indicator, knowledge of the word processor being tested, was 2.0 with a range of 1 to 5. The subjects were somewhat more knowledgeable about word processing than about spreadsheets.

The number of subjects for the demographic data in Table 3 was 213. The mean scores shown in the same table were all based on a Likert scale which had 5 categories as
shown in Appendix J. The scores in Table 3 were a result of the self rating process of the students. Some of the students may have exaggerated their scores while others may have been conservative. The affect should have been evenly distributed because of random assignment.

Table 3

Demographic Data

<table>
<thead>
<tr>
<th>Mean Age For All in Years</th>
<th>22.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male Percent</td>
<td>59%</td>
</tr>
<tr>
<td>Female Percent</td>
<td>41%</td>
</tr>
<tr>
<td>Mean for Spreadsheet Knowledge</td>
<td>1.4</td>
</tr>
<tr>
<td>Mean for Word Processing Knowledge</td>
<td>2.2</td>
</tr>
<tr>
<td>Mean for Tested Spreadsheet</td>
<td>1.3</td>
</tr>
<tr>
<td>Mean for Tested Word Processor</td>
<td>2.0</td>
</tr>
<tr>
<td>Sample Size</td>
<td>213</td>
</tr>
</tbody>
</table>

All cell sizes ranged from 23 to 32 and were adequate for the statistical methods used. The cell sizes are listed in Table 4 on the following page.
Linear Regression Model

The dependent measure developed in this research was SCORE. The experimental model is also listed on the following page.

Table 4
Experimental Cell Sizes

<table>
<thead>
<tr>
<th>Task</th>
<th>Complexity</th>
<th>System</th>
<th>Size</th>
<th>Cell#</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math</td>
<td>High</td>
<td>Keyword</td>
<td>25</td>
<td>5</td>
</tr>
<tr>
<td>Math</td>
<td>High</td>
<td>Semantic</td>
<td>30</td>
<td>7</td>
</tr>
<tr>
<td>Math</td>
<td>Low</td>
<td>Keyword</td>
<td>32</td>
<td>6</td>
</tr>
<tr>
<td>Math</td>
<td>Low</td>
<td>Semantic</td>
<td>24</td>
<td>8</td>
</tr>
<tr>
<td>Verbal</td>
<td>High</td>
<td>Keyword</td>
<td>23</td>
<td>2</td>
</tr>
<tr>
<td>Verbal</td>
<td>High</td>
<td>Semantic</td>
<td>27</td>
<td>1</td>
</tr>
<tr>
<td>Verbal</td>
<td>Low</td>
<td>Keyword</td>
<td>25</td>
<td>4</td>
</tr>
<tr>
<td>Verbal</td>
<td>Low</td>
<td>Semantic</td>
<td>27</td>
<td>3</td>
</tr>
</tbody>
</table>

Experimental Model

\[ Y = B_1X_1 + B_2X_2 + B_3X_3 + B_4X_4 + B_5X_5 + B_6X_6 + B_7X_7 + B_8X_8 + B_9X_9 \]

where: \( Y = \text{SCORE} = \text{performance} \)

and

\( X_1 = KVS = \text{keyword versus semantic driven} \)

\( X_2 = \text{LVH} = \text{low verses high task complexity} \)

\( X_3 = \text{VVM} = \text{verbal versus mathematical task types} \)

\( X_4 = K_1 = \text{general knowledge about spreadsheets} \)

\( X_5 = K_2 = \text{general knowledge about word processors} \)
The previous model had several categories of variables. The first category was the dependent variable Y. The data for this variable ranged from zero to the maximum of twenty. The next category of variables was the treatment affects. These are shown as X1, X2 and X3. X1 represents whether or not the subject used the semantic system. If the subject did use the semantic help system, the value was one; if the subject used the keyword help system, the subject received a value of zero. X2 represents whether or not the subject was in the low task complexity class. If the class assigned to the subject was low, the subject received a one, otherwise it was a zero. X3 represents whether or not the subject was in the verbal class. If the subject was assigned a verbal task type, the subject received a one, otherwise it was a zero. The next category of variables were concerned with the prior knowledge of the subject. This classification scheme was based on a Likert scale from 1 to 5 as shown in Appendix J.
It was a self reporting score. The last two variables relate to demographic type information of age and gender of the subject.

Table 5
Results From The Linear Analysis

<table>
<thead>
<tr>
<th>Variable</th>
<th>PR&gt;F</th>
</tr>
</thead>
<tbody>
<tr>
<td>KVS</td>
<td>.001</td>
</tr>
<tr>
<td>LVH</td>
<td>.9346</td>
</tr>
<tr>
<td>VVM</td>
<td>.0142</td>
</tr>
<tr>
<td>K1</td>
<td>.4383</td>
</tr>
<tr>
<td>K2</td>
<td>.7953</td>
</tr>
<tr>
<td>K3</td>
<td>.9935</td>
</tr>
<tr>
<td>K4</td>
<td>.4453</td>
</tr>
<tr>
<td>AGE</td>
<td>.1836</td>
</tr>
<tr>
<td>GENDER</td>
<td>.5188</td>
</tr>
</tbody>
</table>

As indicated in Table 5, the keyword driven versus semantic help system and verbal versus mathematical task types were the only two variables that show a significant impact on the dependent variable.
Individual Cell Data

The individual cell data was obtained by analyzing the experimental data. Each of the statistical results was derived after the non-beginners were removed from the data pool by the procedure described earlier. All of the averages presented in Table 6 were relatively low. However, there were differences in performance levels.

Table 6

Cell Statistics

<table>
<thead>
<tr>
<th>Cell</th>
<th>Obs</th>
<th>N</th>
<th>Mean</th>
<th>Std Dev</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>27</td>
<td>27</td>
<td>9.7</td>
<td>6.3</td>
<td>1</td>
<td>20</td>
</tr>
<tr>
<td>2</td>
<td>25</td>
<td>25</td>
<td>7.6</td>
<td>3.9</td>
<td>2</td>
<td>15</td>
</tr>
<tr>
<td>3</td>
<td>27</td>
<td>27</td>
<td>10.0</td>
<td>5.4</td>
<td>1</td>
<td>17</td>
</tr>
<tr>
<td>4</td>
<td>32</td>
<td>32</td>
<td>6.2</td>
<td>3.3</td>
<td>0</td>
<td>12</td>
</tr>
<tr>
<td>5</td>
<td>25</td>
<td>25</td>
<td>6.0</td>
<td>3.5</td>
<td>1</td>
<td>11</td>
</tr>
<tr>
<td>6</td>
<td>24</td>
<td>24</td>
<td>8.0</td>
<td>4.8</td>
<td>0</td>
<td>16</td>
</tr>
<tr>
<td>7</td>
<td>30</td>
<td>30</td>
<td>8.3</td>
<td>5.7</td>
<td>0</td>
<td>16</td>
</tr>
<tr>
<td>8</td>
<td>23</td>
<td>23</td>
<td>7.6</td>
<td>4.6</td>
<td>0</td>
<td>15</td>
</tr>
</tbody>
</table>

Interaction Effects

All other regression equations using two-way and three-way interactions were tried using all combinations
of variables to detect for interaction effects. None of the new combinations of variables was significant.

If there had been significance in the interactions, this would be a reason for concern. Several reasons could cause the unwanted interaction affect. The first reason is that the variables are not measuring accurately the variables under investigation. The variables could be measuring another phenomenon that is not understood. This would require further research to identify the measurement inaccuracy or mismatch. The second reason is the presence of a significant variable that is not being investigated that is affecting several of the variables.

Results by Hypotheses

On the following page is a list of the proposed hypotheses. There is a statistical test associated with each one. The results of the test statistic is shown along with the result.

The conclusions for each of the hypothesis are discussed in Chapter VII on conclusions. In general most of the subset hypotheses were not rejected.
Table 7

Results For Each Hypothesis

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Test Statistic</th>
<th>Result</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>HoA1</td>
<td>Regression</td>
<td>reject</td>
<td>.001</td>
</tr>
<tr>
<td>HoA2</td>
<td>Regression</td>
<td>fail to reject</td>
<td>.9346</td>
</tr>
<tr>
<td>HoA3</td>
<td>Regression</td>
<td>reject</td>
<td>.0146</td>
</tr>
<tr>
<td>HoB1</td>
<td>t-test, 1 way</td>
<td>fail to reject</td>
<td>.15</td>
</tr>
<tr>
<td>HoB2</td>
<td>t-test, 1 way</td>
<td>fail to reject</td>
<td>.87</td>
</tr>
<tr>
<td>HoC1</td>
<td>t-test, 1 way</td>
<td>fail to reject</td>
<td>.14</td>
</tr>
<tr>
<td>HoC2</td>
<td>t-test, 1 way</td>
<td>reject</td>
<td>.002</td>
</tr>
<tr>
<td>HoD1</td>
<td>t-test, 1 way</td>
<td>fail to reject</td>
<td>.13</td>
</tr>
<tr>
<td>HoD2</td>
<td>t-test, 1 way</td>
<td>fail to reject</td>
<td>.12</td>
</tr>
<tr>
<td>HoE1</td>
<td>t-test, 1 way</td>
<td>fail to reject</td>
<td>.65</td>
</tr>
<tr>
<td>HoB2</td>
<td>t-test, 1 way</td>
<td>fail to reject</td>
<td>.80</td>
</tr>
</tbody>
</table>
CHAPTER VII

CONCLUSIONS

Conclusions on the outcomes of the research are presented. Limitations of the research and directions for future research are also discussed.

HoA1: There will be no difference in task performance between subjects using the keyword and semantic help systems.

HoA2: There will be no difference in task performance between subjects performing high complexity tasks and low complexity tasks.

HoA3: There will be no difference in task performance between subjects performing verbal and mathematical tasks.

HoB1: There will be no difference in task performance between subjects using the semantic online help system and subjects using the keyword driven help system when the subjects are given a low complexity level verbal task.

HoB2: There will be no difference in task performance between subjects using the semantic online help system and subjects using the keyword driven help system when the subjects are given a high complexity level verbal task.
**Conclusions For Each Hypothesis**

The preceding is a list of the hypotheses studied in this research. The result for each is discussed along with the implication from either the rejection or non-rejection of the hypothesis.
There will be no difference in task performance between subjects using the keyword and semantic help systems. This hypothesis was rejected. It became evident from the start of the data collection process as early in this study as the first pilot phase that the semantic help system was much easier and more efficient to use than the keyword help system. The students were not ready and/or ill equipped to handle the foreign words and phrases that were built into the keyword help system. The students just seemed to stare or look at the researcher at times, hoping the researcher would take pity on them in their predicament. Remember, the students in the experimental data collection phase thought this would negatively affect their grade. Even with this consequence, the motivation level to use the help system of either type seemed low.

The teachers of the students in the study later informed the students that experimental participation would not negatively affect their grade. But the negative affects listed above, such as low motivation and frustration seemed less important if the student just tried the semantic system. If the student just tried the semantic system at the beginning when continuation was impossible
the student was able to use the system successfully. As a result, the student was more likely to use the system again. Increased use usually resulted in a higher score.

There will be no difference in task performance between subjects performing high complexity tasks and low complexity tasks. This hypothesis was not rejected. It appears that almost all tasks are perceptually complex to a beginner. It could be that the instrument in the low complexity category was not discriminatory. It could also be that the subject needs a minimal amount of understanding concerning the concepts and words being used for a given task. The significance for this finding is either people need to learn a minimum number of concepts, words and phrases for a given task before feedback becomes meaningful or the system in use must change to present people with familiar terms, phrases and concepts so people can then extend their own understanding and accomplish the task.

There will be no difference in task performance between subjects performing verbal and mathematical tasks. This hypothesis was rejected at a less significant level than the search mechanism hypothesis. Although the
relationship is less pronounced, it is still representative of the fact that most people in our society talk before they attempt number concepts. People usually must be able to communicate in our society in order to function. This fact probably influences the overall average scores people assign themselves relative to their prior knowledge about spreadsheets. One of the first functions automated in the work environment is typing. The skills used in typing are directly transferable to the process of using a word processor. The demographics of the student population attending University of North Texas have traditionally been younger full-time students, but this is changing. Many older people are either entering or re-entering the academic setting. This phenomenon could significantly impact the research results of another study, especially if the disparity in the prior knowledge numbers becomes greater.

There will be no difference in task performance between subjects using the semantic online help system and subjects using the keyword driven help system when the subjects are given a low complexity level verbal task. This hypothesis was not rejected. This finding is
surprising. The failure to discriminate could be the results of two factors. One, the measurement instrument was not sensitive enough. Two, the complexity level was not low enough. This caused confusion in the subjects, and they could not overcome this confusion in the time frame given.

There will be no difference in task performance between subjects using the semantic online help system and subjects using the keyword driven help system when the subjects are given a high complexity level verbal task. This hypothesis was not rejected. After the researcher observed the students unsuccessfully attempt to accomplish the tasks assigned to them, it is possible that if the task complexity level is too high, no currently available help system technology would have helped them solve the problem of task accomplishment. Until the subject develops a critical mass of relevant information that can be used as a base from which the subject can extend and make inferences about different problem domains, all tasks will be perceived as too complex and unaccomplishable.

There will be no difference in task performance between subjects using the semantic online help system and
subjects using the keyword driven help system when the subjects are given a low complexity level mathematical task. This hypothesis was not rejected. One possible condition could have existed. The subjects were not at all familiar with concepts surrounding mathematical issues. Therefore, they were unable to understand the task to be accomplished. Since most students had a lower level of understanding about mathematical than verbal concepts, the students would have less understanding in how the help system could help them accomplish the given task.

There will be no difference in task performance between subjects using the semantic online help system and subjects using the keyword driven help system when the subjects are given a high complexity level mathematical task. This hypothesis was rejected. Scores for the semantic systems were significantly different from the keyword systems. The significance of the t-test for this hypothesis is consistent with the regression equation showing that the independent variables of keyword and semantic online help systems significantly contribute to explaining the variation in SCORE. Ordinarily numerous
t-tests can result in a spurious rejection, however, since
the regression equation for HoAl was so significant, one
would expect at least one of the t-tests to be
significant.

There will be no difference in task performance
between subjects using the semantic online help system
given a verbal task type and varying the task complexity.
This hypothesis was not rejected. It seems that task
complexity is not a significant variable. It could be
because to beginners all tasks are complex. Even though
the subjects were using the more efficient and easier help
system, the scores between the two complexity levels were
the same.

There will be no difference in task performance
between subjects using the keyword driven online help
system given a verbal task type and varying the task
complexity. This hypothesis was also not rejected. Even
though task complexity to beginners may appear to be
complex for all tasks, for this hypothesis the subjects
were using the keyword help system. From observation it
was evident that the keyword system was more difficult for
the students to use. This could have been the over-riding factor in the failure to reject this hypothesis.

There will be no difference in task performance between subjects using the semantic online help system given a mathematical task type and varying the task complexity. This hypothesis was not rejected. Even the ease of use and the efficiency of the semantic system were not significant to overcome the potential lack of understanding on the part of the subjects related to mathematical tasks and concepts.

There will be no difference in task performance between subjects using the keyword driven online help system given a mathematical task type and varying the task complexity. This hypothesis was not rejected. The combination of mathematical type task and the use of the keyword help system was enough to cause much frustration and low task accomplishment for both groups.

From the additional statistics shown in Table 7 in Chapter 6 other conclusions can be made. For example, the comparison between cells 5 and 7 was significant even though the numbers are relatively low. Beginners were expected to have low scores.
Research Conclusions and Recommendations

As the data were being collected, it was evident that the subjects had a much easier time using the semantic help system. The keyword based help system was more difficult to use. One of the phenomenon that occurred during the data collection phase was that subjects tried to ask questions. Although end user interaction with the researcher was not one of the variables under investigation, (it would have invalidated the experiment if answers were given), it was evident that those who were assigned the semantic system made fewer attempts to ask questions.

A major recommendation for this research topic is the investigation and development of a task difficulty variable. The task difficulty variable could include components of the knowledge the subject has concerning the task domain and other task characteristics that may affect the task difficulty level. This research used task complexity in place of task difficulty because of the literature base.

Based on the experience of the data gathering process, a following hypothetical model is presented in
Figure 7. The model shows the relationship of task complexity to computer knowledge. As the subject acquires more knowledge, the task complexity quotient of any given concept or a set of concepts decreases.

Figure 7. Task Complexity Gradient

This research demonstrates that it is possible to influence productivity with a well designed help system.

In a domain where information is limited, it is possible
to construct a help system that will increase task performance. In the business world, if the cost of construction is lower than the added benefits, the company should at least investigate the proposition.

**Limitations of the Research**

The conclusions of this study cannot be projected to any populations other than beginners. All of the subjects of this study were beginners. The tendency of the population was to be oriented more toward word processors; however, this tendency did not influence the outcomes. The apparent complexities of the two help systems were similar to a beginner; however, if the semantic help system had to compete in the business world, it would need a much bigger knowledge base and many more entry phrases.

A design limitation was the use of a five-point scale to measure prior knowledge. First, prior knowledge was a perceived value and was not measured by a subject's actual knowledge. Second, only a five-point scale was used. If the test had been to measure actual knowledge, the task complexity results may have been different.
This experiment did not study the actual behaviors of the subjects as they attempted to complete the tasks. It measured only the outcomes of their behavior.

**Directions for Future Research**

Future research could be improved by making several changes to this study. The first would be to change the task characteristic to task difficulty. Levels of complexity may not be directly related to the difficulty level a subject has in task accomplishment. The second is changing the time constraints of the activity being researched. Add the time variable as a dependent variable. The third is to add a questionnaire to test the actual level of knowledge of the subject with regard to the task domain and the program(s) being used.

Future research could include a different method of classifying tasks. The tasks could be designed to address different types of brain activity or different tasks associated with the business environment.

Future research should include non-beginners. The design required for more advanced computer users may be different than for beginners. Future research should, at
a minimum, include prior testing of knowledge levels about the task(s) and the programs used in the experiment.

There are several avenues a researcher may take in conducting future research in help systems. Replication of this research would be helpful. With the advances in artificial intelligence, it could be included in the construction of future help systems. Hyper-text is another capability that could be investigated. Investigation into a task difficulty variable may provide significant insight in the help systems topic.

Summary

This research developed a framework and an experimental model which may be used by other researchers. This research is apparently the only one to date that has included task type and task complexity. The results of this research partially support its purpose that search mechanism, with respect to task type and complexity, affects the performance level of the user.

Future research should focus on whether task type, task difficulty and how problem solving characteristics may influence the design of online help systems.
Researchers should carefully match the online help system design with task characteristics and user characteristics. They should also include measures of both quantity and quality with regard to productivity.
APPENDIX A

LIST OF DEFINITIONS
Appendix A

Definitions and Explanations:

Task Complexity - A level which relates to the number of elements and the number of inter-relationships among the elements for a given task.

On-line access mechanism - A screen oriented interface that allows the subject to retrieve information directly from the computer.

Performance - See task performance.

Protocol analysis - Discovery of information by asking the subject questions before, during and after a given behavior along with direct observation of the subject.

Search techniques - Method by which a user explores for information.

Semantic access - Combining words and phrases to build a complete sentence which will provide the computer to provide the user with information.

Task - An assignment which must be completed by the subject.

Task set - A list of tasks.

Task performance - A measurement of the quality level of how well a task has been completed.

Protocol analysis - The process by which the researcher watches the subject as the subject attempts to accomplish a given task on the computer. When the subject is working, the researcher may then ask the subject several questions, like "what are you trying to do?" or "what information do you need to help you?" Protocol analysis also involves the process of direct observation of the subject and the development of judgments about the behavior of the subject.
Semantic help system - This is a type of interface that lets the user construct a question to retrieve help type information. As an example, let us assume the subject wants information on how to format a 720K disk. The sentence the subject would construct would involve four different phrases:

1. How do I
2. format
3. a disk
4. size 720K

To construct a whole sentence, the screen would have four different windows showing. An example of the semantic type of interface (using three windows) is shown in Appendix F. The cursor would move to the phrase or word in the upper left hand corner and the subject would choose "How do I". Then the subject would go to the next window and choose another word - "format". Then the subject would go to the third windows and choose the phrase - "a disk". Finally, the subject would go to the fourth window and choose the size of the disk, in this case - 720K. After the sentence is constructed, the subject tells the computer to begin the search. The phrase construction creates a unique address. This address is used to determine which file will be shown on the screen. Hopefully the file chosen contains the information the subject needs to accomplish the task.

Keyword based online help system - This system is implemented by presenting the subject with a list of words. To get help, the subject chooses the correct word and the system enters another level of words. Going ever deeper into sub-levels of keywords occurs until the subject has specified enough words so the system generates helpful information. The difference between the semantic and the keyword-based system is that the subject must make a choice for each level in the keyword lists. For the semantic system, the subject constructs a sentence by choosing phrases.
Task type - Tasks can be classified in different ways. A mathematical task involves the manipulation and understanding of numbers. A verbal task involves the understanding and manipulation of words.
APPENDIX B

AN INFORMED CONSENT DOCUMENT

DURING THE PROTOCOL AND PRE-EXPERIMENTAL PHASES
Appendix B
An Informed Consent Document
During The Protocol and Pre-experimental Phases

Name of Subject ________________________________

Name of Investigator ________________________________

1. I hereby consent to a protocol analysis before, during and after the completion of a class assignment.

2. I have (seen, heard) a clear explanation and understand the nature and procedure or treatment; possible appropriate alternative procedures that would be advantageous to me (him, her); and the attendant discomforts or risks involved and the possibility of complications which might arise. I have (seen, heard) a clear explanation and understand the benefits to be expected. I understand that the procedure or treatment to be performed is investigational and that I may withdraw my consent at any time without prejudice or penalty. With my understanding of this, having received this information and satisfactory answers to the questions I have asked, I voluntarily consent to the procedure or treatment designated in paragraph 1 above. If the subject believes there are any negative feelings and/or outcomes, the subject may contact the dissertation committee chairman, Dr. Michael Vanecek or the department chairman, Dr. Jack Becker.

Date ____________________

Signed Subject: ________________________________

Signed Investigator: ________________________________
APPENDIX C

PRE-EXPERIMENTAL PROTOCOL

TASK LISTS
Appendix C

Pre-experimental Protocol Spreadsheet Tasks

Low Task Complexity

You are to take the spreadsheet found in a file called FILEONE and add one additional column of data. Place the following values in column C.

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Officers' Salaries</td>
<td>333,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Workers' Salaries</td>
<td>222,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Payroll Tax</td>
<td>8,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Depreciation</td>
<td>7,777</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Postage</td>
<td>999</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Dues</td>
<td>224</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Computers</td>
<td>10,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Maintenance</td>
<td>1,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>TOTAL</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix C

Pre-experimental Protocol Spreadsheet Tasks

High Task Complexity

The worksheet on the next page should be prepared according to these directions.

1. Set the following column widths:
   - Column A = 20.
   - Column B, C, & D = 12 each.
   - Column E = 16.

2. You are to use the prefixes ' ^ " to enter the words "Left", "Center" and "Right" to justify correctly Or use the /Range Label command to position the labels appropriately.

3. Use the backslash (\) to cause a character repeat/fill for each of these characters: * = -.

4. Use the @NOW function to acquire the current system time/date with Date formats 1, 2 & 3, and Time formats 1 & 2.

5. Enter the following numeric \values in columns B, C, D & E respectively:
   - 0.987654321
   - 9.87654321
   - 9876.54321
   - 987654321

Use these numbers for all numeric format rows and format as indicated. For example: Percent (P2) means format all values in that row as a percentage display with 2 decimal places.
Appendix C

Pre-experimental Protocol Spreadsheet Tasks

High Task Complexity

(Student name)
BCIS 2610. ???
Lotus Assignment

<table>
<thead>
<tr>
<th>Character repeat</th>
<th>Left</th>
<th>Center</th>
<th>Right</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repeat *</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Repeat =</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Repeat -</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Format</th>
<th>Date</th>
<th>Time</th>
<th>General (Default)</th>
<th>Fixed (F1)</th>
<th>Fixed (F4)</th>
<th>Scientific (S2)</th>
<th>Currency (C0)</th>
<th>Currency (C2)</th>
<th>Comma (,)</th>
<th>Comma (,3)</th>
<th>Percent [D0]</th>
<th>Percent [D2]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>07-Jan-91</td>
<td>03:20:57 PM</td>
<td>0.987654321</td>
<td>9.87654321</td>
<td>987654321</td>
<td>987654321.0</td>
<td>$1</td>
<td>$9.877</td>
<td>9.877</td>
<td>9877000000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix C

Pre-experimental Protocol Word Processing Tasks

Low Task Complexity

Below, you will find a rough draft of the history of the ABC computer found in Computer Fundamentals for an Information Age by Shelly and Cashman on p. 2.1 - 2.2. You are to make the necessary adjustments listed below. You will find the uncorrected version in a file called WP-1R.TXT on your disk.

Evaluation:

3pts Get the file.

2pts Place your name and date at the top of the page.

2pts Delete the second paragraph.

3pts Put your address at the bottom of the page.

2pts Put your phone number after paragraph one.

2pts Delete the last sentence in the second paragraph.

2pts Add two blank lines under your name.

1pts Tab every paragraph.

3pts Print the document.
How Did It All Begin?

In the late 1930's, Dr. John V. Atanasoff, a mathematics professor at Iowa State College in Ames, Iowa, required a calculating device to perform mathematical operations for 20 masters and doctoral candidates. After examining various mechanical calculating devices then available, Atanasoff concluded that none of the devices was adequate for his needs. Instead, he felt the solution to his problem was in the development of a digital computing device based upon electronics.

Returning to the laboratory, Atanasoff, together with his assistant Clifford Berry, finished the design and began building the first electronic digital computer. It is generally agreed that the design of the "ABC" provided the foundation for the next advances in the development to the electronic digital computer.

Atanasoff, therefore, set about designing his own machine. He faced numerous problems in designing the logic circuitry for the machine. As with many inventors, some ideas were easier to come by than others. In the winter of 1937-38, frustrated at not being able to complete the design, he drove across the Mississippi River into Illinois and settled in for a drink in a small roadside tavern. For some reason which he could not later identify, the ideas for computer memory and the associated logic which would not come to him in the laboratory came to him as he relaxed in the bar. Thus, some of the basic concepts for the electronic digital computer were formulated that night.

by Shelly and Cashman
Computer Fundamentals for an Information Age
p. 2.1 - 2.2
Appendix C

Pre-experimental Protocol Word Processing Tasks

High Task Complexity

Below, you will find a rough draft of the history of the ABC computer found in Computer Fundamentals for an Information Age by Shelly and Cashman on p. 2.1 - 2.2. You are to make the necessary corrections, including indentation of each paragraph and spacing, then store the corrected version in a WP-1.TXT file. You will find the uncorrected version in a file called WP-1R.TXT on your disk. Print once in PICA, 10cpi and once in ELITE, 12 cpi.

Evaluation:
2pts Place your name and date, top 2 lines flush right.

3pts Format the document to have 1.5" right and left margins; a top margin of 2"; right justify off; and page numbering at the center of the bottom.

2pts Spelling corrections.

2pts Insert the sentence, "They named the machine the Atanasoff-Berry-Computer, or simply the 'ABC'." after the first sentence in the last paragraph, using the typeface given.

2pts Boldface the sentence you just added and Dr. John V. Atanasoff in the first sentence.

2pts Center the title. Underline the title of the source book by Shelly and Cashman.

3pts Move the paragraph starting with "Atanasoff, therefore, ..." to be the second paragraph after the paragraph ending with "... based upon electronics."

2pts Hardcopy in PICA. 2pts Hardcopy in ELITE.
How Did It All Begin?

In the late 1930's, Dr. John V. Atanasoff, a mathematics professor at Iowa State College in Ames, Iowa, required a calculating device to perform mathematical operations for 20 masters and doctoral candidates. After examining various mechanical calculating devices then available, Atanasoff concluded that none of the devices was adequate for his needs. Instead, he felt the solution to his problem was in the development of a digital computing device based upon electronics.

Returning to the laboratory, Atanasoff, together with his assistant Clifford Berry, finished the design and began building the first electronic digital computer. It is generally agreed that the design of the "ABC" provided the foundation for the next advances in the development of the electronic digital computer.

Atanasoff, therefore, set about designing his own machine. He faced numerous problems in designing the logic circuitry for the machine. As with many inventors, some ideas were easier to come by than others. In the winter of 1937-38, frustrated at not being able to complete the design, he drove across the Mississippi River into Illinois and settled in for a drink in a small roadside tavern. For some reason which he could not later identify, the ideas for computer memory and the associated logic which would not come to him in the laboratory came to him as he relaxed in the bar. Thus, some of the basic concepts for the electronic digital computer were formulated that night.

by Shelly and Cashman
Computer Fundamentals for an Information Age
p. 2.1 - 2.2
APPENDIX D

EXPERT PANEL RANKINGS
Appendix D

Word Processor Expert Questionnaire

Please rate the following on a scale of 0 to 100 based on your experience of the task complexity level as perceived by a beginning computer user. Zero on this scale would indicate that a beginner would have no trouble completing the task without any help whatsoever. One hundred on this scale would indicate that a beginner would require extensive input from an expert to complete the task. A one hundred is the maximum task complexity a beginner might encounter.

Entering text. ______. 
Deleting text. ______. 
Blocking function. ______. 
Exiting a document. ______. 
Saving a document. ______. 
Printing a document. ______. 
Entering bold text. ______. 
Blocking and modifying to bold. ______. 
Spell checking. ______. 
Adding to the dictionary. ______. 
Formatting a document. ______. 
Top margins. ______. 
Bottom margins. ______. 
Left margins. ______. 
Right margins. ______. 
Moving text. ______. 
List files function key. ______. 
Cursor movement. ______. 
Reveal Codes function. ______. 
Flush right function. ______. 
Justification of text. ______. 
Page numbering. ______. 
Inserting text. ______. 
Aligning text. ______. 
Different typefaces. ______. 
Different fonts. ______. 
Pica and Elite. ______. 
Centering text. ______. 
Multiple page documents. ______. 
Underlining text. ______. 
Importing graphics. ______. 
Mail-merge function. ______. 
Producing and editing tables. ______. 

Are there any other routine functions you think an average document maker/editor would utilize in their day to day workings with the word processor? At what level of complexity would these activities be rated?

These documents in this appendix are a representation of what was given to the expert panel.
Word Processor Expert Questionnaire

Please rate the following on a scale of 0 to 100 based on your experience of the task complexity level as perceived by a beginning computer user. Zero on this scale would indicate that a beginner would have no trouble completing the task without any help whatsoever. One hundred on this scale would indicate that a beginner would require extensive input from an expert to complete the task. A one hundred is the maximum task complexity a beginner might encounter.

Entering text. _____
Deleting text. _____
Blocking function. _____
Exiting a document. _____
Saving a document. _____
Printing a document. _____
Entering bold text. _____
Blocking and modifying to bold. _____
Spell checking. _____
Adding to the dictionary. _____
Formatting a document. _____
Top margins. _____
Bottom margins. _____
Left margins. _____
Right margins. _____
Moving text. _____
List files function key. _____
Cursor movement. _____
Reveal Codes function. _____
Flush right function. _____
Justification of text. _____
Page numbering. _____
Inserting text. _____
Aligning text. _____
Different typefaces. _____
Different fonts. _____
Pica and Elite. _____
Centering text. _____
Multiple page documents. _____
Underlining text. _____
Importing graphics. _____
Mail-merge function. _____
Producing and editing tables. _____

Are there any other routine functions you think an average document maker/editor would utilize in their day to day workings with the word processor? At what level of complexity would these activities be rated?
Spreadsheet Expert Questionnaire

Please rate the following on a scale of 0 to 100 based on your experience of the task complexity level as perceived by a beginning computer user. Zero on this scale would indicate that a beginner would have no trouble completing the task without any help whatsoever. One hundred on this scale would indicate that a beginner would require extensive input from an expert to complete the task. A one hundred is the maximum task complexity a beginner might encounter.

Using the Lotus help system. 30
Entering commands. 60
Moving the cursor around the spreadsheet. 20
Entering a label, left justified 45
centered 55
right justified. 55
Editing a label. 60
Entering a number. 10
Using the range format command. 70
Setting column widths. 40
Entering the @now function. 30
Formatting the @now function for different dates. 65
Formatting the @now function for different times. 75
Cell fill/repeat character. (\ key). 40
Using the copy command. (ranges) 85
Using the move command. (ranges) 85
Saving a spreadsheet. 40
Retrieving a spreadsheet. 40
Understanding the differences among functions, equations and commands. 70
The printing process, window or range 45
top of page 35
cell formula formats 90
printer commands and codes 85
margins 50
printing In text format 65
exiting the printing process. 30
The escape key and how it is used. 45
The different modes (editing, error, ready, etc.) 55
The location of the cursor. 20
Creating graphs. 80
Creating macros. 85
Conducting data sorts. 90
Data extraction with input and output windows. 95

Are there any other routine functions you think an average spreadsheet user would utilize in their day to day workings of a spreadsheet? At what level of complexity would these activities be rated?
Spreadsheet Expert Questionnaire

Please rate the following on a scale of 0 to 100 based on your experience of the task complexity level as perceived by a beginning computer user. Zero on this scale would indicate that a beginner would have no trouble completing the task without any help whatsoever. One hundred on this scale would indicate that a beginner would require extensive input from an expert to complete the task. A one hundred is the maximum task complexity a beginner might encounter.

<table>
<thead>
<tr>
<th>Task</th>
<th>Complexity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Using the Lotus help system.</td>
<td>90</td>
</tr>
<tr>
<td>Entering commands.</td>
<td>90</td>
</tr>
<tr>
<td>Moving the cursor around the spreadsheet.</td>
<td>10</td>
</tr>
<tr>
<td>Entering a label, left justified</td>
<td>30</td>
</tr>
<tr>
<td>Entering a label, centered</td>
<td>75</td>
</tr>
<tr>
<td>Entering a label, right justified</td>
<td>75</td>
</tr>
<tr>
<td>Editing a label.</td>
<td>30</td>
</tr>
<tr>
<td>Entering a number.</td>
<td>15</td>
</tr>
<tr>
<td>Using the range format command.</td>
<td>70</td>
</tr>
<tr>
<td>Setting column widths.</td>
<td>70</td>
</tr>
<tr>
<td>Entering the @now function.</td>
<td>35</td>
</tr>
<tr>
<td>Formatting the @now function for different dates.</td>
<td>95</td>
</tr>
<tr>
<td>Formatting the @now function for different times.</td>
<td>95</td>
</tr>
<tr>
<td>Cell fill/repeat character. (\ key).</td>
<td>70</td>
</tr>
<tr>
<td>Using the copy command. (ranges)</td>
<td>80</td>
</tr>
<tr>
<td>Using the move command. (ranges)</td>
<td>80</td>
</tr>
<tr>
<td>Saving a spreadsheet.</td>
<td>50</td>
</tr>
<tr>
<td>Retrieving a spreadsheet.</td>
<td>50</td>
</tr>
<tr>
<td>Understanding the differences among functions, equations and commands.</td>
<td>80</td>
</tr>
<tr>
<td>The printing process, window or range</td>
<td>65</td>
</tr>
<tr>
<td>top of page</td>
<td>25</td>
</tr>
<tr>
<td>cell formula formats</td>
<td>95</td>
</tr>
<tr>
<td>printer commands and codes</td>
<td>95</td>
</tr>
<tr>
<td>margins</td>
<td>90</td>
</tr>
<tr>
<td>printing In text format</td>
<td>95</td>
</tr>
<tr>
<td>exiting the printing process.</td>
<td>10</td>
</tr>
<tr>
<td>The escape key and how it is used.</td>
<td>15</td>
</tr>
<tr>
<td>The different modes (editing, error, ready, etc.)</td>
<td>90</td>
</tr>
<tr>
<td>The location of the cursor.</td>
<td>40</td>
</tr>
<tr>
<td>Creating graphs.</td>
<td>100</td>
</tr>
<tr>
<td>Creating macros.</td>
<td>100</td>
</tr>
<tr>
<td>Conducting data sorts.</td>
<td>100</td>
</tr>
<tr>
<td>Data extraction with input and output windows.</td>
<td>100</td>
</tr>
</tbody>
</table>

Are there any other routine functions you think an average spreadsheet user would utilize in their day to day workings of a spreadsheet? At what level of complexity would these activities be rated?
Spreadsheet Expert Questionnaire

Please rate the following on a scale of 0 to 100 based on your experience of the task complexity level as perceived by a beginning computer user. Zero on this scale would indicate that a beginner would have no trouble completing the task without any help whatsoever. One hundred on this scale would indicate that a beginner would require extensive input from an expert to complete the task. A one hundred is the maximum task complexity a beginner might encounter.

<table>
<thead>
<tr>
<th>Task Description</th>
<th>Complexity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Using the Lotus help system.</td>
<td>60</td>
</tr>
<tr>
<td>Entering commands.</td>
<td>20</td>
</tr>
<tr>
<td>Moving the cursor around the spreadsheet.</td>
<td>30</td>
</tr>
<tr>
<td>Entering a label, left justified</td>
<td>15</td>
</tr>
<tr>
<td>centered</td>
<td>35</td>
</tr>
<tr>
<td>right justified.</td>
<td>35</td>
</tr>
<tr>
<td>Editing a label.</td>
<td>30</td>
</tr>
<tr>
<td>Entering a number.</td>
<td>15</td>
</tr>
<tr>
<td>Using the range format command.</td>
<td>60</td>
</tr>
<tr>
<td>Setting column widths.</td>
<td>60</td>
</tr>
<tr>
<td>Entering the @now function.</td>
<td>10</td>
</tr>
<tr>
<td>Formatting the @now function for different dates.</td>
<td>90</td>
</tr>
<tr>
<td>Formatting the @now function for different times.</td>
<td>90</td>
</tr>
<tr>
<td>Cell fill/repeat character. (\ key).</td>
<td>20</td>
</tr>
<tr>
<td>Using the copy command. (ranges)</td>
<td>80</td>
</tr>
<tr>
<td>Using the move command. (ranges)</td>
<td>80</td>
</tr>
<tr>
<td>Saving a spreadsheet.</td>
<td>30</td>
</tr>
<tr>
<td>Retrieving a spreadsheet.</td>
<td>30</td>
</tr>
<tr>
<td>Understanding the differences among functions, equations and commands.</td>
<td>40</td>
</tr>
<tr>
<td>The printing process, window or range</td>
<td>30</td>
</tr>
<tr>
<td>top of page</td>
<td>25</td>
</tr>
<tr>
<td>cell formula formats</td>
<td>85</td>
</tr>
<tr>
<td>printer commands and codes</td>
<td>95</td>
</tr>
<tr>
<td>margins</td>
<td>80</td>
</tr>
<tr>
<td>printing in text format</td>
<td>80</td>
</tr>
<tr>
<td>exiting the printing process.</td>
<td>15</td>
</tr>
<tr>
<td>The escape key and how it is used.</td>
<td>25</td>
</tr>
<tr>
<td>The different modes (editing, error, ready, etc.)</td>
<td>45</td>
</tr>
<tr>
<td>The location of the cursor.</td>
<td>25</td>
</tr>
<tr>
<td>Creating graphs.</td>
<td>90</td>
</tr>
<tr>
<td>Creating macros.</td>
<td>95</td>
</tr>
<tr>
<td>Conducting data sorts.</td>
<td>95</td>
</tr>
<tr>
<td>Data extraction with input and output windows.</td>
<td>100</td>
</tr>
</tbody>
</table>

Are there any other routine functions you think an average spreadsheet user would utilize in their day to day workings of a spreadsheet? At what level of complexity would these activities be rated?
APPENDIX E

SEMANTIC HELP SYSTEM INTERFACES
Appendix E

Semantic Interface For the Word Processor

<table>
<thead>
<tr>
<th>I need help on:</th>
<th>around in the document.</th>
</tr>
</thead>
<tbody>
<tr>
<td>moving the cursor</td>
<td>characters and blocks of things.</td>
</tr>
<tr>
<td>deleting</td>
<td>characters, blank lines &amp; page breaks</td>
</tr>
<tr>
<td>inserting</td>
<td>bold, underlined and/or centered.</td>
</tr>
<tr>
<td>changing the appearance to</td>
<td>flush right in appearance.</td>
</tr>
<tr>
<td>formatting text to</td>
<td>the document.</td>
</tr>
<tr>
<td>saving</td>
<td>a document.</td>
</tr>
<tr>
<td>printing</td>
<td>words, phrases and paragraphs.</td>
</tr>
<tr>
<td>retrieving</td>
<td>italics.</td>
</tr>
<tr>
<td>centering</td>
<td>paragraphs to different locations.</td>
</tr>
<tr>
<td>imputing characters as</td>
<td>changes: left, right, top &amp; bottom.</td>
</tr>
<tr>
<td>moving</td>
<td>page numbers on the page.</td>
</tr>
<tr>
<td>margin</td>
<td>character pitch and size (cpi).</td>
</tr>
<tr>
<td>placing</td>
<td>files.</td>
</tr>
<tr>
<td>changing</td>
<td></td>
</tr>
<tr>
<td>getting a list of</td>
<td></td>
</tr>
</tbody>
</table>

F10 to execute

Just hit the ESCape key to exit back to your document.
Appendix E

Semantic Interface For Spreadsheet

<table>
<thead>
<tr>
<th>I need help on:</th>
</tr>
</thead>
<tbody>
<tr>
<td>moving the cursor</td>
</tr>
<tr>
<td>deleting</td>
</tr>
<tr>
<td>inserting</td>
</tr>
<tr>
<td>changing the appearance to</td>
</tr>
<tr>
<td>widening or shortening</td>
</tr>
<tr>
<td>saving</td>
</tr>
<tr>
<td>printing</td>
</tr>
<tr>
<td>retrieving</td>
</tr>
<tr>
<td>entering</td>
</tr>
<tr>
<td>reordering the list by</td>
</tr>
<tr>
<td>defining a cell</td>
</tr>
<tr>
<td>replacing a cell with</td>
</tr>
<tr>
<td>executing a</td>
</tr>
<tr>
<td>using the</td>
</tr>
<tr>
<td>generating</td>
</tr>
<tr>
<td>overall</td>
</tr>
<tr>
<td>around in the spreadsheet.</td>
</tr>
<tr>
<td>characters and cells.</td>
</tr>
<tr>
<td>characters and numbers.</td>
</tr>
<tr>
<td>decimal places and dollar formats.</td>
</tr>
<tr>
<td>the column widths.</td>
</tr>
<tr>
<td>the spreadsheet.</td>
</tr>
<tr>
<td>the spreadsheet.</td>
</tr>
<tr>
<td>a spreadsheet.</td>
</tr>
<tr>
<td>equations and functions.</td>
</tr>
<tr>
<td>sorting.</td>
</tr>
<tr>
<td>cell, range and location of cursor.</td>
</tr>
<tr>
<td>correct characters.</td>
</tr>
<tr>
<td>command.</td>
</tr>
<tr>
<td>escape key.</td>
</tr>
<tr>
<td>a graph.</td>
</tr>
<tr>
<td>concepts.</td>
</tr>
</tbody>
</table>

Just hit the ESCape key to exit back to your spreadsheet.
Appendix F

Standard Help Screen For the Word Processor

Word processor Template (Enhanced Layout)

<table>
<thead>
<tr>
<th>F1</th>
<th>F2</th>
<th>F3</th>
<th>F4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shell</td>
<td>Spell</td>
<td>Screen</td>
<td>Move</td>
</tr>
<tr>
<td>Thesaurus</td>
<td>Replace</td>
<td>Reveal Codes</td>
<td>Block</td>
</tr>
<tr>
<td>SETUP</td>
<td>&lt;-SEARCH</td>
<td>SWITCH</td>
<td>--&gt;Indent&lt;--</td>
</tr>
<tr>
<td>Cancel</td>
<td>--&gt;Search</td>
<td>Help</td>
<td>--&gt;Indent</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>F5</th>
<th>F6</th>
<th>F7</th>
<th>F8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Text In/Out</td>
<td>Tab Align</td>
<td>Footnote</td>
<td>Font</td>
</tr>
<tr>
<td>Mark Text</td>
<td>Flush Right</td>
<td>Columns/Table</td>
<td>Style</td>
</tr>
<tr>
<td>DATE/OUTLINE</td>
<td>CENTER</td>
<td>PRINT</td>
<td>FORMAT</td>
</tr>
<tr>
<td>List</td>
<td>Bold</td>
<td>Exit</td>
<td>Underline</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>F9</th>
<th>F10</th>
<th>F11</th>
<th>F12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Merge/Sort</td>
<td>Macro Define</td>
<td>Graphics</td>
<td>Macro</td>
</tr>
<tr>
<td>MERGE CODES</td>
<td>RETRIEVE</td>
<td>End Field</td>
<td>Save</td>
</tr>
</tbody>
</table>

Press 1 to view the PC/XT keyboard template
Selection: 0

(Press ENTER to exit Help)
Appendix F

Standard Help Screen For the Spreadsheet

<table>
<thead>
<tr>
<th>1-2-3 Help Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>About 1-2-3 Help</td>
</tr>
<tr>
<td>Cell Format</td>
</tr>
<tr>
<td>Cell/Range References</td>
</tr>
<tr>
<td>Column Widths</td>
</tr>
<tr>
<td>Control Panel</td>
</tr>
<tr>
<td>Entering Data</td>
</tr>
<tr>
<td>Error Message Index</td>
</tr>
<tr>
<td>Formulas</td>
</tr>
<tr>
<td>@Function Index</td>
</tr>
<tr>
<td>Function Keys</td>
</tr>
<tr>
<td>Keyboard Index</td>
</tr>
<tr>
<td>Learn Feature</td>
</tr>
</tbody>
</table>

To select a topic, press a pointer-movement key to highlight the topic and then press ENTER. To return to a previous Help screen, press BACKSPACE. To leave Help and return to the worksheet, press ESC.
APPENDIX G

PILOT I PRE-EXPERIMENTAL TASK LIST
Appendix G

Pilot I Pre-experimental Task List

Word Processor High Complexity

1. Retrieve TEST2.DOC from drive A:.

2. Put your name and section at the bottom of the document.

3. Change left, right, top and bottom margins to 2".

4. Italicize and underline the first occurrence of the word transistor.

5. Save the modified document on drive a: using the first 8 characters of your last name as the filename.

6. Print the document.
Appendix G

Pilot I Pre-experimental Task List

Word Processor Low Complexity

1. Retrieve the file called TEST.DOC from the A: drive.

2. At the top of the document, put your name, date and address in left justified format.

3. Insert a blank line after the last paragraph in the document then type the following "This sentence is in bold." Make sure this sentence is in bold as you type it into the document. The bold sentence should be left-justified.

4. Insert another blank line after the boldfaced sentence. Then type in "This is an underlined sentence." This sentence should be the only sentence that is underlined. Don't underline the period at the end of the sentence.

5. Insert another blank line after the underlined sentence. Then type in the following "This sentence is centered." The text should be automatically centering and readjusting as you type.

6. Save the document to drive A: using your last name, up to 8 characters, as the filename.

7. Print the document.
Appendix G

Pilot I Pre-experimental Task List

Spreadsheet High Complexity

1. Retrieve a spreadsheet called A:grades from drive A:.

2. Put your name and section number in cell A1.

3. Average each student's grades.

4. Compute the class average.

5. Sort the data by each individual average grade and print the results.

6. Save the spreadsheet on drive A: using the first 8 characters of your last name for the filename.

7. Print the whole spreadsheet.
Appendix G

Pilot I Pre-experimental Task List

Spreadsheet Low Complexity

1. In A1, enter your first name.
   In A2, enter your middle initial.
   In A3, enter your last name.
   In A4, enter your section number.

2. In A7, type in "Number formats".
   In B7, type in "Numbers".
   In A8, type in "Currency (C2)".
   In A9, type in "Fixed (F2)".
   In A10, type in "Comma".

3. In cells B8 through B10, put the number 10000.
   In cells C8 through C10, put the number .01.

4. Format cells B8 through D8 for currency, 2 decimal places.
   Format the cells in C8 through C10 for fixed, 2 decimal places.

5. In A13, type in "Math functions".
   In A14, type in "Add".
   In A15, type in "Subtract".
   In A16, type in "Multiply".
   In A17, type in "Divide".
   In B13, put in the number 3.
   In C13, put in the number 3.
   In B14, add the two numbers.
   In B15, subtract the two numbers.
   In B16, multiply the two numbers.
   In B17, divide the two numbers.

6. Set each of the individual column widths to as wide as needed so all labels have 1 blank space after the last character.
7. Save the spreadsheet with the following command, /FS using the first 8 digits from your last name as the filename.

8. Print the spreadsheet.
Appendix G

Pilot I Pre-experimental Task List

Word Processor High Complexity

1. Retrieve TEST2.DOC from drive A:.

2. Put your name and section at the bottom of the document.

3. Move the largest paragraph in the document to the beginning.

4. Change left, right, top and bottom margins to 2".

5. Print page numbers on all pages in the upper right hand corner.

6. Print the whole document in 12 characters per inch mode.

7. Center and make bold the title "The Computer Comes of Age".

8. Print the document.
Appendix G

Pilot I Pre-experimental Task List

Word Processor Low Complexity

1. Retrieve the file called TEST.DOC from the A: drive.

2. At the top of the document, put your name, date and address in left justified format.

3. Make sure there is a blank line after your address and the first paragraph.

4. Type in the following (don't type the quotes) "This is the first day of the rest of my life. I will make the most of it." between paragraphs one and two. Make sure there is a blank line above and below this paragraph.

5. Insert a blank line after the last paragraph in the document then type the following "This sentence is in bold." Make sure this sentence is in bold as you type it into the document. The bold sentence should be left-justified.

6. Insert another blank line after the boldfaced sentence. Then type in "This is an underlined sentence." This sentence should be the only sentence that is underlined. Don't underline the period at the end of the sentence.

7. Insert another blank line after the underlined sentence. Then type in the following "This sentence is centered." The text should be automatically centering and readjusting as you type.

8. Go to the phrase "second paragraph" and change it to say "third paragraph".

9. Save the document to drive A: using your last name, up to 8 characters, as the filename.

10. Print both pages.
Appendix G

Pilot I Pre-experimental Task List

Spreadsheet High Complexity

1. Retrieve a spreadsheet called A:grades from drive A:.

2. Put your name and section number in cell A1.

3. Average each students' grades.

4. Compute the class average.

6. Compute the average for the girls for each assignment.

7. Compute the average for the boys for each assignment.

8. Print the whole spreadsheet.

9. Save the spreadsheet on drive A: using the first 8 characters of your last name for the filename.

10. Print the average girls, average boys and class average in a line chart.
Appendix G

Pilot I Pre-experimental Task List

Spreadsheet Low Complexity

1. In A1, enter your first name.
   In A2, enter your middle initial.
   In A3, enter your last name.
   In A4, enter your section number.

   In A5, enter the @NOW function and format for date.
   In A6, enter the @NOW function and format for time.

3. Change the global column width to 14.

4. In A7, type in "Number formats".
   In B7, type in "Numbers".
   In A8, type in "Currency (C2)".
   In A9, type in "Fixed (F2)".
   In A10, type in "Comma".

5. In cells B8 through B10, put the number 10000.
   In cells C8 through C10, put the number .01.

6. Put 100 in cells D8 through D10.
   Put .0001 in cells E8 through E10.

7. Format the cells in B8 through B8 for currency,
   2 decimal places.
   Format the cells in B9 through B9 for fixed,
   2 decimal places.
   Format the cells in B10 through B10 for comma,
   0 decimal places.

8. Fill cell A11 with the - key.
   Fill cell B11 with the * key.
   Fill cell C11 with the = key.

9. In A13, type in "Math functions".
   In A14, type in "Add".
162

In A15, type in "Subtract".
In A16, type in "Multiply".
In A17, type in "Divide".
In A18, type in "Power".
In B13, put in the number 3.
In C13, put in the number 3.
In B14, add the two numbers.
In B15, subtract the two numbers.
In B16, multiply the two numbers.
In B17, divide the two number.
In B18, do the number in B13 to the power of the number in C13.

10. In A20, type in "What is (3+2*3)?"
    In A21, type in "What is (3-2*3)?"
    In B20, type in the answer to solve the problem from A20.
    In B21, type in the answer to solve the problem from A21.

11. Set each of the individual column widths to as wide as needed so all labels have 1 blank space after the last character.

12. Save the spreadsheet with the following command, /FS using the first 8 digits from your last name as the filename.

13. Print the spreadsheet.
APPENDIX H

EXAMPLE HELP SCRIPTS FOR SEMANTIC SYSTEM
Appendix H

Example Help Scripts for Semantic System

Moving the cursor around in the document.

You can move the cursor around the document with the arrow keys.
The left arrow moves left.
The right arrow moves right.
The up arrow goes up.
The down arrow goes down.

To go to the top of the document, hit the following key sequence:
the <home> key twice and then the up arrow key
To go to the end of the document, hit the following key sequence:
the <home> key twice and then the down arrow key

You can move the cursor with the <backspace> key but this deletes as it goes.

Deleting characters and blocks of things.

You can delete characters under the cursor with the <delete> key.
You can delete characters to the left of the cursor with the <backspace> key.

You can delete blocks or chunks of text by “blocking” it first. Do the following steps:
1. Move cursor to start of block.
2. Press down the <ALT> key and at the same time hit the F4 function key.
3. Move cursor to end of where you want deleted.
4. Hit the <delete> key.
5. It will ask you if you really want to delete, just hit the Y key.

Inserting characters, blank lines & page breaks

Example: to insert an “a”
1. Move the cursor to the location desired (it will go to the left of the cursor).
2. Make sure you are in INSERT MODE by pushing the <Insert> key on the right side of the keyboard above the arrow keys several times until the lower left hand corner of the screen does NOT say “Typeover”.
3. Hit the a key.

To add a blank line where your cursor is located, hit the Enter or Return key just to the right of the “ key.

To insert a page break so the cursor moves to the next page, hold down the <CTRL> key and hit the Enter or Return key at the same time. This will add a line of = signs in your document that shows where the new page starts.
Appendix H

Example Help Scripts for Semantic System

Moving the cursor around in the spreadsheet.

You can move the cursor around with the arrow keys: up, down, left and right. You can also use <PGUP> and <PGDOWN> keys.

If you want to go to a specific cell that is far away, hit the F5 function key and type in the address you want. (Addresses are letters followed by numbers.

Deleting characters and cells.

You can delete a character in a cell by "editing the cell". Move the cursor to the cell you want to edit. Hit the F2 function key on the upper row of the keyboard. Now, use the left and right arrow keys to move the cursor to the character to be deleted. Once there, hit the <delete> key and then hit the <Enter> key to complete the change.

If you need to erase or blank out a cell, do the following:
1. Move the cursor on top of the cell to be erased.
2. Hit the following keys (not the quotes) "/" "R" "E" "<Enter>"

Inserting characters and numbers.

Move to the cell you want to enter the characters or letters. Type the characters as you want to enter them. When you are finished, hit the <Enter> key. This places them in the cell.

To enter a number, move to the cell, and hit the numbers you want followed by the <Enter> key.
APPENDIX I

PILOT II AND EXPERIMENTAL DATA COLLECTION TASK LIST
Appendix I

Experimental Data Collection Word Processor

High Task Complexity

1p. 1. Retrieve TEST2.DOC from drive A:.

1p. 2. Put your name, section and computer number at the bottom of the document.

2p. 3. Move the largest paragraph in the document to the beginning.

2p. 4. Change left, right, top and bottom margins to 2".

2p. 5. Print page numbers on all pages in the upper right hand corner.

2p. 6. Print the whole document in 12 characters per inch mode.

2p. 7. Center and make bold the title "The Computer Comes of Age".

2p. 8. Italicize and underline the first occurrence of the word transistor.

2p. 9. Center the whole paragraph that starts with "The modern television set ..."

2p. 10. Save the modified document on drive A: using your section number and your computer number as the filename.

   Example:  0355 where 03 is the section number and 55 is the computer number

2p. 11. Print the document.
Appendix I

Experimental Data Collection Word Processor

High Task Complexity

The Computer Comes of Age

The computer revolution of the past quarter-century has been so vast and all-pervading as to defy comprehension. This ubiquitous record-keeping calculator is strategically involved with the details of our lives—with the food we eat, the products we use, the entertainments we attend, and the money we have or do not have. There is no escaping its effect.

One of the most obvious precursors of today's computer was a punch-card tabulating machine invented by Herman Hollerith and used in the 1890 U.S. census. Hollerith's machine worked, was continually improved on, and was later applied to other problems of data storage and retrieval. With the development of electricity and electronics and, most particularly, the transistor, the present-day computer has evolved, based on principles established by Hollerith.

The transistor itself is a near-miraculous means of miniaturizing complicated electrical circuits. Its electronic complexities defy simple explanation. Suffice it to say that, without generating any heat, a minute piece of solid semiconducting material can switch, modulate, and amplify electronic impulses just as the vacuum tube does. Sponsored by Bell Telephone Laboratories, the transistor was called a corporate invention but it was created by the genius of individuals. The leaders of the team that developed it were John Bardeen, Walter H. Brattain, and William B. Shockley. The three inventors were awarded the Nobel Prize in physics in 1956 for their accomplishments. The tiny chip of germanium containing two wires, which was the first solid state transistor, fulfilled Bell's specifications beyond its developers' fondest dreams, and
today the computer industry is based on this miniature component.

It has since been further miniaturized and now nearly 5,000 computer circuit elements can be integrated on a single silicon chip 1/16-inch square.

Television and the Future

The modern television set is the result of thousands of prior patents and theories, but the big breakthrough that made it possible can be credited to two men, Vladmir K. Zworykin and Phil T. Farnsworth.

Zworykin, born in Murom, Russia, in 1889, worked in the laboratory of Boris Rosing. Rosing was the first to design a television system using the cathode ray table, which has since proved a key component of the electronic industry. When Zworykin immigrated to America in 1919, he was already deeply involved in the theory of television, and during the next 20 years became a leader in the field. His most important development was the iconoscope, basic to the TV camera.

Farnworth, an Idaho farm boy, revealed an amazing grasp of science at an early age. In 1922, when he was 15, he conceived a television system more advanced that of Rosing and Zworykin. By the early 1930's he had greatly increased the clarity of the television image and was ready for commercial production. Commercial telecasting began in 1941 but was interrupted by the war. Farnsworth went on to create other applications for his theories of electronics.
Appendix I

Experimental Data Collection Word Processor

Low Task Complexity

1p. 1. Retrieve the file called TEST.DOC from the A: drive.

1p. 2. At the top of the document put your name, section number and computer number.

1p. 3. Make sure there is a blank line after your computer number and the first paragraph.

1p. 4. Between paragraphs one and two, type in the following (don't type the quotes) "This is the first day of the rest of my life. I will make the most of it.". Make sure there is a blank line above and below this paragraph.

1p. 5. Insert a blank line after the last paragraph in the document then type the following "This sentence is in bold." Make sure this sentence is in bold as you type it into the document. The bold sentence should be left-justified.

1p. 6. Insert another blank line after the boldfaced sentence. Then type in "This is an underlined sentence." This sentence should be the only sentence that is underlined. Don't underline the period at the end of the sentence.

1p. 7. Insert another blank line after the underlined sentence. Then type in the following "This sentence is centered." The text should be automatically centering and readjusting as you type.

1p. 8. Go to the phrase "second paragraph" and change it to say "third paragraph".

1p. 9. Go to the phrase "will be much shorter" and change it to "is much shorter".
lp. 10. Go to the end of the third paragraph and add the phrase "but not by much" before the period.

lp. 11. Go to the bottom of the 1st page of the document. Add a blank line after the centered sentence. Then type in "University of North Texas" using the flush-right function.

lp. 12. Add a blank line after the University of North Texas line.

2p. 13. When you are positioned at the bottom of the first page, insert a "hard page command" by pressing the <Control> key and hitting the <Enter> key at the same time. This will put you on page 2 of the document.

2p. 14. Create a title page by typing in your centered name, section number, computer number and date.

2p. 15. Save the document to drive A: using your section number and computer number for the filename. Example: 0355 where 03 is the section number and 55 is the computer number

2p. 16. Print both pages.
Appendix I

Experimental Data Collection Word Processor

Low Task Complexity

The following is the test document the subjects were to use during this procedure. It had intentional misspellings and other errors. The subjects were to correct them as they typed in or after the document was typed.

This is the test document that is to be used during the editing procedure. This is the first paragraph of the document. Some of the paragraphs will be long while others may be short.

This is the second paragraph of the document. It will be much shorter than the first.
Appendix I

Experimental Data Collection Spreadsheet

High Task Complexity

1p. 1. Retrieve a spreadsheet called GRADES from drive A:

1p. 2. Put your name in cell A1 your section number in cell A2 and your computer number in cell A3.

2p. 3. Average each students' grades.

2p. 4. Compute the class average.

2p. 6. Compute the average for the girls for each assignment.

2p. 7. Compute the average for the boys for each assignment.

2p. 8. Print the whole spreadsheet.

2p. 9. Sort the data by each individual average grade and print the results.

2p. 10. Save the spreadsheet on drive A: using your section number and computer number for the filename.

Example: 0355 where 03 is the section number and 55 is the computer number

2p. 11. Print the whole spreadsheet again.

2p. 12. Print the average girls, average boys and class average in a line chart.
Appendix I

Experimental Data Collection Spreadsheet
High Task Complexity

<table>
<thead>
<tr>
<th>NAME</th>
<th>SECTION NUMBER</th>
<th>COMPUTER NUMBER</th>
<th>Aver</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fred</td>
<td>99 67 78 77 92</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dave</td>
<td>60 65 78 73 81</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mike</td>
<td>98 99 100 90 94</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anne</td>
<td>78 89 83 92 99</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jane</td>
<td>65 70 72 80 68</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix I

Experimental Data Collection Spreadsheet

Low Complexity Task

2p. 1. In A1, enter your first name.
   In A2, enter your last name.
   In A3, enter your section number.
   In A4, enter your computer number.

2p. 2. In A7, type in "Number formats".
   In B7, type in "Numbers".
   In A8, type in "Currency (C2)".
   In A9, type in "Fixed (F2)".
   In A10, type in "Comma".

2p. 3. In cells B8 through E10, put the number 10000.
   In cells C8 through C10, put the number 10.
   In cells D8 through D10, put the number .01.
   In cells E8 through E10, put the number .00001.

2p. 4. Format the cells in B8 through E8 for currency,
   2 decimal places.
   Format the cells in B9 through E9 for fixed,
   2 decimal places.
   Format the cells in B10 through E10 for comma,
   0 decimal places.

2p. 5. Fill cell A11 with the - key.
   Fill cell B11 with the * key.
   Fill cell C11 with the = key.

2p. 6. In A13, type in "Math functions".
   In A14, type in "Add".
   In A15, type in "Subtract".
   In A16, type in "Multiply".
   In A17, type in "Divide".
In B13, put in the number 3.
In C13, put in the number 3.
In B14, enter an equation that adds B13 to C13.
In B15, enter an equation that subtracts C13 from C13.
In B16, enter an equation that multiplies B13 and C13.
In B17, enter an equation that divides B13 by C13.

2p. 7. In A20, type in "What is (3+2*3)?"
In A21, type in "What is (3-2*3)?"
In B20, type in the equation to answer A20.
In B21, type in the equation to answer A21.

2p. 8. Set each of the individual column widths to as wide as needed so all labels have at least 1 blank space after the last character.

2p. 9. Save the spreadsheet with the following command, /FS using your section number and computer number as the filename on drive A:. Example: 0321 NNnn

2p. 10. Print the spreadsheet.
APPENDIX J

QUESTIONNAIRE FOR EXPERIMENTAL DATA COLLECTION
Appendix J

Questionnaire For Experimental Data Collection

Name ________________________________
ID Number ________________________________
Section Number ________________________________
Computer Number ________________________________

Circle the most appropriate response.

1. What has been your experience with spreadsheets in general?
   none very little some average way above average

2. What has been your experience with word processors in general?
   none very little some average way above average

3. What has been your experience, if any, with Lotus?
   none very little some average way above average

4. What has been your experience, if any, with word processor?
   none very little some average way above average

6. What is your age? _______

7. What is your sex? _______

8. Have you heard anything about this exercise from anyone else?
   yes no
BIBLIOGRAPHY


Copeland, Ronald M., Arthur J. Francia and Robert Strawser


Vasilash, G. S. "CAD/CAM In Italy" *Production* 104 2 Feb (1992): 32.
