THE EFFECTS OF
DOT/LINE AND BAR/LINE COMBINATION GRAPHS ON
PROFICIENCY OF SEARCH, EVALUATION,
AND CHOICE OF GRAPHICAL FORMAT
IN A POLICY DECISION CONTEXT

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ABSTRACT

Graphs reveal complex data by displaying answers to questions concerning details, relationships, and trends (Wainer, 1992). This study evaluated combination bar/line versus dot/line graphical formats in terms of presenting information at these three search levels. The formats were explored for proficiency, time to complete, and preference when presenting information.

Forty volunteer trustees of health care organizations were randomly assigned to two groups. The Graphicacy Test (Wainer, 1980) was examined as a pretest for graphic research. Neither graphicacy, education, service on a board, or financial management experience showed a significant influence. Each group read financial reports in two presentations: one in combination bar/line and the other in combination dot/line graphical format.

The findings were discussed in terms of their practical application. The bar/line graph was found to be significantly better than the dot/line format for the proficient search for details, relationships, and trends when in the second presentation. The subjects evaluated the formats in terms of ease of understanding and use. After experiencing both formats, they rated the bar/line significantly higher than the dot/line for clarity, readability, accuracy and overall satisfaction. The trustees chose the combination bar/line format for presenting information in the experiment and in their own organizations.
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Chapter One

INTRODUCTION

The basic problem for communicators of numerical information is how to present information so that readers understand and feel confident in their knowledge. Graphs have been suggested as a tool for visualizing data but there are many graphical formats and applications. Choosing a format that highlights key facts and trends for understanding and evaluating forecasts is a challenge. This study examined two graphical formats designed to present complex information to decision-makers.

1.01 Research Issues:
There have been many comparisons of graphs for decision accuracy with simple data (for reviews see: Desanctis, 1984; Hard, 1989; Vessey & Galletta, 1991), but there has been little exploration of combination graphical formats, for analyzing trends and evaluating forecasts in complex data. Lines are often included on other types of graphs to add guideline or statistical information; however, this combination effect has not been recognized. The Dot chart has been suggested as a superior

^Terms peculiar to the field which are defined in the glossary are underlined the first time they appear in the text.
method for presenting quantitative information for scientific analysis (Cleveland, 1993; Cleveland & McGill, 1985); as yet this format has not been combined with lines and compared to a combination bar/line graph, in a practical setting. Previous studies of graphical formats have tested only the accuracy of readers' acquisition of information (Davis, 1989; Desanctis & Jarvenpaa, 1989), instead of examining the effects on information understanding and use in the proficiency of search for details, relationships, and trends. The effects of formats on making decisions have been researched in the laboratory with college students (Hard, 1989; Jarvenpaa, 1990), but there has been inadequate measurement of use and satisfaction with graph formats in the field.

The question of preference for one graphical format remains unresolved. Research subjects have usually experienced only one format and the researchers were looking for significant group differences of rated satisfaction with relatively small sample sizes and limited instruments (Jarvenpaa, 1986). When subjects experience both formats in a decision-making context, and rate these formats on several aspects, their judgement and choice should be clearer to them and more meaningful to format designers.

Important individual differences need to be measured and accounted for in graphical experiments. Using measures of
graphicy and experience as covariates could remove some predictable individual differences and give a more precise measure of the effects of the graphical format. When comparing graphical formats, researchers have pretested visual cognitive styles, a component of graphicacy, but not the basic ability to read and understand graphs (Barfield & Robless, 1989; Brown, 1992; Head & Moore, 1991; Vessey & Galletta, 1991). There has been some work done with children to test a basic level of graphic reading ability and to measure the graphicate age, but this has not been extended to adults (Sofo, 1985; Wainer, 1980). Reading with understanding means actively relating information to background knowledge and judging the writer's message (Hiebert, 1991). In experiments using graphed financial data, experience and training in financial management have been measured, but not treated as a covariate, (Hard, 1989; Jarvenpaa, 1986). Prior knowledge would improve readers' visual search by helping them to anticipate what to look for, to select appropriate material, and to group symbols into meaningful chunks (Winn, 1993). Therefore, background knowledge of the subject area should be accounted for when testing the understanding of the graphic message.

To summarize, research is needed on presenting complex data in new combinations of graph formats while controlling for the effects of graphicacy and experience. Studies of the effects of graphical format on the comprehension of details, relationships and trends in quantitative information should be carried out in a
natural setting.

1.02 The Problem Statement and Research Questions:
The problem this study addressed was how to improve the presentation of quantitative information. I compared two combinations of graph formats for their ability to summarize and organize information to examine if there was more useable information in an eye-view and if memory and experience capabilities were expanded. It was important to find out if combining graph designs would successfully blend the elementary activities attributed to dot, bar or line graphs (Cleveland, 1993; Cleveland & McGill, 1985; Tan & Benbasat, 1990). Readers should be able to instantly grasp single details, relationships, and trends from information as it is presented (Wainer, 1982, 1992). To test understanding and organization of knowledge the experimental tasks included second and third level cognitive thinking as well as simple acquisition of data values (Royer, Cisero, & Carlo, 1993; Wainer, 1992).

Experience was expected to affect a subject's ability to search for and use information. The Graphicacy Test was explored as a means to establish the pre-experiment reading level of graphical formats, and a questionnaire was used to collect information on education, employment background in finance and administration, and length of service on a board. These aspects of experience
were tested for suitability as covariates in the analysis.

This was an empirical study of the effects of graphical formats on the efficient use of information. Efficiency assumes maximum communication with minimum time and effort. The subjects were given two sets of data: one financial report in a bar/line graphical format and the other financial report in a dot/line graphical format. With each format, they answered questions at the elementary, intermediate, and comprehensive search levels. The formats were compared for the proficiency of search, which includes the successful completion of searches of the information and understanding the forecasted outcomes. Subjects noted the time when they started and ended each level of search and the time of completion, or duration of time spent with the two formats, were compared. They rated the formats for clarity, readability, and suitability to information search after responding to questions with each graphical format, and, in conclusion, completed an attitude survey on both types of graphical formats. Finally, subjects were asked to give their preference for a graphical format for the experiment and for the future monitoring of information in their own organization.

Dependent variables:

a. Proficiency of search for details, relationships, and trends for the understanding of forecasted outcomes.

b. Time to complete each of the three levels of search.
c. Preference for format.

Independent variable:
Hospital monthly financial reports presented in combination bar/line or dot/line graphs.

Covariates:
Graphicy and educational, financial, and trusteeship experience.

The Primary Research Questions:
1. What are the effects of combination graphs on proficiency of search for details, relationships, and trends to understand forecasts?

2. In a field situation, which format is preferred, bar/line or dot/line combination graphs?

3. Can the effects of individual differences in graphicacy and educational, financial or trusteeship experience be controlled in experiments measuring readers' proficiency or time to complete searches of graphically presented information?
1.03 Context of the Study:

This experiment was conducted in a health care setting with subjects who were members of a board of trustees. One of the crucial problems facing health care is the communication of technical information to lay boards. Umbdenstock, Hageman, & Amundson (1990) emphasize the need of hospital Financial Committees to understand the vast amounts of information given them. The successful board has to marry resource management with program services to provide quality care. Boards must ensure that there are suitable monitoring and reporting systems in place for the acquisition, management, and development of financial resources (British Columbia Health Association, 1991). However, there is a serious lack of reported research on ways to present financial information in health care.

Informed professional opinion in the literature suggests trustees should be receiving information in a concise, organized format ready for their use (Carver, 1989; Canadian Comprehensive Auditing Foundation, 1987; Drucker, 1989). Carver (1989) advises that information should be focused for comparisons with policy-based criteria, such as the budget, so that all trustees can judge management performance at a glance. Information systems and communication theories suggest a graph format might improve readers' understanding of trends because graphs present data with order and arrangement. Umbdenstock et al. (1990) recommend using more graphics in reporting to the board in financial and service
At present, tables are used extensively to present financial information to board members in Canadian hospitals. Members of Boards of Trustees are given financial information every month that is intended to help them govern our public institutions but the information is not summarized to clearly show trends and predictions (British Columbia Health Association, 1991; Canadian Comprehensive Auditing Foundation, 1987). Instead, many non-profit organizations give trustees the same information that is given to management (Carver, 1989). Currently, hospital Boards are given financial information in two documents: the balance sheet and the statement of Revenue and Expense. Six hospitals surveyed gave this information in tabular form following standard accounting procedures (see Appendix A.9. and Monnery, 1993).

Graphs are routinely used in many medical situations, for example, monitoring heart-rate and other vital signs. A few hospitals use graphs to show simple census statistics like waiting lists or patient days (Appendix 9 and Monnery, 1993). This experiment took actual data from one month's financial packages given to real board members and presented the information in bar/line and dot/line graphs. The totals from the financial tables were rounded to simplify the numbers and much of the management details were omitted. The key components of the report that show trends and predicted outcomes were presented in the graphs: revenue and expense totals with patient revenues,
salary expenses and budget totals.

The difficulties that Boards of Trustees experience in governing and relating monthly reports to the depletion of resources might be solved by shifting the emphasis from the accuracy of tables to formats that highlight exceptions and trends (Boulton, 1978; British Columbia Health Association, 1991; Yates, 1985). By examining financial information for year-to-date compared to forecasted year-end balances, Trustees would be able to monitor the implementation of their budget (The Board Doctor, 1991). Combination graphs should assist memory by showing revenues and expenses over time, including boundaries such as the budget, as well as showing the trends in key components.

1.04 Significance of the Investigation:

The outcome of this study will extend information processing and organizational theories by testing which of these new graphical formats promotes the understanding of concepts of quantity and management of resources. Problem-solving theory suggests organized relationships and multiple cues increase the readers' confidence in decision-making (Bransford & Stein, 1984; Einhorn & Hogarth, 1981; Gick, 1986). Novice or lay individuals need aids to judge the relative importance of amounts and to organize information for determining what is missing, before making decisions. I believe graphs will show the concepts of quantity
and depletion of resources clearly and more concisely than pages of management financial tables.

The findings from this practical setting may suggest changes in policies and practices for presenting financial information to governing bodies in hospitals or other publicly funded organizations. Monitoring financial information, discovering trends and inferring validity of forecasts is the responsibility of institutional board members. In our present economy, because less money is available for government funded institutions, it is crucial that Board Members recognize and quickly evaluate inconsistencies when determining fiscal accountability. For society's benefit we must be certain governing boards are given information in an improved decision-making format.

Chapter Two reviews the literature which gives the characteristics and advantages of the experimental graph combinations. Visual perception and cognitive theories that form the basis for the objectives of the experiment are discussed.
Chapter Two

LITERATURE REVIEW

In this chapter, first theories and then recent research considering graphs, perception, and cognition will be reviewed as they apply to information presentation. Theories concerning the effects of format on the levels of search stress the need to separate the tasks for measuring the dependant variables. The characteristics of dot, bar, and line graphs give a basis for selecting the two experimental formats. Perception theories and research concerning readers' adaptation to anchors and salience form part of our understanding of the decoding of formats. Cognitive theories explain the strategies used to set up a mental representation of the problem and how graphs communicate information in a similar representation. Experiments investigating the effects of prior knowledge, time to complete, and confidence in decision-making suggest individual considerations for choosing a format. There is a foundation of knowledge leading to the present concern for studying the understanding, efficient use, and acceptance of graphical formats.

2.01 Graphical Theory of Information Presentation:
The theories that explain how graphs present complex information provide the basis for choosing the two experimental formats.
Graphical patterns display information so that people are able to find details, relationships and trends. Successful graphs mirror our mental image of the problem. Further study is needed to compare the characteristics of new graph types.

**Three Levels of Search:**
Before selecting a format to present information, we must understand the three levels of information search. Wainer (1992) combined the thinking of Pierce (1891) and Bertin (1983) to explain that graphs could answer questions at three levels. Each level cannot be constructed from, or reduced to, a lower one and we have no need for a concept of "fourthness" (Pierce, 1981). At the first level, readers conduct an elementary search for simple data extraction; at the second, or intermediate level, they examine relationships and trends; at the third, or overall level of search, readers make a comprehensive study to compare trends and see groupings. Separating the three levels of search makes it easier to construct tests of graphicacy and understand which characteristic of graphicacy we are measuring (Wainer, 1992).

A test of an information format should include all three levels, because readers need to find answers at the three levels to comprehend complex information (Anderson, 1982; Campbell, 1988; Guthrie, Weber, & Kimmerly, 1993). A format would be unsuccessful in showing complex data if any level was left out or poorly displayed. For first level searches it is not necessary
to decode precise, minute values but the scale should give understandable amounts, and the readers should be able to decode quantities to describe the relationships and trends in the data. In a test of graphical formats for searches at the second level, we should not require readers to do complicated computations with acquired values; the graphic structure and symbols should give an accurate impression of differences and relationships between the elements graphed. For third level searches there should be no need to mentally restructure the information to reveal trends. Changes in the levels or similarities over time should be easily interpreted.

Proficiency of search is a measure of how well graphical formats can be read to assess complex data. We do not know to what extent manipulations of the symbol systems of different types of graphical formats affect the readers' discrimination of details or understanding of the configuration (Winn, 1993). This study compared two graphical formats, presenting the same information, by asking readers to answer questions at the three levels of search.

Level One: Can they see the detail of one value and read the scale accurately? Are the data points easily connected to the component labels?

Level Two: Can they compare two entities to detect the size of their differences? Can the magnitude of the difference be determined visually?
Level Three: Can they note how the entities vary over time and compare these levels to guidelines or statistics? Can they reach conclusions about the whole picture?

Figure 1. A Theoretical model of proficiency of search.

The meta-analysis concerning the effects of formats on decision-making performance by Schaubroeck and Murlidhar (1991) discourages further comparative studies of tables versus graphs. A comparison of dot/line versus bar/line should increase our knowledge of the effects of different graphical formats on presenting information.

**Dot Charts:**

Cleveland (1993) maintained that visualization was critical to data analysis and he was certain that one tool, the dot chart, led to efficient, accurate visual decoding. He reported that the
dot chart gave insights into data which were not apparent when using statistics to assess linearity because the statistics suspended the use of prior knowledge. The dot chart presented all the information, and the visualization of the structure and the patterns in the data allowed inferences to be drawn. Cleveland wrote that the dot chart gave him a more powerful summarization of data. In an examination of the relationship of singers' height to their voice part, he felt the dot chart improved the presentation of information over a histogram using bars. "The final result is a convincing, quantified picture of the relationship between height and pitch interval." (Cleveland, 1993, p. 41). When statisticians used two-way tables to record and examine barley crop yields, they missed important conclusions made apparent by the use of dot charts. In Cleveland's analysis of the same data, multiple dot charts presented the information in a structured report that revealed the patterns in the data. "The poverty of tabular presentation did not allow even an exceptional data analyst to see the pattern in the reversal that triggers suspicion. Visualization is a necessary part of data analysis. Tools Matter." (Cleveland, 1993, p. 340).

What is a dot chart? A dot chart is a new graphical format that
Bar/line vs dot/line 16

uses dotted lines, a series of printed periods that end in a larger circle at the data point (Cleveland, 1993; Cleveland & McGill, 1985). Examples of the dot charts used in the experiment appear in Figures 2, 4, 6, and 8. A dot chart resembles a bar graph, but unlike bar graphs the line of periods does not vary in width or carry shading, colour or hatching to differentiate entities. The rows of dotted lines begin at the left edge of the graph, one row for each variable label. The final circle may be open, or filled in, to represent two different entities. Dot charts follow the convention that ordered variables increase going from left to right on the horizontal scale and from bottom to top on the vertical scale. The dotted lines visually connect a graphed value with its name or label.

Characteristics of Bar, Dot and Line Graphs:

Tan and Benbasat (1990) predicted that if the anchoring characteristics from their graph and task taxonomies are matched, performance would be facilitated. The anchoring characteristics of simple bar graphs suit elementary acquisition tasks, where readers anchor first on axis labels to direct their search. Dot graphical formats should exhibit similar characteristics because each dotted line also begins at the label on the axis. Dot
Bar/line vs dot/line 17

graphical formats, because they also emphasize data points may exhibit some of the characteristics attributed to scatter plots, and they may give moderate aid to the comprehension of relationships and trends. The sequential anchoring on data points connected in a series, which is the characteristic of line graphs, facilitates the acquisition of comprehensive relationships and trends. The elements of bar/line and dot/line combination graphs show complementary and coinciding characteristics.

Combination Graphs:

How the information is being used and the type of information being presented or questioned affects the choice of graph (Macdonald-Ross, 1977). Graphs are appropriate for communication or analysis purposes (Kosslyn, 1989). Bar graphs are useful for making static comparisons; line graphs are superior for dynamic comparisons (Wright, 1977). Simcox (1984) explains that we are biased to look at the height and slope of lines; this makes trend and level information quickly noticeable. Bar charts show discrete areas for each segment of information and can be subdivided into divisions relating to the make-up of the total quantity (Wildbur, 1989). Golen and Linn (1985) suggest that in
business reporting, for item comparisons, bar graphs are best, whereas for time comparisons, line graph are more suitable. Dot charts have been used to present scientific data for visual analysis but have not been included in previous reviews of graphical formats in the literature. Tan & Benbasat (1990) suggested that composite designs would combine the elementary characteristics of both graph types merged. Combination graphs have not been explored extensively in the literature, and Desanctis (1984) cautions that subtle differences in displays may have significant effects on users' interpretation and decision-making.

A combination graph should improve the efficiency of presenting information (Higgins, 1989). Patterns presented by complex graphs extend the meaning in a person's immediate vision or "eye-view" (Dukes, 1976; Gross 1990). Graphical displays should encourage the eye to compare different pieces of data (Tufte, 1983). One way to add information to graphs is to merge two graph types together. Graphic communicative power can be enhanced by the combination of graphs in a single presentation (Gross, 1990). With present computer software, lines showing trend and level information can be merged with bars or dotted
lines that show item comparisons or difference information. Lines can be included in graphs to show summary statistics, such as averages, or maximum levels, so that readers do not have to compute or remember these guidelines when judging quantities. Connected lines can be used to show the trends of components of the total items being compared. Merged graphs reveal new patterns in the data when they combine detail, trend, and relationship concepts.

Kosslyn (1985) stated that the recognition of graph type, graphic elements, and their interrelationships was a critical first step in the comprehension process. Line and bar graphs are the most common in print; a combination of the two should be an easily recognizable format, however, there has been no research reported on how people react to dot graphical formats combined with lines. The present research compares the effects when the information is presented in combination dot/line or bar/line format.

The Advantages of Reading Graphs for Information: Tufte declared "Graphical excellence is that which gives the viewer the greatest number of ideas in the shortest time with the least ink in the smallest space" (Tufte, 1983, p. 51). In his review of graphic literacy, Sofo (1985) realized that workers used reading-to-do skills, where information was read and used
directly from spatial display without being memorized. He suggested one can learn by eye as well as one can learn by ear, that is, without translating learning into verbal or word text. If this is true, then readers of graphs, who acquire information in a spatial sense, could use it directly to relate differences in quantities. Bars of certain heights or lines at different levels would be directly compared. The information would not be translated into numbers before decisions of quantity are made, and the conclusion would be held in terms of perceived amounts. This mental image would allow graphical information to be immediately compared and incorporated.

2.02 Research in Graphicacy and Graph Presentation Formats:
Research into the effects of individual differences in graphic reading abilities over various levels of tasks form a basis for the methodology used in the present experiment. Timing in experiments, and error investigations suggest links to cognitive theories of expertise.

Graphicacy Research:
Individual differences in the ability to read graphs should be controlled in experiments studying the use of graphs for presenting information. Hard (1989) discovered perceived graphical knowledge was inadequate for judging graphical performance in decision-making. In her experiment, the self-
rating of graphical knowledge by university students did not correspond to their proficiency levels; students with high self-ratings did equally well with tables or graphs. A pretest of both formats should give more information of basic ability (Hard, 1989). This experiment repeated the same self-rating tool to discover if the results were different when health care trustees rated their pre-experiment graphical knowledge.

Wainer (1980) developed a tool to investigate graphically in children. The Graphicacy Test used rainfall data for four cities and asked elementary, intermediate, and comprehensive level questions. A combination bar/line graph, a modified pie chart, and a table gave equal results. Wainer (1980) found item difficulty increased with question level and graphicacy increased with age. The test indicated different levels of graphicacy with a reliability of over .80 using a Rasch model (Kuder-Richardson 20) and had high face validity.

It was proposed that The Graphicacy Test be used with adults to establish a basic level of graphical understanding. The face validity seemed to suit the purpose that this experiment required. Wainer indicated "The test was constructed to mirror accurately the complexity of graphics that a literate adult would be expected to deal with in a day-to-day existence." (Wainer, 1980 p. 337). His conclusion that graphicacy increased with age suggested that further investigation with adults was indicated.
The questions the test asks were based on proficiency in the three levels of search:

1. Elementary. The extraction of exact information, e.g., how much rain fell in February in San Francisco?
2. Intermediate. The detection of trends, e.g., during what season did the amount of rainfall decrease each month?
3. Comprehensive. The comparison of whole structures, e.g., which season has the most rain?" (Wainer, 1980 p. 332)

One of the graphs tested in Wainer's experiment used bars for the rainfall data and a line to show the rainfall average. This was a combination bar/line graphical format presenting simple data. The finding that four different formats gave almost equal results (Wainer, 1980) suggested that any graphical format could be substituted and tested. It was thought that a dot/line graph could be used to present the same information and the Graphicacy Test would then pretest graphicacy with both experimental formats.

**Experiments in Levels of Search:**

It is crucial that all levels of search be part of a comparison of two graphical formats. Guthrie, Webber, and Kimmerly (1993) found there was a separate factor that characterized global or third level searches which they labelled "abstraction". There were great individual differences in the ability to make global interpretations. Global, or level three questions, require
readers to abstract or integrate new information with their personal knowledge. In their study with university students, they found global searches for trends had more errors than local searches for specific detail. Local or level one searches that required short answer replies had less room for error. Global searches, where subjects needed to summarize relationships and trends gave more error opportunities in omission as well as in interpretation. Pinker (1983) agreed. He discovered errors, and also the time to answer, increased with global questions. Wainer (1993) found elementary level questions had a lower mean difficulty score than secondary or third level questions. Hard (1989) used separate tasks for each level and detected significant differences between graphs and tables on two of three tasks. This followed the results of previous research where tasks defined the outcome and no "best" format was found between simple graphs and tables (Desanctis, 1984). Formats used in test conditions should be capable of presenting complex data at all search levels but the research indicates that questions be separated out by level. More information is needed on the interaction between new formats and tasks.

The Effects of Format on Time in Experiments:
A short time spent searching graphs may indicate information was conveyed efficiently but it depends on the level of search; generally, second and third levels take longer than simple acquisition of values. Peterson (1983) found graphs and tables
shortened the reading time of a narrative, and she measured a slightly shorter reading time and better reader retention with tables than with graphs. However, her students were searching for factual information from the presentation, so actual numbers from tables would suit the questions more than graph generalities. The more reversals in trend lines, the more time was used to study graphs and the more interpretation there was of local details (Carswell, Emery, & Lonon, 1993). In the Carswell et al. study, longer times resulted in more complete interpretations, the goal of the task. Pinker (1983) agreed that questions about global properties or alternation took longer to answer than questions about local properties or consistency. From this review of the research we would expect speed of completion to be affected by the level of search.

An important consideration of speed with graphs is that we do not know the impact of graph competency on decision speed (Desanctis, 1984). Experts are not always faster than novices. Although the times were not significant, expert readers, who had more prior knowledge to process, appeared to take longer to respond to secondary tasks than novice readers (Britton & Tesser, 1982). Experienced managers took less time than novice managers to solve a production management problem from graphs on computer but novice managers were faster than experienced managers when using graphs on paper (Barfield & Robless, 1989). There has been conflicting information collected regarding time in experiments
with graphic formats. Time to complete was measured as a dependent variable in the present study as part of the total effects of either dot/line or bar/line graphical format with complex data and tasks that emphasised the three levels of search.

**Familiarity With Graph Formats:**
Several researchers have postulated that graph readers have to go through a familiarization or learning process before the graphical information becomes meaningful (Davis, 1989; Hard, 1989; Vessey & Galletta, 1991). We should be concerned with the difficulties encountered by naive readers. Desanctis & Jarvenpaa (1985) found there is a learning curve with the use of graphs over only five graph presentations. The performance curve for graphs (in the Desanctis & Jarvenpaa experiment) continued to improve and showed no sign of levelling off (Jarvenpaa, 1986).

**2.03 Visual Perception in Information Processing:**
This section relates the concepts or visual perception to information processing. How information is processed when it is presented visually depends on the reader's visual capacities, the attention demanded by the format and the visual cues given. Complex information demands complex graphic design, like combination bar/line or dot/line formats. Visual pretests need to relate to the individual differences in reading graphs.
Visual Capacities:
Acquisition and processing of information from graphs is dependent on our visual capacities. Visual decoding is the instantaneous perception of the visual field which comes without apparent mental effort and allows us to detect geometric patterns and assess magnitudes (Cleveland & McGill, 1985). The human visual system can recognize length, height, orientation, curvature, shape, parallelism, smoothness, and compactness of a line or set of lines quickly and with minimum effort (Pinker, 1983). Our eyes can make 25,281 distinctions within a square inch, variations of one property can be combined with variations of others, allowing a single mark to convey a large amount of information (Tufte, 1983). Graphs exploit the first stage of visual processing by making the patterns instantly recognizable and meaningful.

Salience:
Sensory input from graphs is influenced by size or contrast corresponding to the feature's salience. Graphs should be constructed so that one notices the more important things first (Kosslyn, 1985). Salience may be the intensity, frequency, familiarity, or generally, the "signal-to-noise" ratio of the features (Tversky, 1977). The organization of information on a display makes some search strategies more costly or cognitively effortful than others, so novices may be more affected by
The Perception of Dot Charts vs. Bar and Line Graphs:
Cleveland and McGill (1985) claimed dot charts were superior to other graphical formats because they presented information as positions along a common scale, the most accurately judged aspect of elementary perception tasks in their list of graphic reading tasks. They contended that dot charts did not ask readers to judge length, angle, slope, area, volume, density, colour saturation, or colour hue. They suggested that if the dotted lines were made light they would not impose or obscure the numerical values. The reading of bars graphs, on the other hand, included judgements of length, area, volume, and density as well as position, and could include colour. The reading of line graphs demanded judgements of length, slope, and angle as well as position, and could include colour. Cleveland and McGill (1985) proposed that bar and line graphs required readers to perform more error ridden tasks of perceptual judgement than dot charts.

Anchoring:
Combination graphs first give peripheral anchors to act as cues to direct acquisition of information, and then readers use data as anchors within the graph for visual comparison. These two visual processes explain how we get information from graphs. In an experiment, we can ask questions that require readers to do
one level of search-task at a time. However, we must remember that to comprehend complex data readers combine these anchoring assignments.

Tan and Benbasat (1990) explained that we decode information using specific parts of the graph as guides, or anchors for extracting information. The divisions along both axes act as anchors. Bar graphs are suited to tasks requiring comparisons because bars begin at the X axis, allowing readers to anchor on component labels and trace bar lengths to discover the component quantities. Line graphs aid decisions regarding trends because the data points act as sequential anchors for judging angles and the direction of change.

However, when comparing proportions within the graph, anchoring involves eye contact with the first quantity and then scanning, projecting or using superimpositions to estimate values (Simkin & Hastie, 1987). For example, when comparing two bars we anchor on the top level of the first bar, move the eye parallel to the second bar, match and/or scan the residual to judge the amount of difference, then project to the Y axis scale to decode values. Points on a line, and supposedly end-dots, are similarly eyed to decode values. The graph is an organizational tool that allows comparisons of data on common scales. The longer the time allowed for inspection, the more intermediate anchors and adjustments are used, producing greater accuracy (Simkin &
Multiple Cues:
Graphical formats present data compactly, giving current information with past references to indicate concurrent, moderating, or causal influences. Presenting information over time enhances repetition of cues, compresses a lot of information in a small space, and extends human judgement. When we present information in units of time past, present, and future, there is a means of comparison where distance is a measure of time travelled. This moving measurement allows a pattern to grow or interact with other patterns so multiple elements can be built up step-by-step and several layers of information can be combined. Multi-functioning graphical elements can effectively display complex, multi-variate data (Tufte, 1983). The search for information in graphs is limited without large losses in predictive accuracy, attention is highly selective, and reliability of cues is assured by having multiple measures of the same cue available (Einhorn & Hogarth, 1981).

Multiple bars and lines increase the information in the eye view by giving numerous anchors and data values. Perceptual discrimination processes detect similarities and differences, while configuration processes connect data into groups of clearest, simplest forms (Winn, 1993). The visual shape of patterns is instantly recognizable and remembered even after the
Multiple lines show sub-relationships and trends within components. Lines encourage eye movement to draw comparisons between related levels and time periods. It is easy to mentally continue relationships to make predictions based on the patterns of past trends. Kirk & Howell (1983) found subjects tended to use all four cases when presented in graphic form, but only selected ones when the same information was displayed numerically. Combination bar/line and dot/line graphs should present a lot of summarized information.

2.04 Visual Perception Research:
The results of investigations using graphs point out the need to find visual pretests which disclose pertinent individual differences. None of the pretests used in the literature surveyed produced statistically significant results.

**Visual Pretests:**
Visual-type pretests have not been successful in measuring control variables for graphic research (Barfield & Robless, 1989; Brown, 1992; Head & Moore, 1991; Vessey & Galletta, 1991). Barfield and Robless (1989) used a Cube Comparison Post-Test, but found no significant difference between 3-D Spatial orientation to problem-solving accuracy or speed with two and three-
dimensional graphs. The Embedded Figures Test, either for individuals or groups, has been used to indicate a cognitive style of field dependence or field independence. Field independent people are able to perceive an object as distinct from its background and would be more analytical than field dependent persons. Brown (1992) concluded that graphic aids and cognitive style, in conjunction, affected decision-making. This confirmed that searching graphs requires the reader to find shapes and patterns in the format but would not help us to differentiate between two graphical formats. In a study by Head and Moore (1991) those who were field dependent when reading graphs generally did better than those who were field independent, and in their experiment, this was not affected by graph type (Head & Moore, 1991). However, high experimental scores for all subjects, indicating a ceiling effect, may have prevented the detection of significant differences in recall of information from graphs (Head & Moore, 1991). The problems previous research had in controlling pre-experiment abilities prompted trials with The Graphicacy Test.

2.05 Cognitive Theories:
Cognitive theories are related to the expert understanding and use of graphs. Graphs should be like expert mental models of the problem. Experience in the subject area should be measured and used as a controllable element of expertise. We want readers to
base their preference on how well graphs aid their insight into complex tasks and make them experts at reading numerical information.

**Decision-Making Intuition:**

Graphs should generate active interpretation of the trends in data and promote creative insight. Payne et al. (1992) suggested intuitive decision-making was a rapid, smooth process of comparing one's image (values or goals) with an alternative. Graphs use time and natural numerical sequence to order data. This arrangement of the data predisposes readers to detect series and sets. Wainer (1992) stated: "We can be forced to discover things from a graph without knowing in advance what we are looking for." (p. 14). The spaces in graphs encourage active and open minds to search, extend visible trends, match evidence of components, and compare outcomes or goals (Baron, 1988). We can examine a graph of revenue and a graph of expense, but the interesting comparison is found by putting them together - it is the space between that has essential meaning. Graphs should aid insightful decision-making.

**Reader Reaction to Graphical Formats:**

We want readers to base their preference for a graphical format on how well the graphical type helps them to find and use information. Anderson (1982) presented the theory that productions, or procedures for performing a cognitive skill, were
best evaluated according to whether they achieve the desired goals. Graphs supply information in a format that should simplify search procedures for analyzing data.

We would expect a graphical format to be chosen by readers if it helped them to make decisions and aided memory. Campbell (1991) advanced the theory that people chose a task performance strategy (TSP) that was perceived to require the least effort. Desanctis (1989) suggested the additional sensory information given by graphs should serve as a cue in recall and increase confidence in decisions. Recalling from memory slows learning because information has to be continually evaluated and matched to goals. If a graph readily presents past and future trends, memory loads are eased, and readers are able to process additional associative information and recognize new alternatives. Many errors and slowness in decision-making were attributable to working memory errors (Anderson, 1982). Graphs present information compactly, showing past trends, creating less strain on memory.

Metacognition, the capacity to govern one's own learning activities, is likely to be domain specific (Royer, Cisero, & Carlo, 1993). Ensuring that each task requires all three levels of search will control for only selecting a graph that is best for one type of question. To prevent the final selection being biased by the recency effect of the last format encountered, we can precede the choice consideration with overall evaluations of
the experiment. Subjects were asked to choose a format they judged was best for the experimental tasks and also to select a format for presenting information to their own organization. It is expected that the choice reflects the best format for trustees of health care and other public agencies.

**Complex Tasks:**
Campbell (1988) suggested complex tasks place high cognitive demands if they had several integrated elements or uncertain alternatives. Judgement tasks, which require the doer to integrate diverse sources of information and predict the likelihood of a future event, were complex tasks. Complex tasks require an individual to develop a task-performance strategy (Campbell, 1991). Local searches for specific information involve setting goals, selecting categories and integrating. Global searches, to get the main idea, mean identifying and interrelating all categories and forming abstractions to compare categories and generalize similarities (Guthrie, Weber, & Kimmerly, 1993). Third level, overall searches are complex tasks.

**Experts and Experience:**
Writers and graphical designers present information to try to make all readers experts. Experts see detail if the task sets them up to see it, but they generally represent information more abstractly and can answer questions on inferences better than
novices. Their general model allows skilful thinkers to elaborate or change an element in isolation without exceeding the limits of working memory (Adelson, 1984). Experts sort and perform activities in less time and with fewer steps whereas novices are continuously referring back (Royer et al., 1993). We need to know which graphical format presents the right amount of detailed information in a general, organized form to make readers experts.

The difference we wanted to detect between the two graphs, either dot/line or bar/line, is that which makes readers more proficient, speedier and confident: in short, experts. The format of the graph should match the best internal problem space of the reader. The graphic presentation of information all in one eye-view should be equivalent to the mental picture of the problem produced by proficient cognitive strategies. The organization of a graph lifts the burden of memory, because past trends and guidelines for decisions can be presented simultaneously with current data. In a well-designed graph, the data would be efficiently organized to equal expert strategies for the task.

One important requirement for expertise is a basic knowledge in the subject area. The way to become an expert is to acquire contextual information and actively seek linkages between new evidence to knowledge that is already stored (Glover, Ronning, &
Experts formulate questions, recognize adequacy of data for quality and quantity, and predict probable consequences (Gick, 1986). If we could control for this familiarity with the subject area, we would be better able to isolate the effects of the presentation format on the readers' proficiency.

2.06 Cognitive Research:
We often equate experience and expertise and conclude that both will lead to confidence in decision-making. Experts have to have experience in the area of study. Experience does affect how expertly we search and use information. Successful comprehension does give confidence. We have some research on which to base these ideas but more is needed.

Expert - Novice Research:
Experts have a store of domain specific knowledge they relate and integrate with new information. Egan and Swartz (1979) studied expert and novice electronic technicians. Skilled technicians chunked or grouped symbols into functional units and were able to recall more. The size of the chunks increased with study time. Experts identified the whole conceptual category and were able to retrieve elements. Adelson (1984) found novices represented problems concretely and answered questions about details better.
than experts, but experts were superior at abstract representations for making inferences. Pinker (1983) concluded that when graph readers are familiar with a graph format and the trends are displayed as recognizable shapes they mentally translate the trend directly without estimating point values and calculating the trend by numbers.

Research - Confidence in Decision-making:
In the literature, there were inconclusive reports as to which format subjects perceived as "best." Familiarity with a subject acted as a boundary or limiter in information processing (Payne & Bettman, 1992). Jarvenpaa (1986) concluded that there was a conditioning bond towards tables in standard business reporting that may take some time to break down. Vessey and Galletta (1991) concluded that problem solvers prefer to work with tables rather than graphs, but they had only MBA students as subjects. Desanctis and Jarvenpaa (1989) reported the groups showed insignificant differences for confidence, in their experiment, between the first and fifth trials, however, there was a trend for confidence to grow with graphs (Desanctis & Jarvenpaa, 1989). In post-experiment interviews people preferred graphs when they gave a specific visual cue (Davis, 1989). These findings all are based on mean scores of groups which experienced only one format in the experiment and no statistical significant differences were found. A truer gauge of appreciation of one format over another would be shown if subjects were able to use and compare both
formats for similar tasks, rate several aspects of preference, and make a final choice.

2.07 Summary of the Review of Literature:
Theories and recent research form the basis for the present study, suggesting types of presentation formats, and critical areas of investigation. The health care and graphic literature suggest a field experiment would extend the laboratory findings on levels of search, graphic perception and the use of graphs to monitor information. Previous research indicates that combination bar/line and dot/line graphs present summarized multiple cues differently and a comparison of these two graphs would clear up some of the confusion over the selection of a format for information display. The graphicacy test appears to be a possible way of controlling for individual differences in reading and using graphs. Previous studies support the objectives of the present research.

The literature reviewed stressed the importance of including all levels of search with complex data. The primary objective was to compare the two graphical formats at the three levels of search to determine which shows details, allows correct comparisons of relationships and the visualization of trends. The data for the graphs in this experiment were taken from real hospital financial reports and should reflect the complexity of real life. The
readers were asked to make local and global searches. The complexity of the tasks was a challenge to test the graphical formats for successful presentation of information.

The secondary objective was to test readers' preference for a format in a field situation. Preference is based on perceived efficiency. This study examined many aspects of preference by asking them to judge the format after each use and in a summary evaluation. Subjects also recorded the time as they proceeded through the experiment and this made them aware of elapsed time but did not add the pressure of a timed experiment. Readers' confidence in a decision is a result of finding the answers to questions easily, efficiency, and in their preferred manner.

The third objective was to discover measures of graphicacy and experience that could reduce the effects of individual differences and allow a truer comparison on the effects of the formats. To this end, the Graphicacy Test was used to measure pre-experimental graphic reading proficiency, speed, and preference and these were compared to the outcome variables. Education, work, and board experience were examined individually and as a composite covariate to attempt to control for experience as a factor in graphical expertise.

The next chapter specifies the hypothesis and research design that has developed from this literature review and gives a
description of the volunteer subjects. The processes for conducting the experiment including the scoring of the instruments to measure the dependent variables and samples of the graphical formats used are given.
Chapter Three

METHODOLOGY

3.01 Overview:
The problem this research addressed was how to present financial information to ensure proficiency of search for details, relationships, and trends that would lead to an informed evaluation of forecasts. This experiment tested combined bar/line versus combined dot/line graphs to follow exploratory work with bar versus line graphs (Tan & Benbasat, 1990) and dot charts (Cleveland & McGill, 1985). Education, work experience, and experience on a health care board were assembled using a background questionnaire similar to that used by Hard (1989) to look at experience covariates with non-university students. The value of the Graphicacy Test as a pretest for graphic ability of adults was explored as well (see Wainer, 1980).

In health care, trustees are responsible for assuring they are receiving appropriate information. They approve an annual budget which serves as a standard to judge what has been done in their organization. The subjects judged from the financial information presented whether administration was maintaining budget expectations, and whether the forecasted outcome was adequate. They were also asked to rate the presentation formats with each use, and to state their choice of a format for the future
presentation of financial information. They experienced both formats in strenuous search conditions before they chose one format over the other.

3.02 Design of the Study:
This study followed an experimental design using a pretest with random assignment of subjects to groups. Graphical format, the single experimental variable, was counterbalanced in the experiment to allow between-subject and within-subject analysis. The Graphicacy Test (Wainer, 1980) was modified for use as a pretest to measure adult proficiency of reading and understanding of the two graph types.

Hypothesis:
In this investigation of bar/line versus dot/line graphical formats the following hypothesis were formulated:

1. There is no difference between the effects of combination bar/line or combination dot/line graphical formats on the proficiency of search for details, relationships and trends to understand forecasts.

2. There is no difference between the effects of combination bar/line or combination dot/line graphical formats on preference for a format.

3. Individual differences in graphicy and educational, financial or board experience will not affect readers' preference
for a format, proficiency, or time to complete searches of information presented in bar/line of dot/line graphical formats.

When testing these hypothesis the dependent variables were (a) proficiency of search, (b) time to complete, and (c) preference for format measured for the two graphical presentations. The research was divided into two presentations of the information so that each subject could experience both formats and get a complete picture of monthly fluctuations as well as relationships and trends in cumulative totals. Questions were chosen to reflect the chief concerns of a hospital governing board when monitoring financial data: "How are we doing?", and, "Is the information we are getting adequate to make evaluations?". The questions to measure the proficiency of search and preference for a format are listed in Appendices A.8, A.9, and A.10.

Rather than compare two groups of subjects who had viewed different formats the present research allowed every subject to experience both formats in strenuous search over two graphic presentations. Making only minor changes in the computation of the information and the scale of the graphs allowed the same information to be used twice. The research design is presented in Table 1.
Research Design:

Table 1

Experimental Design

<table>
<thead>
<tr>
<th>GRAPH CONTENT</th>
<th>GROUP (N=40)</th>
<th>FORMAT COMBINATION</th>
<th>DEPENDANT VARIABLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Periodic Totals I (n=20)</td>
<td>Dot/Line</td>
<td>Proficiency of Search</td>
<td></td>
</tr>
<tr>
<td>II (n=20)</td>
<td>Bar/Line</td>
<td>Time to Complete</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Preference for Format</td>
<td></td>
</tr>
<tr>
<td>Cumulative Totals I</td>
<td>Bar/Line</td>
<td>Proficiency of Search</td>
<td></td>
</tr>
<tr>
<td>II</td>
<td>Dot/Line</td>
<td>Time to Complete</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Preference for Format</td>
<td></td>
</tr>
</tbody>
</table>

3.03 Subjects:
The target population was board members who regularly monitor quantitative information and make judgements regarding forecasted outcomes. The accessible population in this study was members of boards of trustees of facilities/agencies in B.C. The sample for the study was recruited from hospitals and care facilities in the Greater Vancouver Regional District: St. Vincent's Hospital, Delta Hospital, The Burnaby Hospital, Youville Residence, and Dogwood Lodge. The subjects participated on a voluntary basis. Board members of hospitals and care facilities are unpaid and they volunteered for this experiment as representatives for their organizations, so that no monetary incentive was necessary.
Recruiting and Consent forms:

To recruit volunteers for the experiment, the Presidents of the hospitals and care facilities were asked to suggest people from their board of trustees or from their staff who would fit the experimental criteria. The criteria for selection was that all subjects be members of boards of trustees of QUANGOS (quasi autonomous non-governmental organizations, that is: semi-public bodies with financial support from, and senior appointments made by government). This was to ensure that all subjects had a basic understanding of the elements of the financial statements and the budget review process. The Board chairpersons were informed about the experiment and were invited to participate. Hospital board members were sent a letter of invitation to take part in the study and a consent form. All individuals who volunteered were contacted by phone to arrange a convenient time to take part in the experiment. I collected the consent forms before beginning each experiment.

3.04. Procedures for conducting each experiment:

The setting was either in the board rooms of the health care facilities or in individual offices, where subjects were used to reading reports. Appointments were made from June to August 1994. The appointment times varied from nine in the morning to seven-thirty at night. I believe the variety of times would correspond to the many different times that board members would
During the experiment the subjects sat at a table or their desk, and I sat directly opposite. I read aloud the introduction and the instructions to administer the experimental instruments (See Appendix A.7). During the experiment, I wrote down all questions asked and my answers as well. I tried to give only "yes" or "no" answers to their questions. I used a stop-watch identical to the ones given to the subjects, and followed the subjects in recording the times during the experiment. For each subject, I filled in the blanks on a time sheet (see Appendix A.4). The inter-rater agreement between the subjects' timing and mine was an average correlation of .92. I also wrote down their oral comments with as little distraction as possible. When they had finished the experiment, I asked them for a final comment I might write down regarding the graphical formats.

3.05. Instruments / Materials:
The instruments used to measures the variables were:

a) Background Questionnaire
b) Graphicacy Test
c) Graph One - Periodic Review of Operations
d) Graph Two - Cumulative Strategic Review
e) Evaluation of Formats
The materials used were booklets of the test instruments, metal pens, and individual digital stop-watches.

a) Background Questionnaire:
A Background Questionnaire was used to collect information on age, sex, educational level, experience as board members, financial experience, and experience with graphs in a framework similar to Hard (1989) (See Appendices A.5 and A.14). A composite score of these was planned to be used as a covariate in the analysis to rule out experience as a factor explaining differences. Subjects were asked to confirm they had normal or corrected to normal vision.

Education was scored out of a possible total of 11, by adding 1 for each level of education from high school to doctorate degree and 1 for each financial or administrative speciality. For example, a Bachelor Degree in Business Administration would add 2 to the total score. Work experience was measured by years of administrative and financial related work experience and training, for a possible weighted total of 11. The scoring of years of administrative work was as follows: 1-5 years = 1, 6-17 years = 2, 18-25 years = 3, and over 25 years = 4; years of financial work and years of service on a board were scored similarly. Experience as a trustee was computed by adding weightings for the years of service as a trustee and the executive positions held for a possible score of 11. The scoring
for executive experience was: finance committee = 1, treasurer = 2, and chairman = 3. It was surmised that these three areas of experience, education, work, and board service would contribute equally to a variable of total experience. The highest possible weighted score for total experience was 33.

b) Pretest: The Graphicacy Test
The Graphicacy Test developed by Wainer (1980) was used to test each subject's proficiency at reading and understanding the two graph types (See Appendix A.14). Previously, the test showed good psychometric properties with Kuder-Richardson 20 reliability scores generally over .80. The test was designed to find the graphicacy age of children, that is, when they could read graphs and answer elementary questions extracting detailed information, intermediate questions detecting relationships, and comprehensive questions comparing whole patterns. These types of questions correspond to the three levels of search used in the experiment. Wainer found that by the fourth grade children had acquired an acceptable minimal level of graphicacy. In the present study, this test was used to indicate the extent of subject's prior competence with the graphical formats.

The Graphicacy Test was modified for use with adults. One intermediate and one comprehensive level question were added to equalize the levels of search represented. Only two formats were tested, combination bar/line and dot/line graphs. The data for
two cities were used, New York and San Francisco. The data values were omitted from the top of the bars because it was expected that adults would easily decode values. Figures 2 - 5 show copies of the graphs used.
Figure 2. Graph 1, Dot/line: Monthly rainfall in New York city.
Figure 3. Graph 1, Bar/line: Monthly rainfall in New York city.
Figure 4. Graph 2, Dot/line: Monthly rainfall in San Francisco.
Figure 5. Graph 2, Bar/line: Monthly rainfall in San Francisco.
Pretest - Recording Time to Complete:
The subjects were prompted to record the times as they proceeded through The Graphicacy Test in boxes containing the words and blanks "TIME: __:__:__". They wrote down the time they began, the time after finishing question five, and the time after completing the last question with each presentation format (see Appendix A.6 for time prompts). This timing served as a practice of timing procedures used in the experiment.

Pretest - Preference Rating of Formats:
They rated each format for clarity, readability, and completeness to questions asked to indicate their initial preference for the formats. The subjects responded to five-point Likert-scales with descriptive word headings ie. "very confusingly" to "very clearly". The experimental design of the pretest allowed both groups to experience simple graphs in dot/line and bar/line formats. The design for presenting the pretest is summarized in Table 2.

Table 2
Pretest Design

<table>
<thead>
<tr>
<th>GRAPH CONTENT</th>
<th>GROUP (N=40)</th>
<th>FORMAT COMBINATION</th>
<th>DEPENDANT VARIABLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rainfall in San Francisco</td>
<td>I (n=20)</td>
<td>Dot/Line</td>
<td>Proficiency of Search</td>
</tr>
<tr>
<td></td>
<td>II (n=20)</td>
<td>Bar/Line</td>
<td>Time to Complete</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Preference for Format</td>
</tr>
<tr>
<td>Rainfall in New York</td>
<td>I</td>
<td>Bar/Line</td>
<td>Proficiency of Search</td>
</tr>
<tr>
<td></td>
<td>II</td>
<td>Dot/Line</td>
<td>Time to complete</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Preference for Format</td>
</tr>
</tbody>
</table>
**Background Investigation:**

This study investigated the need to find a practical solution for presenting financial information to those who must use it to govern. Copies of monthly financial reports given by six hospitals to their board of trustees were examined to note the similarities of content and need for explanation. The written explanations accompanying the financial reports emphasized the need to appreciate the monthly variances in light of the budget and year end forecast. None of the reports used graphs to present financial information, however, it seemed to be expected that the readers of the reports would remember past trends. It was assumed board members would review or remember the previous months figures. The reports were filled with the same detail used by management and administration.

I interviewed administrators and staff in a hospital finance department to learn what they considered important information and how graphs were presently produced. Their comments emphasised the need for trustees to understand general trends, bottom-line totals, comparisons to budget and forecasted year-end. There was software available to produce standard graphs. I also reviewed hospital reports where graphs were used. The graphs were either combination bar/line graphs or pie charts.

**Data for Graphs:**

Two sets of data were prepared using the actual numbers for
period 8, November 5, 1992, from St. Vincent's Health Care Society's financial report. The details of the Statement of Operations were reduced to budget revenues, patient revenues, actual revenues, budget expenses, salary expenses, and actual expenses. The data were given in 13 reporting periods, with actual totals for the eight periods to date and forecasted totals for the five periods to year end. The amounts were rounded to thousands of dollars. The first set gave the total amounts for each reporting period, the second data set used the same information but calculated the cumulative totals for each period.

**Designing the Graphs:**

c) First Graphical Presentation - Graph One:
Combination bar/line graphs were produced using the first data set. The X-axis was divided into the 13 reporting periods. The Y-axis scale ran from 0 to 3,000 thousand dollars in 500 thousand dollar increments. Bars were used for revenues and expenses; filled black bars for revenues and open bars for expenses. On the same graph, a wavy line was used for budget revenues and solid lines were used for budget expenses, salary expenses, and patient revenues. The lines were labelled outside the right side of the graph and a key showed revenue and expense shadings on bars. A year was shown in reporting periods 1-13, period 8 was labelled "Year-to-Date" and period 13 was labelled "Year End". A line was drawn between periods 8 and 9; left of the line was labelled "Forecasted" and the right area labelled "Actual".
Dot graphs were prepared for each data set using the same labels. Budget revenues, budget expenses, salary expenses, patient revenues, forecasted and actual labels were shown in the same way. Dotted lines for each reporting period ended in larger dots representing the values for revenues and expenses; filled black dots for revenues and open dots for expenses.

d) Second Graphical Presentation - Graph Two:
The second data set in cumulative totals was used to prepare bar/line and dot/line graphs for the second graphical presentation. The scale on the Y-axis ran from 0 to 40,000 thousand dollars in 5,000 thousand dollar increments.

The Graphs were constructed according to the standards suggested in the literature (Cleveland, 1985; Cleveland & McGill, 1985 & 1988; Higgins, 1989; Johnson et al., 1980; Kosslyn, 1988; Simcox, 1984; Tan, 1990; Tufte, 1983; Wainer, 1982). Copies of Graphs One and Two in both formats are given in Figures 6, 7, 8, and 9.
Budgeted and Total Revenues and Expenses with Patient Revenues and Salary Expenses for each Reporting Period

Figure 6. Graph One, Dot/line: The Review of Operations.
Part One: Review of Operations

Mercy Hospital - Period 8, November 5

Budgeted and Total Revenues and Expenses with Patient Revenues and Salary Expenses for each Reporting Period

Figure 7. Graph One, Bar/line: The Review of Operations.
Part Two: Strategic Review
Mercy Hospital - Period 8, November 5

Cumulative Budgets, Revenues, and Expenses
with Patient Revenues and Salary Expenses

<table>
<thead>
<tr>
<th>Year End</th>
<th>Patient Revenues</th>
<th>Salary Expenses</th>
<th>Budgeted Revenues</th>
<th>Budgeted Expenses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year-To-Date</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$0</td>
<td>$5,000</td>
<td>$10,000</td>
<td>$15,000</td>
<td>$20,000</td>
</tr>
<tr>
<td>$1</td>
<td>$25,000</td>
<td>$30,000</td>
<td>$35,000</td>
<td>$40,000</td>
</tr>
</tbody>
</table>

Dollars (Thousands)

- ● Revenues
- ○ Expenses

Figure 8. Graph Two, Dot/line: The Strategic Review.
Cumulative Budgets, Revenues, and Expenses with Patient Revenues and Salary Expenses

Figure 9. Graph Two, Bar/line: The Strategic Review.
Introduction to the experiment:
An introduction to the experiment was written. The subjects were asked to imagine that as members of the Board of directors of "Mercy Hospital" they had received the information presented with an agenda for their next board meeting. They were told that the agenda stated the board planned to discuss a strategic review of the hospital's operations, and a system for reporting financial information to the board.

Questions for measuring Proficiency of Search:
The questions pertaining to each graph were written by the researcher to incorporate the three levels of search. The questions were based on the health care literature and the background research conducted. These questions required only a basic understanding of financial information and did not require any complex calculations. The questions were reviewed by a hospital administrator for content validity.

e) Evaluation of the Formats:
The evaluation begins with general questions, then asks the subjects to rate the bar/line and dot/line formats separately, and ends with them stating their choice of a format. The subjects judged their impression of the difficulty of the experiment, their interest in the subject matter, and how long they felt they would remember the information. Although these impressions are important in understanding positive or negative
feeling towards the formats, these questions also served the purpose of getting the subjects to think generally about the whole experiment and avoid any recency effect of the last format they had used when they rated the two experimental formats for accuracy and overall satisfaction and finally chose their preferred format.

3.06 Data Processing:

Data Collection and Recording:
Experimental booklets were made up containing: copies of the consent form; title page; background questionnaire; pretest - graph 1 with data in combination bar/line or dot/line format; The Graphicacy Test; judgement of clarity, readability, and completeness of information; pretest - graph 2; The Graphicacy Test; judgement of clarity, readability, and completeness of information; Introduction to the experiment; graph one, periodic review of operations; questions for graph one, periodic review of operations; judgement of graph one for: clarity, readability, and completeness of information; graph two, cumulative strategic review; questions for graph two, cumulative strategic review; judgement of graphical format two for: clarity, readability, and completeness of information; and the evaluation of reporting systems for financial information (see Appendices A.1 - A.10).

These booklets were made for two groups. Group 1 began the
Graphicacy Test with a combination dot/line graph format and Group 2 began with a combination bar/line graph then the formats alternated for the rest of the experiment. Each page was stamped with a subject-identification number. The booklets, a page of blank paper, and a blank return envelope were placed in a sealed envelope for each identification number.

Experimental Group Assignment:
Subjects were randomly assigned to two groups. A set of 40 code numbers were listed and group I or group II were randomly assigned to each code number. The first 15 subjects were listed alphabetically and then assigned to the code numbers. Then, as subjects were contacted, they were assigned consecutive code numbers. I conducted the experiment with twenty-six individual subjects, four pairs of subjects, and two groups of three subjects.

Dependent Variables:
The dependent variables were (a) proficiency of search, (b) completion time and (c) preference for format measured when two graphical formats were presented.

(a) Proficiency of Search
Graph One presented a condensed report of the monthly financial information followed by fifteen questions which required five searches at level one, five secondary searches, and five third
level searches. Subjects made two context-specific judgements of the information. Graph Two presented the same information computed in cumulative totals, and made the same requirements of search and similar context-specific judgements. The correct responses were totalled for each level of search.

(b) Time to Complete:
The subjects wrote the time they began, the time after each set of questions requiring first, second and third search levels, and the time they finished all the questions for each task. They used individual stop-watches with digital displays of minutes and seconds. The displays of hours and tenth of seconds were covered with masking tape to minimize distractions. In the pre-experiment instructions they were told to copy their beginning times from the stop-watch into boxes above question one, and again whenever they saw "TIME: _:_:_:_" on the experimental pages.

I recorded the time concurrently, using an identical stop-watch. The timing was kept as unobtrusive as possible. I sat opposite the subject at the same table and matched their actions of writing down the time. If a subject was interrupted while doing the experiment, the interruption time was noted and subtracted from the total time later. The volunteers had few interruptions and none affected the timing during the completion of the levels of search in the experiment. I computed the completion times for
Bar/line vs dot/line 66

each subject.

There were some minor discrepancies in timing. Some subjects wrote the beginning time before they started to look at the graph or questions, some wrote after they had studied the graph, and some wrote the time when they felt they were ready to select the first answer. I did not time the first three subjects and their stop-watches did not have the hours and tenths of seconds readout covered.

(c) Preference for Format:
Preference evaluations were made with each presentation of a graphical format after Pretest 1 and 2, and after Graphical presentation one and two, and in summary ratings at the close of the experiment. The subjects rated each graph format used for (1) clarity, (2) readability, and (3) completeness of the information. They also indicated their choice of format for the experiment and for presenting information in their own organizations.

3.07 Statistical analysis:
The SPSS for MS Windows release 6.0 software was used for all statistical analysis.

Graph One:
I used multivariate analysis of variance, MANOVA, to determine if
(a) proficiency of search, or (b) the elapsed time to complete the responses differed between groups of subjects at the three search levels. Hotellings Multivariate Tests of Significance (S = 1, M = 1/2, N = 17) tested the group effect. An overall F-test of the differences between the groups reading either the bar/line of the dot/line format. The critical F-ratio for 3 and 36 degrees of freedom was 2.88. Univariate F-tests with (1,38) D. F. were used to indicate whether the Group effect of using either combination bar/line or dot/line graphical formats was different at one or all of the levels of search. The critical F-ratio at 1 and 40 degrees of freedom was 4.08. An alpha level at 0.05 was used to assess the effect size and observed power for both multivariate and univariate tests.

The same statistical procedures of MANOVA and Hotellings Test were also used to analyze Group effects on preference for either format in judgements of: clarity, readability, or completeness of the information.

**Graph Two:**

The analysis was repeated for Graph Two for (a) proficiency of search, (b) time to complete, and (c) preference of format.

Learning was controlled in two ways, by presenting the same information in periodic and cumulative accounts for the two tasks and by counterbalancing the order of presentation format.
Group I had the periodic dot/line graph first and the cumulative bar/line graph format second; Group II had periodic bar/line first, cumulative dot/line graphical format second.

**Within-subject Analysis:**
In the measurement of choice, the same subjects were randomly assigned to graph format group at the pretest and alternated formats thereafter. It was judged that when subjects had experienced both formats they would be better able to make an informed choice and multiple measures would give plausible information. The effects of progression through the experiment were examined graphically in Box Plots. The subjects' choice of format for the experiment and for the presentation of financial information in their own organizations was tallied and the frequencies were reported.

**Covariates:**
I looked at the statistical effects of perceived familiarity with graphical presentations, factors of experience, and graphicacy as they were measured before the experiment using The Graphicacy Test and the background questionnaire. The subjects' perceived familiarity with graphical presentations of financial information was their self-rating on a five-point Likert-scale. Weighted totals of educational, board and financial experience, measured on the Background Questionnaire, were combined for a measure of Experience. Graphical reading ability as measured by The
Graphicacy Test was scored as the total number correct out of ten. These variables were then correlated with the outcome variables of proficiency, time to complete, and preference for both graphical presentations in a 2-tailed test of significance with an \( \alpha \) level of .05.

In this study, experience affecting graphic proficiency was considered to be any one or a combination of education, work experience with financial data, and experience as a trustee on a Board. The correlation coefficients between the outcome variables from using both graphical formats and the information collected on the background survey was examined for values above .8 that would indicate a high correlation.

**Visual Analysis:**
Graphs were prepared from the summary statistics to aid visualization of the data. Bar/line graphs were used to show comparisons of means for each graph presentation. Line graphs were used to show the trends for the two formats for proficiency, completion times and preference ratings. Bar graphs presented the ratings of each graph format for accuracy and satisfaction, and frequency data on choice of formats.

**SUMMARY OF METHODOLOGY AND DESIGN:**
The design was experimental, with random assignment of subjects
to two groups. The single independent variable was presentation format, either combination bar/line or dot/line graphs. The dependent variables were (a) proficiency and (b) completion time for the three levels of search and (c) preference for format. The setting was in a hospital boardroom or in the subjects' offices using 40 volunteer subjects who were all members of boards of trustees.

The experiment was divided into two presentations of graphical formats. Combination bar/line and dot/line graphs were made using data from St. Vincent's Health Care Society's financial report for Reporting Period 8, November 5, 1992. "Mercy Hospital" was the fictitious name used in the experiment. Group I viewed the information presented in a dot/line graph for Graph One and in a bar/line graph for Graph Two. Group II reversed the order of graphical formats. Graph One presented the information with totals for each reporting period. Graph Two presented the same information computed in cumulative totals. With each Graph the subjects answered multiple choice questions which required five searches at Level 1 for details, five searches at Level 2 to understand relationships, and five searches at Level 3 to use the information about trends in the data. Subjects recorded the time as they proceeded through the experiment and the elapsed times were calculated.

Multivariate analysis of variance (MANOVA) was used to evaluate
time of completion and proficiency of search for the two graphical formats for the three levels. Graphs were prepared of the summary statistics to aid visualization of the data.

The preference for the formats was rated on Likert scales. The subjects experienced both formats and evaluated the formats for the clarity, readability, and completeness of the information given. MANOVA was used to examine readers' rating of these three elements of preference for the two formats. They also rated the accuracy of the formats and their overall satisfaction. The subjects' choice of format for Mercy Hospital, for the experiment, and for presentation of financial information in their own organizations were tallied.

The subjects were pretested with a modified version of The Graphicacy Test (Wainer, 1980) and they completed a Background Questionnaire to give a measure of their financial and educational experience. The Graphicacy Test and experience variables were correlated to outcome variables of the two graphic presentations but were not used as covariates in analysis of covariance.

Chapter Four reports the results of the statistical tests and a summary of the written and oral comments. The demographic data collected on the subjects and the results of the Graphicacy Test are tested for their value as covariates in the analysis.
Chapter Four

RESULTS

In this chapter, the characteristics of the sample are discussed first; then, the results are organized as two separate graphical presentations - Graph One and Graph Two. Graph One presented the information in periodic totals under the title: Graph One Periodic Review of Operations. Graph Two presented the same information in cumulative totals under the title: Graph Two Cumulative Strategic Review. With both graphical formats, the group effect represents the presentation of financial information by either dot/line or bar/line combination format. With Graph One, Group I read the dot/line and Group II read the bar/line. With Graph Two the formats were crossed, Group I used the bar/line and Group II used the dot/line.

With Graph One, the two formats were compared at the three levels of search using measures of a) proficiency, the sum of correct responses and b) elapsed time to complete. Also, the two formats were compared on c) three aspects of preference: clarity, readability, and completeness of the information. The same analysis was completed with Graph Two, for the second graphical presentation.

Data collected before and during the experiment were compared. The Graphicacy Test, given as a pretest, was analyzed for
proficiency, time to complete, and preference variables. The effects of individual differences in Graphicacy, education, board and work experience were examined through correlational analysis. Graphs were made to show the means and frequencies of subjects' responses for visual analysis. Oral and written comments are summarized. The chapter ends with a summary of the results.

4.01 Demographics and Characteristics of the Sample:
The study took place in the greater Vancouver area of B.C. where, traditionally, boards of trustees have been given the responsibility to govern acute care hospitals, extended care facilities, and related health care agencies. The study invited volunteers from the staff and boards of St Vincent's Health Care, The Burnaby Hospital, Youville Residence, Delta Hospital, and Dogwood Lodge. All volunteers were members of boards of trustees of organizations receiving government funds.

Forty people, 17 men and 23 women, filled in a background survey before beginning the experiment. They ranged in age from 38 to 81, although the average age was 53. Only one subject had not completed High School and only one held a PhD. Twenty-nine had a Bachelor's Degree. Twenty-nine subjects indicated their education had included some financial background and 24 of the 40 said they had taken some financial courses. One person had taken 15 courses in finance but the average number of courses taken was
four. Fourteen people had no work experience in accounting, finance or administration. Ten people had an average of 14 years each of work experience in finances and 21 people had an average of ten years experience each in administration; six people had work experience in both. Although seven people reported a year or less experience on a board, and five reported more than 18 years on a board, the average of the sample was 8.7 years experience serving on a board.

Serving on the executive of a board might give more expertise in finances than just being a board member. Twenty-eight of the subjects had been executives of their organizations, and five had served in all three offices responsible for finances: chairman, treasurer, and as a member of the finance committee.

Assignment to Experimental Conditions:
The 40 subjects were randomly assigned to two groups; 20 in Group I and 20 in Group II. The two groups were almost equal in the aspects of gender and age. Group I had ten males and ten females with an average age of 54. Group II had seven males and thirteen females with an average age of 53.

4.02 Graph One - Periodic Review of Operations:
The goal of the first graph presentation was to review Mercy Hospital's financial report looking at periodic totals for
Reporting Period 8. Group I read the information in a dot/line combination graph and Group II read a bar/line combination graph. The results of the first graphical presentation were analyzed for (a) proficiency of search, (b) time of completion, and (c) format preference.

(a) Graph One - Proficiency of Search

To test proficiency of search, the subjects answered five items at each level of search and the correct responses were totalled. The three levels of search are: (1) search for details, (2) search for relationships, and (3) search for trends. The means, presented in Table 3 and Figure 10, for the two groups were compared at the three search levels. Group II, reading the bar/line format, consistently had a higher mean response in acquiring and understanding details, relationships and trends in the data. The standard deviation was about one and a half responses except for the bar/line graph in the search for trends. The graph (Figure 10) shows that the difference between the two formats is greatest for level two.

Table 3

<table>
<thead>
<tr>
<th>SEARCH LEVELS</th>
<th>GROUP I DOT/LINE</th>
<th>GROUP II BAR/LINE</th>
</tr>
</thead>
<tbody>
<tr>
<td>LEVEL 1 - SEARCH FOR DETAILS</td>
<td>3.2 (1.44)</td>
<td>3.6 (1.64)</td>
</tr>
<tr>
<td>LEVEL 2 - SEARCH FOR RELATIONSHIPS</td>
<td>2.85 (1.39)</td>
<td>3.45 (1.50)</td>
</tr>
<tr>
<td>LEVEL 3 - SEARCH FOR TRENDS</td>
<td>3.8 (1.36)</td>
<td>4.0 (1.64)</td>
</tr>
<tr>
<td>AVERAGE MEAN</td>
<td>3.28</td>
<td>3.68</td>
</tr>
</tbody>
</table>
A MANOVA revealed that the difference between the two groups was not statistically reliable. The probability of the F-tests (p) for the three levels are higher than .05. However, care must be taken in rejecting the hypotheses because the group reading the bar/line graphical format was more proficient at the three levels of search than the group reading the dot/line format. The difference between the formats was not detectable due to low power and there is a possibility of making a Type II error if the hypotheses is rejected. The effect size and power to detect differences were low for this sample. The results are summarized in Table 4.
Table 4

Graph one - The Effect of Graphical Format on Proficiency of Search

<table>
<thead>
<tr>
<th>Test Name</th>
<th>Value</th>
<th>Exact F</th>
<th>Hypoth.DF</th>
<th>Error DF</th>
<th>Sig. of F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hotellings</td>
<td>.046</td>
<td>.55</td>
<td>3</td>
<td>36</td>
<td>.65</td>
</tr>
</tbody>
</table>

Multivariate Effect Size and Observed Power at .05 Level

<table>
<thead>
<tr>
<th>Test Name</th>
<th>Effect Size</th>
<th>Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hotellings</td>
<td>.044</td>
<td>.15</td>
</tr>
</tbody>
</table>

Univariate F-tests

<table>
<thead>
<tr>
<th>Variable</th>
<th>MSe</th>
<th>F (1,38)</th>
<th>p</th>
<th>Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>PROFICIENCY OF SEARCH:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LEVEL 1 - DETAILS</td>
<td>2.36842</td>
<td>.68</td>
<td>.42</td>
<td>.16</td>
</tr>
<tr>
<td>LEVEL 2 - RELATIONSHIPS</td>
<td>2.09211</td>
<td>1.72</td>
<td>.20</td>
<td>.25</td>
</tr>
<tr>
<td>LEVEL 3 - TRENDS</td>
<td>1.18947</td>
<td>.34</td>
<td>.57</td>
<td>.06</td>
</tr>
</tbody>
</table>

(b) Graph One - Time to Complete:

To test for the time to complete the three levels of search, the time was noted at the beginning and at the end of each set of items at each level, and the elapsed time was compared for the two groups. The large Standard Deviations of the means, all more than a minute, reflect the wide range of completion times and may indicate some inefficiency in the timing procedures. The total time to complete the questions with Graph One ranged from 431 seconds to 1706 seconds. At each search level, lower mean-scores indicate, on average, the group is faster. The groups were very similar when searching for details and trends but Group II, using the bar/line, format was slightly faster when searching for
Bar/line vs dot/line

relationships, as is shown in Table 5 and Figure 11.

Table 5

<table>
<thead>
<tr>
<th>SEARCH LEVELS</th>
<th>GROUP I</th>
<th>GROUP II</th>
</tr>
</thead>
<tbody>
<tr>
<td>DOT/LINE</td>
<td>MEAN S.D.</td>
<td>MEAN S.D.</td>
</tr>
<tr>
<td>LEVEL 1 - SEARCH FOR DETAILS</td>
<td>261.53 (107.5)</td>
<td>265.1 (158.7)</td>
</tr>
<tr>
<td>LEVEL 2 - SEARCH FOR RELATIONSHIPS</td>
<td>276.79 (102.6)</td>
<td>251.65 (103.6)</td>
</tr>
<tr>
<td>LEVEL 3 - SEARCH FOR TRENDS</td>
<td>206.84 (118.2)</td>
<td>182.6 (86.0)</td>
</tr>
</tbody>
</table>

Figure 11. Graph One - Mean elapsed times for three search levels.

A MANOVA indicated that the significance of the F statistics (p) are all above the .05 level. This means that for this graphic presentation and sample size, we cannot detect the difference of the effect of the two graphical formats on the speed of reading at the each search-level. Descriptive statistics are presented in Table 6.
Table 6

Graph One - The Effect of Graphical Format on Time of Completion at Three Levels of Search

Multivariate Tests of Significance (S = 1, M = 1/2, N = 17)

<table>
<thead>
<tr>
<th>Test Name</th>
<th>Value</th>
<th>Exact F</th>
<th>Hypoth. DF</th>
<th>Error DF</th>
<th>Sig. of F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hotellings</td>
<td>.035</td>
<td>.41</td>
<td>3</td>
<td>35</td>
<td>.77</td>
</tr>
</tbody>
</table>

Multivariate Effect Size and Observed Power at .05 Level

<table>
<thead>
<tr>
<th>TEST NAME</th>
<th>Effect Size</th>
<th>Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hotellings</td>
<td>.034</td>
<td>.12</td>
</tr>
</tbody>
</table>

Univariate F-tests

<table>
<thead>
<tr>
<th>Variable</th>
<th>MSE</th>
<th>F (1.38)</th>
<th>p</th>
<th>Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>TIME OF COMPLETION:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LEVEL 1 - DETAILS</td>
<td>18552.5</td>
<td>.006</td>
<td>.94</td>
<td>.04</td>
</tr>
<tr>
<td>LEVEL 2 - RELATIONSHIPS</td>
<td>10635.67</td>
<td>.58</td>
<td>.45</td>
<td>.14</td>
</tr>
<tr>
<td>LEVEL 3 - TRENDS</td>
<td>7920.25</td>
<td>.72</td>
<td>.40</td>
<td>.16</td>
</tr>
</tbody>
</table>

(c) Graph One - Preference of format

After answering the question with Graph One the subjects rated their format on five-point Likert-scales for clarity, readability, and completeness of presenting the information. If a subject gave a high rating of four or five it means that they liked the graph they worked with. Three and above are positive ratings of preference to the format. The means for the group using the bar/line format was higher than the means for the group using the dot/line format for all judgements of preference. As is shown in Figure 12, Group II rated the bar/line graphical format higher than Group I rated the dot/line format for clarity,
readability and completeness of presenting the information.

Table 7

Graph One - Means and Standard Deviations for Preference of Bar/line or Dot/line Format

<table>
<thead>
<tr>
<th>JUDGEMENT OF PREFERENCE</th>
<th>GROUP I DOT/LINE</th>
<th>MEAN S.D.</th>
<th>GROUP II BAR/LINE</th>
<th>MEAN S.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLARITY</td>
<td>2.1 ( .79)</td>
<td></td>
<td>2.75 (.79)</td>
<td></td>
</tr>
<tr>
<td>READABILITY</td>
<td>2.45 ( .76)</td>
<td></td>
<td>3.0 ( .65)</td>
<td></td>
</tr>
<tr>
<td>COMPLETENESS</td>
<td>3.1 (1.12)</td>
<td></td>
<td>3.35 (.99)</td>
<td></td>
</tr>
</tbody>
</table>

Figure 12. Graph One - Mean ratings of preference.

The statistical analysis (MANOVA), in Table 8, shows the bar/line graph is rated significantly higher than the dot/line graph with Graph One for clarity and readability of the information, and although the rating of completeness of the information was also higher for the bar/line graph, it is not an emphatic distinction.
Table 8

Graph one - The Effect of Graphical Format on Preference for Format

<table>
<thead>
<tr>
<th>Test Name</th>
<th>Value</th>
<th>Exact F</th>
<th>Hypoth.DF</th>
<th>Error.DF</th>
<th>Sig. of F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hotellings</td>
<td>.02</td>
<td>2.52</td>
<td>3</td>
<td>36</td>
<td>.07</td>
</tr>
</tbody>
</table>

Multivariate Effect Size and Observed Power at .05 Level

<table>
<thead>
<tr>
<th>TEST NAME</th>
<th>Effect Size</th>
<th>Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hotellings</td>
<td>.174</td>
<td>.57</td>
</tr>
</tbody>
</table>

Univariate F-tests

<table>
<thead>
<tr>
<th>Variable</th>
<th>MSerror</th>
<th>F (1.38)</th>
<th>p</th>
<th>Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>PREFERENCE OF FORMAT:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CLARITY</td>
<td>.61974</td>
<td>6.82</td>
<td>.01</td>
<td>* .72</td>
</tr>
<tr>
<td>READABILITY</td>
<td>.49868</td>
<td>6.07</td>
<td>.02</td>
<td>* .67</td>
</tr>
<tr>
<td>COMPLETENESS</td>
<td>1.11447</td>
<td>.56</td>
<td>.46</td>
<td>.14</td>
</tr>
</tbody>
</table>

(* p < .05)

4.03 Graph Two - Cumulative Evaluation

The objective of the second presentation with Graph Two was to look at cumulative totals of budgeted expenses and revenues, actual expenses and revenues, with salary expenses and patient revenues to evaluate the forecasted outcomes to the year end. The same financial data were used to make up bar/line and dot/line graphs showing cumulative totals. The graphical formats were reversed; Group I was presented the information in a bar/line graphical format and Group II was presented the same information in a dot/line graphical format. The results with Graph Two were also analyzed for (a) proficiency of search, (b) time of completion, and (c) format preference.
(a) Graph Two - Proficiency of Search

To test Proficiency of Search the subjects answered five items at each level of search and the responses were totalled. The means for the two groups were compared at the three search levels in Table 9 and Figure 13. The group using the bar/line graph, this time Group I, had a higher average on all three levels of search. When we compare graphs One and Two we see that there were more correct responses with Graph One than with Graph Two, although the general pattern is repeated for both formats (see Figure 14).

Table 9

<table>
<thead>
<tr>
<th>SEARCH LEVELS</th>
<th>GROUP I</th>
<th>GROUP II</th>
</tr>
</thead>
<tbody>
<tr>
<td>B/L LINE</td>
<td>MEAN S.D.</td>
<td>MEAN S.D.</td>
</tr>
<tr>
<td>LEVEL 1 - SEARCH FOR DETAILS</td>
<td>3.2 (1.01)</td>
<td>2.45 (1.28)</td>
</tr>
<tr>
<td>LEVEL 2 - SEARCH FOR RELATIONSHIPS</td>
<td>2.40 (.88)</td>
<td>1.35 (.93)</td>
</tr>
<tr>
<td>LEVEL 3 - SEARCH FOR TRENDS</td>
<td>3.40 (1.27)</td>
<td>2.3 (1.08)</td>
</tr>
<tr>
<td>AVERAGE MEAN</td>
<td>3.0</td>
<td>2.03</td>
</tr>
</tbody>
</table>

Figure 13. Mean correct responses in proficiency of search with Graph Two.

Figure 14. Proficiency of search with Graphs One & Two.
a) Graph Two - Proficiency of Search

A MANOVA revealed the difference between the two sampled groups was statistically reliable for proficiency of search. The effect size and power to detect differences were high at the .05 level. The univariate statistic, in Table 10, revealed that the differences between the two groups using either graph were significant at all three levels of search. This indicated that presenting information in either a bar/line or dot/line graphical format will likely affect the reader's ability to search proficiently for information. With Graph Two, the bar/line graphical format presented information better than the dot/line format, so that the readers could more easily and efficiently find and understand the details, relationships, and trends.

Table 10

Graph two - The Effect of Graphical Format on Proficiency of Search

<table>
<thead>
<tr>
<th>Test Name</th>
<th>Value</th>
<th>Exact F</th>
<th>Hypoth.DF</th>
<th>Error DF</th>
<th>Sig. of F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hotellings</td>
<td>.31</td>
<td>5.43</td>
<td>3</td>
<td>36</td>
<td>.003*</td>
</tr>
</tbody>
</table>

Multivariate Effect Size and Observed Power at .05 Level

<table>
<thead>
<tr>
<th>Test Name</th>
<th>Effect Size</th>
<th>Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hotellings</td>
<td>.312</td>
<td>.91</td>
</tr>
</tbody>
</table>

Univariate F-tests

<table>
<thead>
<tr>
<th>Variable</th>
<th>MSE</th>
<th>F (1,38)</th>
<th>p</th>
<th>Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>PROFICIENCY OF SEARCH:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LEVEL 1 - DETAILS</td>
<td>1.31974</td>
<td>4.26</td>
<td>.046*</td>
<td>.529</td>
</tr>
<tr>
<td>LEVEL 2 - RELATIONSHIPS</td>
<td>.82500</td>
<td>13.36</td>
<td>.001*</td>
<td>.94</td>
</tr>
<tr>
<td>LEVEL 3 - TRENDS</td>
<td>1.39474</td>
<td>8.68</td>
<td>.005*</td>
<td>.82</td>
</tr>
</tbody>
</table>
* p < .05
(b) Graph Two - Time to Complete

To test for the time to complete each level of search, the time was noted at the beginning and at the end of each set of items in each level, and the elapsed time was compared for the two groups. The total time with Graph Two ranged from 342 seconds to 1325 seconds. Group I, using the bar/line graphical format, was faster for searching for relationships but Group II using the dot/line format was faster for searching for details and trends as is shown in Table 11.

No consistent pattern related to graphical format emerges when we compare the means with both graphs in Figure 16. The times for both graphs are very close in searches for details and trends. There is a wide variation in the times taken to read and understand the relationship with the two graphical formats.

Table 11

<table>
<thead>
<tr>
<th>SEARCH LEVELS</th>
<th>GROUP I</th>
<th>GROUP II</th>
</tr>
</thead>
<tbody>
<tr>
<td>LEVEL 1 - SEARCH FOR DETAILS</td>
<td>313.4 (127.78)</td>
<td>299.65 (129.47)</td>
</tr>
<tr>
<td>LEVEL 2 - SEARCH FOR RELATIONSHIPS</td>
<td>178.8 (48.42)</td>
<td>216.65 (122.28)</td>
</tr>
<tr>
<td>LEVEL 3 - SEARCH FOR TRENDS</td>
<td>218.25 (70.22)</td>
<td>198.7 (103.23)</td>
</tr>
</tbody>
</table>
Figure 15. Mean elapsed time for three search levels with Graph Two.

Figure 16. Time to Complete with Graphs One and Two.

Further analysis (MANOVA) showed that the differences between the groups for any of the times to complete reach a level of significance with the alpha level of .05. The statistics are presented in Table 12.

Table 12

Graph two - The Effect of Graphical Format on Time of Completion at Three Levels of Search

<table>
<thead>
<tr>
<th>Test Name</th>
<th>Value</th>
<th>Exact F</th>
<th>Hypoth.DF</th>
<th>Error DF</th>
<th>Sig. of F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hotellings</td>
<td>.11</td>
<td>1.30</td>
<td>3</td>
<td>36</td>
<td>.29</td>
</tr>
</tbody>
</table>

Multivariate Effect Size and Observed Power at .05 Level

<table>
<thead>
<tr>
<th>TEST NAME</th>
<th>Effect Size</th>
<th>Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hotellings</td>
<td>.098</td>
<td>.32</td>
</tr>
</tbody>
</table>
(Table 12 continued)

Univariate F-tests

<table>
<thead>
<tr>
<th>Variable</th>
<th>MSE</th>
<th>F (1.38)</th>
<th>p</th>
<th>Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMPLETION TIME:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LEVEL 1 - DETAILS</td>
<td>16545.30</td>
<td>1.11</td>
<td>.74</td>
<td>.05</td>
</tr>
<tr>
<td>LEVEL 2 - RELATIONSHIPS</td>
<td>8648.94</td>
<td>1.66</td>
<td>.21</td>
<td>.24</td>
</tr>
<tr>
<td>LEVEL 3 - TRENDS</td>
<td>7793.21</td>
<td>.49</td>
<td>.49</td>
<td>.11</td>
</tr>
</tbody>
</table>

(c) Graph Two - Preference of format

To test for preference of format with Graph Two the subjects rated the formats on three Likert scales for clarity, readability, and completeness of presenting the information, then the means of the two groups were compared. Again, the group using the bar/line graphical format gave a higher rating than the group using the dot/line format for clarity, readability, and completeness. As is shown in Table 13, generally the bar/line graphical format was rated 3 and the dot/line format was rated 2 out of a possible 5. However, the dot/line graphs were rated on the negative side of the likert scale indicating the subjects felt confused. Both groups rated the bar/line graph similarly for the three areas of preference (Figure 18).
Table 13

Graph Two - Means and Standard Deviations for Preference of Bar/line or Dot/Line Format

<table>
<thead>
<tr>
<th>JUDGEMENT OF PREFERENCE</th>
<th>GROUP I</th>
<th>GROUP II</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BAR/LINE</td>
<td>DOT/LINE</td>
</tr>
<tr>
<td>CLARITY</td>
<td>2.55 (.83)</td>
<td>1.75 (.79)</td>
</tr>
<tr>
<td>READABILITY</td>
<td>2.85 (.59)</td>
<td>2.1 (.85)</td>
</tr>
<tr>
<td>COMPLETENESS</td>
<td>3.4 (.99)</td>
<td>2.8 (1.24)</td>
</tr>
<tr>
<td>AVERAGE MEAN</td>
<td>2.9</td>
<td>2.2</td>
</tr>
</tbody>
</table>

Figure 17. Mean ratings of preference with Graph Two.

Figure 18. Preference ratings with Graphs One and Two.

In Table 14, the MANOVA discloses that the overall difference between the two groups, and the higher average rating of clarity
and readability are statistically significant at the .05 level, but the judgement of completeness is not. These statistics replicate the findings for Graph One indicating both groups agree that the bar/line graph is clearer and more readable.

Table 14

Graph Two - The Effect of Graphical Format on Preference for Format:

<table>
<thead>
<tr>
<th>Test Name</th>
<th>Value</th>
<th>Exact F</th>
<th>Hypoth.DF</th>
<th>Error DF</th>
<th>Sig. of F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hotellings</td>
<td>.35489</td>
<td>4.25865</td>
<td>3</td>
<td>36</td>
<td>.011*</td>
</tr>
</tbody>
</table>

Multivariate Effect Size and Observed Power at .05 Level

<table>
<thead>
<tr>
<th>TEST NAME</th>
<th>Effect Size</th>
<th>Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hotellings</td>
<td>.262</td>
<td>.82</td>
</tr>
</tbody>
</table>

Univariate F-tests

<table>
<thead>
<tr>
<th>Variable</th>
<th>MSe</th>
<th>F (1,38)</th>
<th>p</th>
<th>Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>PREFERENCE OF FORMAT:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CLARITY</td>
<td>.65</td>
<td>9.85</td>
<td>.003*</td>
<td>.86</td>
</tr>
<tr>
<td>READABILITY</td>
<td>.54</td>
<td>10.50</td>
<td>.002*</td>
<td>.88</td>
</tr>
<tr>
<td>COMPLETENESS</td>
<td>1.26</td>
<td>2.85</td>
<td>.100</td>
<td>.38</td>
</tr>
<tr>
<td>* p &lt; .05</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4.04 Evaluation and Choice of Formats:

When subjects were asked to evaluate the two graphical formats for accuracy and overall satisfaction they rated the bar/line graph higher than the dot/line graph for both, as is reported in Table 15. A t-test indicated the differences are significant at a .05 level.
Table 15
Evaluations of Graphical Formats for Accuracy and Overall Satisfaction.

<table>
<thead>
<tr>
<th>FORMAT</th>
<th>ACCURACY MEAN S.D.</th>
<th>SATISFACTION MEAN S.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>DOT/LINE GRAPH</td>
<td>2.19 (.78)</td>
<td>1.87 (.84)</td>
</tr>
<tr>
<td>BAR/LINE GRAPH</td>
<td>3.23 (.90)</td>
<td>3.08 (1.22)</td>
</tr>
</tbody>
</table>

Figure 19. Ratings for accuracy and overall satisfaction.

When subjects were asked to choose between dot/line and bar/line graphical formats they overwhelmingly chose the bar/line format. They were asked to recommend a choice for the Mercy Hospital Board (the fictitious hospital in the experiment), for themselves to do this experiment, and for their own organization to present financial information. Sixteen subjects chose the bar/line graph for all three organizations and one subject chose the dot/line format for all three. Usually, when they chose the `other`
category, they indicated that they wanted to receive either explanatory comments or a combination of graphs plus numbers in tabular formats. The tally is given in Table 16.

Table 16
 Choices of Formats for Presenting Financial Information

<table>
<thead>
<tr>
<th>CHOICE FOR:</th>
<th>FORMAT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Bar/Line</td>
</tr>
<tr>
<td>Mercy Hospital:</td>
<td>19</td>
</tr>
<tr>
<td>The experiment:</td>
<td>29</td>
</tr>
<tr>
<td>Own organization:</td>
<td>21</td>
</tr>
</tbody>
</table>

Figure 20. Frequencies of Choice of Format for "Mercy Hospital", for the experiment, and for subjects' own organization.

4.05 Correlation Coefficients to examine possible covariates:

The Graphicacy Test:

Both presentations of the Graphicacy Test were analyzed to discover if it would be a good pretest of graphic reading ability. The bar/line format produced slightly higher mean-
scores than the dot/line in proficiency of search and preference ratings for both pretests and the subjects reading the bar/line took slightly longer to complete their responses than the subjects reading the dot/line graph (see Tables A.6, A.7, and A.8 in Appendix 13). However, there were few errors and all of the mean scores and ratings were high. There was not enough variance captured to isolate the differences between subjects or between formats. In statistical analysis (MANOVA), none of the differences between the means reached a level of significance to indicate there was a statistical difference between the two groups when they read either graphical format in The Graphicacy Test.

The outcome variables with both graphical presentations were compared with the Graphicacy Test totals of proficiency, time, and preference in correlational analysis (see Table 20). To compare the groups when they used the same graphical format Pretest 1 and Graph One; Pretest 2 and Graph Two were parallel. There were statistically significant correlation coefficients at the .05 level for 3 of the 6 search levels of proficiency, 2 of 6 search levels for elapsed time, and for completeness of information ratings with Graph One, but the highest correlation was only .51. A correlation coefficient above .80 would indicate that the graphicacy of the subjects accounted for a large part of the differences in the outcome variables. None of the correlations reached this cut-off value, as is demonstrated in
Table 17.

Proficiency scores from the Graph One presentation were compared with proficiency scores from the Graphicacy Test as a covariate. It was found that the lines of regression were significantly different. This violated an essential assumption of covariance analysis. The means could not be adjusted because the slopes of the regression lines were not parallel and it was confirmed that the measurements from the Graphicacy Tests could not be used in an analysis of covariance (See Appendix A13).

Perceived Familiarity with Graphs:
Generally, the subjects thought they were somewhat familiar with graphs for presenting financial information, a rating of four out of five on the Likert Scale. Five rated themselves extremely familiar, a rating of five, and three rated themselves extremely unfamiliar with graphs, a rating of one. "Perceived familiarity with graphs" produced very low and sometimes negative correlations to the outcome variables with both Graphs One and Two. Therefore, the subjects' prejudgment of their competence with graphs was not a useable covariate.
The second premise of the experiment was that higher education levels and/or experience with financial management would give readers the knowledge to be more selective in searching and more competent in understanding the information. Experience with financial management was judged to be represented in years of work experience in finance or

Weighted Work, Board, Education and Total Experience
administration or years of service on a board. There were few significant correlations between the outcome measures and either graphical presentations with the weighted variables of work experience, board experience, educational experience or total experience. None of the correlations were above .8. Years of work experience was negatively correlated to time to complete and board experience also was negatively correlated to many of the measures. None of the variables of experience, as measured in this experiment, correlated highly enough with the dependent variables to be useful covariates, as is demonstrated in Table 18.
### Table 18
Correlation Coefficients Between Graph One and Two Outcome Variables with Weighted Work Experience, Board Experience, Educational Experience, and Total Experience Variables.

<table>
<thead>
<tr>
<th>OUTCOME VARIABLES</th>
<th>WORK</th>
<th>BOARD</th>
<th>EDUCATION</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>GRAPH ONE</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PROFICIENCY:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DETAILS</td>
<td>.1759</td>
<td>-.0897</td>
<td>.3134</td>
<td>.1723</td>
</tr>
<tr>
<td>P= .278</td>
<td>P= .582</td>
<td>P= .049*</td>
<td>P= .288</td>
<td></td>
</tr>
<tr>
<td>RELATIONSHIPS:</td>
<td>-.2379</td>
<td>-.0675</td>
<td>.3529</td>
<td>-.0705</td>
</tr>
<tr>
<td>P= .129</td>
<td>P= .679</td>
<td>P= .026*</td>
<td>P= .666</td>
<td></td>
</tr>
<tr>
<td>TRENDS</td>
<td>.0581</td>
<td>.0954</td>
<td>.1264</td>
<td>.1470</td>
</tr>
<tr>
<td>P= .722</td>
<td>P= .558</td>
<td>P= .442</td>
<td>P= .366</td>
<td></td>
</tr>
<tr>
<td><strong>GRAPH TWO</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PROFICIENCY:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DETAILS</td>
<td>-.0453</td>
<td>-.0804</td>
<td>.2189</td>
<td>-.0018</td>
</tr>
<tr>
<td>P= .781</td>
<td>P= .622</td>
<td>P= .175</td>
<td>P= .923</td>
<td></td>
</tr>
<tr>
<td>RELATIONSHIPS:</td>
<td>.1248</td>
<td>-.0337</td>
<td>-.0380</td>
<td>.0458</td>
</tr>
<tr>
<td>P= .443</td>
<td>P= .836</td>
<td>P= .816</td>
<td>P= .775</td>
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</tr>
<tr>
<td>TRENDS</td>
<td>.0802</td>
<td>.0472</td>
<td>.1958</td>
<td>.1559</td>
</tr>
<tr>
<td>P= .623</td>
<td>P= .772</td>
<td>P= .226</td>
<td>P= .377</td>
<td></td>
</tr>
<tr>
<td><strong>GRAPH ONE</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TIME:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DETAILS</td>
<td>-.1116</td>
<td>.0108</td>
<td>-.3564</td>
<td>-.1951</td>
</tr>
<tr>
<td>P= .499</td>
<td>P= .948</td>
<td>P= .026*</td>
<td>P= .234</td>
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<tr>
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<tr>
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<tr>
<td>TRENDS</td>
<td>-.1516</td>
<td>.0549</td>
<td>.0570</td>
<td>-.0414</td>
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<tr>
<td>P= .357</td>
<td>P= .740</td>
<td>P= .730</td>
<td>P= .802</td>
<td></td>
</tr>
<tr>
<td><strong>GRAPH TWO</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TIME:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DETAILS</td>
<td>-.0099</td>
<td>.1758</td>
<td>.0620</td>
<td>-.0991</td>
</tr>
<tr>
<td>P= .852</td>
<td>P= .278</td>
<td>P= .704</td>
<td>P= .863</td>
<td></td>
</tr>
<tr>
<td>RELATIONSHIPS:</td>
<td>.0596</td>
<td>-.1827</td>
<td>.2879</td>
<td>-.0530</td>
</tr>
<tr>
<td>P= .715</td>
<td>P= .259</td>
<td>P= .072</td>
<td>P= .745</td>
<td></td>
</tr>
<tr>
<td>TRENDS</td>
<td>.0271</td>
<td>.0603</td>
<td>.2823</td>
<td>.1616</td>
</tr>
<tr>
<td>P= .868</td>
<td>P= .711</td>
<td>P= .078</td>
<td>P= .319</td>
<td></td>
</tr>
<tr>
<td><strong>GRAPH ONE</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PREFERENCE:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CLARITY</td>
<td>-.3108</td>
<td>-.0139</td>
<td>.0579</td>
<td>-.2346</td>
</tr>
<tr>
<td>P= .051</td>
<td>P= .932</td>
<td>P= .723</td>
<td>P= .145</td>
<td></td>
</tr>
<tr>
<td>READABILITY:</td>
<td>-.4006</td>
<td>-.0406</td>
<td>.0272</td>
<td>-.2999</td>
</tr>
<tr>
<td>P= .010*</td>
<td>P= .804</td>
<td>P= .867</td>
<td>P= .060</td>
<td></td>
</tr>
<tr>
<td>COMPLETENESS:</td>
<td>-.1748</td>
<td>-.0112</td>
<td>.0362</td>
<td>-.1088</td>
</tr>
<tr>
<td>P= .281</td>
<td>P= .945</td>
<td>P= .825</td>
<td>P= .504</td>
<td></td>
</tr>
<tr>
<td><strong>GRAPH TWO</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PREFERENCE:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CLARITY</td>
<td>-.2525</td>
<td>-.1418</td>
<td>-.2272</td>
<td>-.3428</td>
</tr>
<tr>
<td>P= .116</td>
<td>P= .383</td>
<td>P= .169</td>
<td>P= .020*</td>
<td></td>
</tr>
<tr>
<td>READABILITY:</td>
<td>-.1531</td>
<td>-.0201</td>
<td>.4291</td>
<td>-.2721</td>
</tr>
<tr>
<td>P= .546</td>
<td>P= .902</td>
<td>P= .006*</td>
<td>P= .083</td>
<td></td>
</tr>
<tr>
<td>COMPLETENESS:</td>
<td>-.1437</td>
<td>.0706</td>
<td>.1635</td>
<td>.0084</td>
</tr>
<tr>
<td>P= .389</td>
<td>P= .674</td>
<td>P= .327</td>
<td>P= .969</td>
<td></td>
</tr>
</tbody>
</table>
4.06 Summary of observations, written, and oral comments:

Observations:

Fourteen subjects used paper, pen or fingers as rulers.

Eleven subjects converted some data points to numbers and did calculations. Not everyone wrote out comments but most did.

Many people chatted while they were working and everyone had comments to make when they were finished. The following gives examples of the most common comments.

Many realized that they were unfamiliar with the numbers being represented:

"Most difficulties because of when working with new information for the first time...Because it was unfamiliar... I'm a data analyst... I liked the dot for the monthly - but I wasn't familiar with the numbers.... I prefer tables... you get a sense of what is happening over time...I'm not used to this scale of dollars"

There was some confusion with the lines on the combination graphs:

"It is not clear if patient revenues are part of total revenues...so I'll say somewhat clear...I didn't like it too much." (Subject was using the dot/line graph.)

Some wanted a further explanation:

"I'd like to get statement accompanied by a graph. We get quarterly statements and a detailed statement at year end."

"Difficult to read without guidance I would like actual facts - presented by the financial officer in charge."

"We sometimes get it in bar graphs, but then they are explained
Bar/line vs dot/line 97

orally. I like it when they explain even though no one asks."

"...need a combined approach. Material must be presented in many ways. I like to ask questions of person who is responsible."

"I need someone there to tell me where they are... People are there (board meeting) for the evening... people do not read it (finance report) before... they rely on intelligence at the moment... I'm a computer programmer but I didn't like this!"

I do better at oral things. I like an explanation of the finances."

Many readers wanted actual numbers:

"Bar graph is a help... I like to look at actual numbers and compare to year before and to budget. Numbers are meaningless unless you marry them to the activities in the hospital. need to look at patient days, for example... or certain departments and then key finances with activities of the hospital or you will be fooled."

Many wanted a combination of graphs and other presentation methods:

"a graph is only as good as the information that accompanies it... It is not a board members place to struggle to interpret... I set a budget plan... as we go through the year... and anything that happens I want to know an explanation why... was it something to meld into the budget?... and affect the plan that has been done?... so just to show a graph of ups and downs... There aren't comparisons that are sufficient for me... need more by hospital program... board has to ask questions... they should be getting an explanation of what is happening and why there are variances..."

Many didn't like dot graphs:

"Dot graph really tough to read... as I get older my eyes... may not see... In part bar graphs used darker lines... better than light dotted lines"

"I found the dot graph difficult to understand."
"I'm more used to tables. Boy is this awful (dot/line graph)! I found myself... I got bored quickly ...I wasn't familiar with the terms... More comfortable with bars - more familiar."

"Those dots were impossible!... The axis are wrong... I want the periods along the bottom and the dollars up the side... I glassed over when I saw it... The bar graph was more familiar... I want to get the "gestalt"... but I found graphs didn't give me enough detail for the questions... The questions asked for detail."

"That was tough stuff... it is not clear... the dots are sooo close... Boy, a ruler would sure help - but I wouldn't have one in a board meeting... so I can't tell. Is this called a dot graph? B000 Hisssss... You can stuff that in your ... I should write board - I'll resign."

"Don't understand this graph - visually offensive!"

Two subjects confused the open dot with a zero:

"... dot is zero... means zero revenue?"

"I would hand this back... Actual is black... are expenses... and zeros are revenues... actual is black?..."

Some found it hard to decide the exact values shown by dots:

"It is hard to see the dots... I found it hard to look at the dots and I had to keep looking at the bottom to see which one was expenses ... I couldn't remember."

"I assume that's 'under' and not 'at' (pointing to the o for April and trying to decide how close it was to the average line.)"

"I can't see an amount... I'll put down "Small amount".

"are we talking the end of the dot or the middle of the dot or the back of it?... Is this a rain drop?..."

"... Are they equal - these little dots... it is hard to tell... although they started equal at the beginning of the year... I don't know how to read this... A line has a stopping point but the dot
Unfamiliarity was a common comment against dot graph. Twelve people commented on this:

"That was interesting! Dot graphs... never seen before... not familiar with them. I had to think... This (pointing to bar graph) said more to me... where revenues and expenses were in relationship to the budget and year end... I'm more comfortable with this."

"I've never seen it presented... never seen financial information for hospitals this way. I think it would be the easiest way to do it because you can see where you are going. I would have to get used to graphs, but it would suit me."

"Interesting... Had to feel your way around the graph to know which way you are going... Graphs are more of a guide... You need to have training... but if you had the training you would be able to use them..."

"I think it is what you are used to... I can look at figures and see if they are more or less... but on this I can't... especially when you are not used to it... I found it difficult... but the bars are easier... In the end if you were familiar... When you look at the dots it is a question where to draw the line... I guess the bar is more accurate."

"I will understand it eventually... This is the future, isn't it?... I'm a novice at this sort of thing."

However, a few liked the dot graph, a little:

"I like dots... Felt I needed a ruler with bar graph, maybe it was because I read it (dot graph) across."

"I definitely want tables of numbers and would like a dot graph as an aid."

"Well I like the dot graph... but I'm not going to give it full marks [Then rated it 3, 3, and 1]."
The most vociferous subject on seeing the dot/line graph ranted for 5 minutes and refused to do the questions with Graph One. When he turned the page and saw the bar/line graph, he did continue with the experiment. I was able to write down only a small part of his comments:

"This hospital is in trouble if these are the reports we run! Am I supposed to work these out?.....harder to read......not used to work with these graphs....wouldn't do it!......maybe if I had some training on using these graphs... but I like to see the figures. I guess if I had lots of time to look at it, and study the trends, and figure which one was what, but with the timer going and knowing time meant something, I just couldn't do it! I think board members would have to have an education to use graphs. If we decided to go with graphs, we would have to introduce it to them right, and show what the numbers meant on the graph. I guess I'm just too old for graphs, I like to see the variance. I work out my own figures, and I make sure I understand it!"

The comment that summed up most people's feelings...

"Dot?..definitely not!"

4.07 Summary of Chapter Four

Forty volunteers took part in the study; 17 men and 23 women; their average age was 53. The majority held a Bachelor Degree. The subjects averaged ten to fourteen years of work experience related to finance and eight years of experience on a board of trustees. They were randomly assigned to two groups of twenty.
In all examinations of the means of the measures taken, the group using the bar/line graphical format was higher than the dot/line format, but the difference did not always reach statistical significance. In the first graphical presentation, the bar/line graph was not significantly better for presenting information for proficiency of searching for details, relationships or trends nor were there any statistical significant differences in speed of completing the three levels. With Graph One, there were significant differences in preference ratings of the graphical format for clarity and readability, however the rating of completeness of the information was not statistically significant.

In the second graphical presentation, the group using the bar/line graph was significantly higher than the group using the dot/line graph for proficiency at all three levels of search. However, at each level the time to complete the questions was not significantly different for the two graphical formats. The Preference ratings followed the same trend as with the first graphical presentation; the ratings for clarity, and readability were significantly higher for the bar/line format but the rating for completeness of the information was not significant.

The Graphicacy Test was significantly different in proficiency of search in the two times of administration, but there was a ceiling effect in the comparisons between the two groups. The difference between the two graph types was not significantly different for
proficiency of search, time to complete, or total ratings of preference.

None of the variables of experience or graphicacy, as measured in this experiment, correlated highly enough with the dependent variables to be useful covariates. Perceived familiarity with graphical formats also was not significantly related to the outcome measures of either graphical presentation.

The oral and written comments supported the preference ratings of the two graphical formats. The bar/line graphical format was chosen for the experiment and for reporting financial information in the subjects's own organizations. The comment that summed up most people's feelings... "Dot?..definitely not!"

The final chapter describes the conclusions reached related to the original issues. Alternate conclusions and limitations are identified and the implications for practice are noted.
Chapter Five

DISCUSSION

This chapter discusses the main findings and their implications, the results that support previous research, and some surprising results. The limitations of the study are reviewed. Recommendations for practice and suggestions for further research are then proposed.

Context of the Experiment:
The ability to generalize the results to the population of "real-world" health care governors should be recognized. This study solicited active board members of health care organizations, gave them real data in a natural setting, and asked questions that challenged their understanding of the financial report. This provided ecological validity and helped to assure the findings would have relevance in practice. All the subjects agreed that finances should be presented in an organized summary. They were eager to discuss the issues of presenting the information graphically, so their statements and final comments were collected. When the comments of the trustees are added to the statistical inferences made from the data it suggests that the understanding of financial reports can be facilitated by presenting information in a bar/line graphical format.
5.1 Main Findings of the Study:

a) First Hypothesis:

Generally, the performance of the subjects when reading the bar/line graphical format suggested the rejection of the null hypothesis. The first hypothesis, that there is no difference between the effects of combination bar/line or combination dot/line graphical formats on the proficiency of search for details, relationships and trends to understand forecasts was rejected for the second presentation of the graphical formats. When the totals were presented cumulatively, the group using the bar/line format was statistically higher in proficiency at all three search levels (p < .05).

The bar/line format presented information so that the subjects were more proficient in searches for details, relationships and trends both times the subjects read graphs. In every comparison of the dot/line and bar/line graphical formats for proficiency the mean correct response with the bar/line format was higher. In practical terms, as is noted in Table 10 and Figure 13, the difference is about one more correct search out of a possible five.

Combination Graphs:

It is readily apparent that all combinations of graph types are not equal. There are three possible answers as to why the bar/line was superior to the dot/line format in this experiment.
The first argument involves the difference in the salience of bar and dot graph types. Readers viewing the dot/line graph have more errors and repeatedly gave the dot/line format a significantly lower rating for clarity and readability. The two graphic formats under study emphasize information differently which may account for differences found in the search and use of information. Bars gave an emphatic impression of size whereas the dotted line may have given a broken gestalt. Perhaps readers relied on the image of volume to make decisions of the relative amounts of the resources. It may be that presenting dollar values with a shape and size helped readers to compare quantities. Tufte (1990) suggests that graphics should convey a spirit of quantitative depth and "emaciated data-thin design provoke suspicions about quality of measurement and analysis" (p. 32). The light dotted lines may not have portrayed a distinct whole quantity.

The solid data-lines were more emphatic than the light dotted lines and may have been given priority over the dotted lines in the initial reading of the graph. Readers may give priority to heavy marks (Kosslyn, 1989). Jarvenpaa (1990) found that when subjects used graphical displays the information with the greatest physical difference was acquired first. This might affect the effectiveness of dot/line displays if data-lines displaying complementary information interfere with the first impressions of the data presented by the end-dots in the graph.
Secondly, the contrast between the type of information that lines and bars characteristically present well gives a clearer distinction than does the information characteristically presented by lines and dots. The communicative power of graphic display is enhanced by visual contrast (Jarvenpaa, 1986). Bars allow comparisons between two quantities and lines show trends. These are complementary functions when presenting information. Therefore bar/line graphs would have the qualities to answer questions about relationships or trends and further, about trends in relationships. If the basic-level constituents are easily identified and interpreted, this will lead to evaluations of the overall organization of the display (Kosslyn, 1989). In the immediate viewing of the bar/line graphs, relationships given by the bars and trends given by the lines combine to give an organized summary to the readers.

Both line and dot graph types characteristically show trends well and the dot/line combination may have given redundant effects instead of aiding comparisons. Kosslyn (1989) says that the capacity of short term memory is notoriously limited. In decoding the dot/line graphs, readers may have mentally connected the end dots to "see" trends in expenses and revenues but then were not able to hold this vision in working memory and also make comparisons to trends shown by data-lines.
Thirdly, dots that were close together presented reading problems. This is evident in the comments and complaints made by the subjects and in their reduced ability to make correct decisions.

Readers had trouble deciding on the value that the dot format indicated because they were not sure whether to read the centre of the dot or the outer edges. When comparing two data points where the dots were close in value, the amount of space between was difficult to judge because of the rounded edges, and when dots were close together, the roundness of the edges may have suggested overlapping and equal properties more than the distinct edges of the bars. As one person commented: "When you look at dots it is a question of where to draw the line."

As was suggested by Higgins (1989), combination graphs appeared to improve the efficiency of presenting information. Readers using the bar/line format found and understood the information in order to answer on average more than three of the five queries for details, relationships and trends tested in both presentations.

Graph Characteristics
This study has reinforced the earlier findings that combination graphs retain some of the basic characteristics of the merged graph types. In their taxonomy of graphic characteristics Tan and Benbasat (1990) maintained that line graphs excel at showing
trends. Both formats used lines to display the same data. Trends were shown to be speedily found and proficiently understood in both combination formats. There were fewer errors and the time of completion was faster in searches for trends than in searches at the other levels with both graphic presentations. Although fewer errors were associated with the bar/line format in the present experiment, both combined formats allowed readers to anchor on axis labels to direct their search for elementary acquisition of details. There was less variation between the two formats in mean time to complete searches for details than in mean time to complete questions concerning relationships or trends.

b) Second Hypothesis
The second hypothesis that there is no difference between the effects of combination bar/line or combination dot/line graphical formats on preference for a format was generally rejected for both presentations of the graphs. The subjects' ratings of the bar/line format for clearness and readability were statistically significant in evaluations after the two presentations (p < .05).

Measurement of Preference:
Preference, in this study was not just a measure of opinion. When all the measures are taken together and the final choice is made, an actual preference is indicated. It is interesting that, as predicted by cognitive theories (Anderson, 1982), subjects
chose the format that they were most successful with, the bar/line graph. In their judgments of the graphs after each use, both groups of trustees rated the bar/line format clearer and more readable. In this study, we initiated the subjects' preference goals by asking them to rate the formats immediately after having used them, for clarity, readability, and completeness of the information. By repeating the rating of the formats, their final choice should have reflected their perception of the format that helped them the most to investigate and comprehend the material.

Graph One presented periodic totals and Graph Two presented cumulative totals. With Graph Two, the cumulative totals resulted in very small discernable differences, and, as is indicated in Table 13 and Figure 17, the bar/line format was judged to be clearer and more readable. This is an important distinction in the evaluation of the two graphical formats. When the information was presented so that readers had to make comparisons of small differences the bar/line format was preferred over the dot/line.

c) Third Hypothesis

The third hypothesis, that individual differences in graphicacy and educational, financial or board experience would not affect readers' preference for a format, proficiency, or time to complete searches of information could not be rejected. None of
the correlation coefficients between the experience variables and the outcome variables showed a critical influence.

**The Graphicacy Test**

It was disappointing to note that The Graphicacy Test did not serve as a useful covariate to remove adult individual differences. This test was designed to examine the combination bar/line with other combination formats and the questions were theoretically based on the three levels of search. However, the captured variation with adult readers was not high enough to warrant analyzing the results with graphicacy as a covariate. The differences in the means between the two formats in Pretest 1 were only 2% for proficiency, 26 seconds elapsed time, and 1.3% for total preference; the differences were similar for Pretest 2. These results show that there was a ceiling effect, in that there were few errors.

The Graphicacy Test was first designed for children and used weather information. Even with modifications, adults found it very easy. The test could be further revised for adults if each graph presented more weather information to allow additional comparisons. Temperature, humidity, and wind information could be added. The pretest did not fully assess the subjects' preexisting ability to read graphs because the information was too simple. Still, the Graphicacy Test did relate to the outcome variables better than perceived familiarity and these results
hold the promise that perhaps an expanded Graphicacy Test would be valuable in future research.

**Relevant Experience:**

Experience on a board or financial work experience (as measured in this study) did not greatly effect subjects' ability to search for and understand information. This sample of volunteers had a wide variety of professional backgrounds, as do most public boards. It was expected that they would give a different and more realistic measure of experience than the college students who were used in previous research. The years of work or board service should have acquainted the individuals with the basic information to relate to new financial data, to spot inconsistencies or to formulate questions. It appeared that the form the information was in was stronger than the experience of the reader in determining the learning from the experimental displays. Perhaps the present financial reporting formats to boards and years of financial or administrative work predisposes readers to financial tables, not to expertise in financial study. An engineer, who found the experiment easy, felt that his training helped him to understand and relate to graphs. It is possible that work requiring visual analytical skills or jobs that require consulting schematic drawings might affect readers' ability to understand graphs and would serve as a more relevant experience factor.
Perceived Familiarity with Graphs

My findings empirically support Hard's (1989) in her study with university students: perceived familiarity with graphs was not a good indicator of proficiency in an experiment. This study asked subjects who were all board members, but who had a variety of backgrounds, the same question, and analysis indicated that there was little correlation of perceived familiarity with graphs to any of the outcome variables. The one significant correlation to a time measurement (p < .05) could be explained by chance relationships between numbers. By combining the findings of both studies it could be concluded that perceived graphic familiarity is not a good indicator of graphic proficiency.

5.2 Unexpected findings:

Relationship Comparisons:

I did not find a linear relationship between the difficulty level of searches for details, relationships and trends. Wainer (1980) found that with different levels of search, as the level of search increased the difficulty also increased. It was expected that graphical formats would show relationships better than details and trends better than relationships (Carswell et al, 1993; Guthrie et al, 1993; Pinker, 1983; Wainer, 1980, 1992), but when we examine the graphed lines of proficiency in Figure 14 they are not straight, but v-shaped, indicating a non-linear relationship. The subjects had more correct responses in
searches for details and trends than relationships at the two presentations using both graphical formats.

In the literature (Golen & Linn, 1985; Macdonald-Ross, 1977; Tan & Benbasat, 1991; Wright, 1977) it has been agreed that bar graphs would be superior for depicting relationships and following the same logic dot graph formats should also show relationships well. One explanation for the opposite findings in this study is that when looking at complex graphs, the relationship between two data points may be more difficult to isolate. The "real information", taken from actual hospital reports, did not provide large differences between expenses and revenues. To find the greatest difference over the year meant evaluating the gaps between the lengths of the bars or between the two dots on a line over 13 reporting periods. Initially people had to find the largest gaps, and then they had to estimate which was the largest of two or three possibilities. If the reporting periods were not side by side, that is, in two consecutive reporting periods, they then had to mentally move two sections of the graph together or eliminate the information between before making a comparison. The subjects may have had difficulty in transposing images with the dot/line and, to a lesser degree, with the bar/line formats to compare relationships between expenses and revenues.

The group using the bar/line graph did better than the group
using the dot/line at finding relationships. When comparing both graphs the mean of the groups is higher with the bar/line format. This may mean that the bar/line presented a stronger image that made comparisons easier, or that it was easier to convert the ends of the bars to numbers on the scale to make comparisons.

Open End-dots Were Confused With Zeros

The end-dots may have presented interpretation problems to readers. Einhorn and Hogarth (1981) explain that in judging similarity people attend more to common features. Open dots are like zeros, so perhaps this was not a suitable symbol to portray dollars. Readers who interpreted the open dot as a zero, or nothing, would not then be able to think of the dot relating to a quantity of dollars on the scale. There should be only one way to interpret graph symbols (Kosslyn, 1989). The study may have revealed unwanted interpretations of end-dots of the dot/line graph.

Accuracy of Graphs

Statistics and people's comments revealed that the dot/line graphs were not superior for decision accuracy. Both groups experienced both formats before they rated them for accuracy and overall satisfaction. Accuracy is one attribute on which graphs are often criticised. In their evaluation of the formats, the subjects rated the bar/line graph significantly higher
statistically in accuracy than the dot/line (p < .05). Their judgment of the graphs, reported in Figure 18 and Tables 7 and 13, shows that they were not completely satisfied with either format, but they preferred the bar/line graphs over the dot/line.

5.3 Implications:

People Need Training to Use Graphs:
One speculation that several subjects made in their comments was that people need training to use new graphical formats. In the survey of hospitals conducted as background to the experiment, none of the hospitals surveyed used graphs to present financial information. There were consistently more errors with the dot/line than with the bar/line graphical format. People commented on their unfamiliarity with dot graphs and said they felt they would do better with more experience with both of the formats. Several subjects were observed using the scrap paper, their fingers, or pens as a ruler. Eleven subjects converted some of the data to numbers and did calculations rather than make spatial judgements. Training to develop graphicacy skills to evaluate patterns might improve readers' proficiency and confidence.

Need to Compare Tabular Formats:
With a larger group, tabular formats could have been contrasted
to the two graphical formats in this study and more comparisons would have been possible. This experiment does not address the issue of how the present tabular format compares to the two formats tested. The health care literature suggested there are problems with the present practices and the comments of the volunteer trustees indicate that they felt graphs would improve the tabular presentations. However, still many wanted some form of actual numbers. Information was presented in bar/line and dot/line and the results are limited to these two formats.

A common comment was that trustees would like a combination of graphs and financial comment, either in summarized numbers or words from the financial officer or the financial committee of the board. Trustees come to the boards with different areas of expertise. Some have no financial background, and rely on the expertise of an accountant on the board or the financial officer to direct their monitoring of financial information. These trustees may have expertise in the services being provided or may be more aware of the needs of their community. Together they set the budget to agree with the demands for services and the resources available. All agree that they want to receive summarized information. Graphs, by the nature of converting numbers to visuals, consolidate facts. In light of these findings, we could investigate if a similar group of trustees would respond to the bar/line and dot/line graphs in the same way when they compare presentations of the two combination formats.
with and without tables. Essentially, we want to discover if the trustees would make different decisions about the allocation of resources or be more confident, when they used graphs.

5.4 Limitations of the Study:

Effect Size and Statistical Power:
The limitations of the study centre on the effect size in the first graphical presentation. Statistical power was low with Graph One. With both graphs the means of the group using the bar/line format were higher than the group using the dot/line however the differences were not statistically detected. With Graph Two the power was .91 whereas the power was .15 with Graph One. To avoid making a Type II error with the first graphic presentation, rejecting the null hypothesis when there is a true difference between the two groups, we should replicate the study with a larger group. Rough calculations using the means and MSe reported with Graph One, with tables derived from the Pearson Hartley functions, would indicate a sample size of 75 to 100 would give statistically significant results (Glass & Hopkins, 1984). The power of the F-statistic would be above the critical F-value in the larger sample measuring the same effect size that was obtained in this experiment.

More Pilot Testing
In retrospect, more testing of the questions asked might have
provided better instruments for detecting the effect size of the first graphical presentation. It is important to note that both formats have more correct responses with Graph One than the bar/line format with Graph Two (See Figure 14). This may indicate that the level of difficulty of the items with the two graphs should be balanced. If Graph One had more difficult questions associated with it then perhaps the effect size of the analyses would be larger and a statistically significant result would be achieved.

Limitations of Timing:
There was not a great difference between the elapsed times with one graphic format over the other. There were many possible reasons for inaccuracy. Comprehension time for the two graphs is difficult to separate from the total time taken. There were no controls over the subjects' time spent reading and talking. The time taken to read and understand the questions or to make comments were not isolated in this experiment. These component activities, although necessary to the experiment, may limit the measurement of efficiency.

However, I am not sure more accurate timing methods would improve this experiment. Reading graphs on computers is not a common practice to most trustees. To put the experiment on computer may have meant including computer training as well. Video taping of the experiment would have meant a very complicated set-up that
might have eliminated meeting the volunteers in their own offices. Time in this experiment may have been a factor of perceived ease and would be included in considerations of the preference ratings. In practical considerations, seconds do not count as much of an advantage in volunteer reading time.

More Research on the Effects of the Time of Day:
A practical suggestion for future research may be to look at the effects of time of day in a natural setting. Several volunteers complained that their appointment was so late in day they had trouble thinking clearly. I'm sure that they would not be able to read their financial reports from their own organization always at a time when they were well rested. But perhaps with further study we could find the best time of day to schedule meetings for trustees.

5.5 Recommendations:
It would be worthwhile to replicate this study with graphs that used different contrasts. White bars and dots were not read well. Some readers complained that they did not see the white bars for a while and two subjects first read the open dot as a zero. This suggests that open bars and dots do not have enough salience to register as well as dots and bars that are filled in. Perhaps when there is too much contrast in the visual intensity, there is a possibility of overlooking the lesser element. There
should be a logical relationship to shading in bars and ultimate contrast may have to be sacrificed.

**Perceived Speed:**

We need theory and more experimentation on the effects of perceived speed with different formats. Perceived speed with a decision aid may affect the choice of one graphical format over another. In the present study, subjects were asked to write down the times as they proceeded through the experiment. This action may have emphasized an advantage of one of the graphical formats that seemed to be faster at revealing the answers to the experimental questions. Comments made indicated that the subjects were aware of their slowness or fastness in comprehending the graphs.

**5.6 Summary of the Experiment:**

In the present experiment the subjects were given a summarized picture of the year-to date and the forecasted year-end. The multiple choice questions directed them at first to search the information for specific values of expenses and revenues; next, to find comparisons of increases, decreases, or variance between the budget and actual; and finally, to explore the past, present and future of each expense and revenue for meaning. In the process of searching the information and looking for similarities and judging the gap between the expected and the real, it was
anticipated that they should arrive at an evaluation of the whole, using their visual sense to intuitively understand patterns and make conclusions.

The subjects were all trustees of health care organizations. It is crucial that Trustees find the details and understand the relationships and trends in the financial reports. This experiment revealed that the information was better comprehended in bar/line than in dot/line formats. Bar/line graphs were preferred and were chosen by readers to present financial information in their own organizations. Many people commented on the need for real numbers. The financial reports to the board could retain some summary figures, but this study would indicate that combination bar/line graphs should be used to present financial information to boards of health care organizations.

The term "proficiency of search" was used to describe the acquisition and use of information. Proficiency was chosen to convey the idea of mastery, of evidence that learning had taken place, learning being the transferring and internalization of information.

It is difficult to teach adults. We provide information, stimulate the need to know, and the individual learns through an internal, personal process. Learning requires more and different information and this information must be available when the need
to know occurs. How information is presented is critical (Jarett, 1993).

There are two approaches to changing decision-making: first, to make current processing practices easier or second, to design formats that guide expert choices (Payne & Bettman, 1993). The purpose of this paper was a practical one - to find a way to help decision-makers by presenting information in graphical formats. The findings in this study hint at a part of the solution. In general, combination graphic designs are accepted and the bar/line graph appeared to show complex data in a way that readers could find, understand, and use details, relationships, and trends.
REFERENCES


GLOSSARY

Anchoring - v. is the process by which specific and diverse parts of an image are segmented by graph readers to act as salient and relevant cues, when extracting information.

Budget - n. is a financial plan that identifies expected expenditures and revenues for a particular time period. It identifies, structures, and allocates resources to provide some service or produce a product over a specified time period.

Decision - n. is a choice of action, based on beliefs, made to achieve goals. Decision accuracy is a measure of a decision requiring a specific quantitative value.

Experimental task - n. The activities a subject is asked to perform within the course of an experiment.

Eye-view - n. is the immediate field of vision; all information taken in at the first instance of viewing.

Financial reports - n. It is standard accounting practice to give trustees monthly reports which include a balance sheet and statement of operations.

Balance sheet - current and fixed assets and liabilities are itemized. Total assets balance (equal) total liabilities.

Statement of operations - An itemized account of revenue and expense for the current reporting period; usually includes monthly and annual budget, year to date totals, and year-end forecasts.


Graph - n. diagram showing the relationship between two variable quantities, measured along one of a pair of axes at right angles.

Graphicity - n. is the ability to read graphs.

Graphical format - n. includes the special design elements
of a graph that distinguishes one form the other.

**Graphicate age** - *n.* is the age when one has achieved a basic understanding of reading and drawing graphs.

**Graphics** - *n.* diagrams used in calculation and design.

**Bar graph** - *n.* A graph using varying lengths of straight narrow rods to represent quantity.

**Combination graphical format** - *n.* One graph merging two or more graph types on one set of axes. A *combination Dot/Line graph* merges a dot graph and a line graph, and a *combination Bar/Line graph* merges a bar graph and a line graph on one set of axes.

**Dot chart** - *n.* A dot chart or graph uses dotted lines that end in a larger circle at the data point. The rows of dotted lines begin at the left edge of the graph, one row for each variable label. The final circle may be open or filled in. Dot graphs follow the convention that ordered variables increase going from left to right on the horizontal scale and from bottom to top on the vertical scale.

**Line graph** - *n.* Horizontal and vertical position of a series of connected points on a graph framework, showing how changes in one quantity are related to changes in another or conveying time series information. Spiked projections indicate accurate data, smooth lines show approximations. Information is reported at fixed intervals not continuously.

**Inference** - *n.* 1. Thing deduced, concluded, implied or suggested 2. the act or an instance of forming a conclusion from facts and reasoning 3. Gaps filled in the representation of the problem in order to extrapolate beyond explicit information.

**Insight** - *n.* 1. Piece of knowledge obtained by mental penetration. 2. The capacity of understanding hidden truths. 3. Sudden realization of a solution, involving reorganization to clarify the problem and suggest a feasible solution.
**Member of a Board of Trustees** - n. is a volunteer, elected or appointed by a non-profit corporate body. Trustees have the responsibility of governing an institution or organization and are legally responsible for: the quality and quantity of service provided, establishing strategic direction, ensuring proper resource management, choosing and evaluating the chief executive, and are accountable to their community.

**Preference** - n. is the inclination to choose a favourite. In this experiment, greatest preference is measured as the highest positive rating on a Likert scale or the selection of one format from a list of formats.

**Problem space** - n. mental representation of all the acquired information, systems and strategies used to solve a problem.

**Process** - n. is a selected series of strategies.

**Proficiency of Search** - n. is a skill measurement of the mastery of finding and using information. In this experiment proficiency of search is measured as the total number of correct responses.

**Salience** - n. quality of prominence, state where some features are more notable because they stand out from surrounding features because of size, intensity or other visual quality.

**Time to complete** - n. is the interval or duration of time from beginning to end. In this experiment it is measured as the total number of seconds to execute responses to experimental test items.
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Re: A study of the effects of presentation format on information acquisition and use.

Dear Trustee:

I am a graduate student in the Department of Education at the University of British Columbia. As partial fulfilment for my Masters of Arts Degree from the Department of Educational Psychology and Special Education I am doing research for a graduate thesis.

I would like you to participate in this research. The purpose of my study is to learn the best way to present information to make it useful to decision-makers.

I am asking you to participate in the study because you are a Board Member of a "QUANGO", a member of the public elected or appointed to oversee a government funded, health or social service society. You will be asked to complete a background questionnaire. Then, you will be given two presentations containing the same financial information. You will review these presentations and respond to questions about the information contained in them. After completing the questions, you will evaluate the usefulness of the reports. The session will take about thirty minutes although there are no time limits.

All information obtained in connection with this study that can be identified with you will remain confidential. You will be assigned a code number and no names will be used. In written reports or publications no one will be identified or identifiable and only summary data will be presented.

Participation in the study is voluntary. If you choose to participate you are free to withdraw from the study at any time without any consequences.
A.2. CONSENT FORM:
Re: A study of the effects of presentation format on information acquisition and use.

You have been asked to participate in a study which will investigate the effects of presentation formats on monitoring financial information. We hope to learn the best way to present information to aid the decision process.

If you decide to participate, you will be asked to complete a background questionnaire. You will then review financial statements and respond to questions about the information in the financial statements. After completing the questions, you will evaluate the usefulness of the reports. The session will take about thirty minutes although there are no time limits.

Any information obtained in connection with this study that can be identified with you will be kept confidential. No names will be used in written reports or publications, and only aggregate data will be presented.

Your decision whether or not to participate will not affect your future relations with the University of British Columbia. If you decide to participate, you are free to discontinue participation in the study at any time and you may withdraw without prejudice after signing this form.

You are making a decision whether or not to participate. Your signature indicates that you have read the information provided above and have decided to participate.

You will receive a copy of this consent form for your own records.

________________________  ______________________
Name - Please Print

________________________  ______________________
Signature Date

How may I contact you? Telephone:____________________________________
Address:______________________________
Fax Number______________________________
A.3.

Instructions to administer experimental instruments.

My name is Darlene Forrester. I am a graduate student at the University of British Columbia. I will be administering this experiment today in partial fulfilment of my Masters degree.

I want to thank you for helping with this study and hope you will benefit by exploring and enhancing your decision-making skills. Plan to work independently on the materials you receive. Please do not talk to your neighbour or others in the room. If you have any questions at any time, please raise your hand and I will answer your question. I will be handing out the materials and explaining the experiment in more detail.

All that you will need is a pen. Please clear the table tops of all other items.

[Pass out experimental envelopes. Each envelope has the subject's name and code number on the outside. Every inside page has the code number only. There is a blank envelope in which to seal the finished papers.] As the materials are being distributed, please leave the packet laying face down until I explain the procedure to you.

[Pass out pens and extra yellow sheets of paper.] This is an extra piece of paper. During the experiment, you may use this extra paper in any way that you wish.

Does everyone have an envelope, extra piece of paper, and a pen?

The first page of the experimental materials is the title page. You can see my name is Darlene Forrester.

Please turn to the next page and complete the Background Questionnaire. If you have any questions about the information being asked, please raise your hand and I will answer your question. When you have finished the questionnaire please stop and wait until you are told to continue.

[Wait until everyone is finished.]

Please turn to the next page which is a Pretest of your
understanding of tables and graphs. There are two parts to this exercise, one set of questions with the information presented in graphs and one with the information presented in tables. You will be asked to rate the formats after you have used them.

There is a space to write the time when you begin and when you finish both sets of questions. Please use the clock at the front of the room not your wrist watch. It is important that everyone use the same time-piece. Please write the time at the top of the page in the blanks provided that look like this. [Point to clock and write the time on a white card so that they can see.] The time now is _ _:_ _:_ _.

When you have finished the pretest, and you see the pink sheet of paper in your package, stop. The rest of the pages are the experiment and I will have some more instructions for you.

[Wait 15 minutes]

Has everyone finished? [If no one indicates that they need more time, continue.] Did you write the time when you finished? The time now is _ _ _ _ _ _ _.

Please turn the page, which begins Section II, Introduction to the Experiment. I will read this page as you follow along. [Read the page.]

Not everyone will be working on the same task. There are 3 parts to the experiment: Part one is called the Review of operations, Part two is called the Strategic Review, and Part three is the Evaluation of the Formats.

When you turn the page to Part One, you will note that the financial information is presented first and the questions follow. You may refer to this financial information as you need to answer the questions. Does anyone have any questions at this point? [Answer questions, then continue.]

Please write the time at the top of the page in the blanks provided as you did in the Pretest.

There are no time restrictions for the remainder of the experiment. Please read the questions and respond to each and every question.
Use as much time as you need. When you have finished, put all your papers in the blank envelope provided, seal it, and hand it in.

The time now is _:_:_.

[When it appears that everyone is finished.] I want to thank you for participating in this experiment. Would anyone like to ask questions about the experiment?

[When no more questions.] Thank you for your help. Here is your copy of the consent form for your records [Give them their copy of the consent form and a thank-you note.].
A.4. Time sheet for experiment

Graph One

Time: _:_:_

Time: _:_:_

Time: _:_:_

Graph Two

Time: _:_:_

Time: _:_:_

Time: _:_:_

R

Time 1: _:_:_

Time 2: _:_:_

Time 3: _:_:_

Time 4: _:_:_

Time 5: _:_:_

S

Time 1: _:_:_

Time 2: _:_:_

Time 3: _:_:_

Time 4: _:_:_

Time 5: _:_:_
A.5

BACKGROUND QUESTIONNAIRE

B1. BIRTH YEAR ____/year

B2. SEX: Male ____ Female ____

B3. I have normal, or corrected to normal, vision. yes ____ no ____

B4. EDUCATION: Check all that apply.

___ (H) High school diploma
___ (A) Certificate or diploma, field of study: ____________
___ (B) Bachelors Degree, specify field of study: _________
___ (M) Masters Degree, specify field of study: ___________
___ (D) PHD, specify field of study: _________________
___ (O) Other, Specify: _______________________________

B5. How many courses in accounting or finance have you completed? _____ courses

B6. Has your past work experience been in accounting, finance, or business administration? yes __ no __
     How many years of experience do you have?
     years experience in finance or accounting __
     years experience in business administration __

B7. How long have you been serving on a Board of Directors?
     _____ months, _____ years

B8. Have you held an executive position on a Board? yes __ no __

B9. If yes, which position(s)?
     Chairman ____ Treasurer ____ Finance committee ____
     please turn the page
B10. Do you receive monthly financial statements from your organization?

yes ____

no ____

B11. Do you receive this information presented in: graphs __

tables __

B12. How familiar are you with graphical presentations of financial information? (Please check one.)

EXTREMELY UNFAMILIAR RATHER UNFAMILIAR SLIGHTLY FAMILIAR SOMEWHAT FAMILIAR EXTREMELY FAMILIAR

_____ (1) _____ (2) _____ (3) _____ (4) _____ (5)

please turn the page
A.6 The Graphics Test

Examine Graph I and then place an X beside the BEST answer:

TNB/L1

TIME: ___ : ___ : ___

NB/L1. How much does it rain in October?

_ a. 95 mm.
_ b. 60 mm.
_ c. 70 mm.
_ d. 83 mm.

NB/L2. Which month has 60 mm. of rain?

_ a. February
_ b. March
_ c. October
_ d. November

NB/L3. Which months have the same amount of rain?

_ a. December & February
_ b. March & May
_ c. June & August
_ d. September & November

NB/L4. How many months have less than the monthly average rainfall?

_ a. 5
_ b. 6
_ c. 7
_ d. 8

NB/L5. Which season has the least rain?

_ a. Winter
_ b. Spring
_ c. Summer
_ d. Fall

TNB/L2

TIME: ___ : ___ : ___

Please turn page...
NB/L6. In which season does the rainfall increase each month?
   ___ a. Winter
   ___ b. Spring
   ___ c. Summer
   ___ d. Fall

NB/L7. Is there more rain in the summer or the fall?
   ___ a. More in summer
   ___ b. More in fall
   ___ c. They are the same

NB/L8. Which month is closest to the monthly average?
   ___ a. April
   ___ b. May
   ___ c. June
   ___ d. July

NB/L9. In New York, as the weather gets colder, there is
   ___ a. more rain.
   ___ b. less rain.
   ___ c. no rain.
   ___ d. constant rain.

NB/L10. In which season does the monthly rainfall vary least from the average?
   ___ a. Winter
   ___ b. Spring
   ___ c. Summer
   ___ d. Fall

Please turn page.
[Mark your judgement of the BAR/LINE GRAPH with an X]

NB/L11. I feel the BAR/LINE graph presented the information....

<table>
<thead>
<tr>
<th>Very Confusingly</th>
<th>Confusingly</th>
<th>Somewhat Clearly</th>
<th>Clearly</th>
<th>Very Clearly</th>
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NB/L12. The readability of the BAR/LINE graph was....

<table>
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<th>Very Difficult</th>
<th>Somewhat Difficult</th>
<th>Easy</th>
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NB/L13. The BAR/LINE graph...

<table>
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<tr>
<th>Had All The Information</th>
<th>Showed Most Of The Information</th>
<th>Showed Some Of The Information</th>
<th>Left Out Some Of The Information</th>
<th>Didn't Have The Information</th>
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Please turn page.
A.7 SECTION II

INTRODUCTION

Please imagine that as a member of the Board of Directors of "Mercy Hospital" you have received the enclosed information with an agenda for the next meeting. The agenda states the board plans to discuss a strategic review of the hospital's operations. They also want your preference for a system for reporting financial information to the board.

The hospital's finances are reported in 28 day intervals which coincide with the payroll dates. The first and thirteenth reporting periods differ in length because the fiscal year start of April 1 may not coincide with a pay day.

The financial reports give actual year-to-date information and forecast the year-end.

Complete the following questions using the Hospital's financial statements which were prepared for the current period.

There are 3 parts to this section,
Part One: Review of Operations
Part Two: Strategic review
Part Three: Evaluation of formats.

When you finish part three you have completed the experiment.

There is no time limit, however don't spend too much time with any one question. Choose the best answer given.
A.8 GRAPH ONE - REVIEW OF OPERATIONS:

TR1

TIME: __: __: __

R1. Match the expense or revenue in LIST A, with its value, for reporting period 8, IN LIST B. Place the item number from LIST A in the spaces provided.

<table>
<thead>
<tr>
<th>LIST A</th>
<th>LIST B</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. ACTUAL TOTAL REVENUE</td>
<td>301 Thousand Dollars</td>
</tr>
<tr>
<td>2. ACTUAL TOTAL EXPENSES</td>
<td>2,849 Thousand Dollars</td>
</tr>
<tr>
<td>3. PATIENT REVENUES</td>
<td>2,371 Thousand Dollars</td>
</tr>
<tr>
<td>4. SALARY EXPENSES</td>
<td>3,106 Thousand Dollars</td>
</tr>
<tr>
<td></td>
<td>2,736 Thousand Dollars</td>
</tr>
</tbody>
</table>

Choose the best answer by placing an X in the space provided:

R2. Mercy Hospital's November 5th. financial report gives information for the...

   ___ a. 8th period out of 13.
   ___ b. mid-point of the budget year.
   ___ c. 5th period out of 12 months.
   ___ d. last 30 days.

TR2

TIME: __: __: __

R3. Which reporting period had the greatest difference between total revenues and total expenses?

   ___ a. period 2.
   ___ b. period 4.
   ___ c. period 6.
   ___ d. period 8.

R4. In the current period, period 8, total actual revenues are...

   ___ a. higher than total actual expenses.
   ___ b. less than budgeted total revenues.
   ___ c. higher than last period.
   ___ d. equal to total actual expenses.

please turn the page
R5. Actual total expenses and revenues were higher than the budget in...
   ___ a. period 1.
   ___ b. period 3.
   ___ c. period 8.
   ___ d. period 7.

R6. How many reporting periods have had equal actual total expenses and revenues?
   ___ a. 0.
   ___ b. 2.
   ___ c. 5.
   ___ d. 8.

R7. The total actual expenses have increased from...
   ___ a. period 6 to period 7.
   ___ b. period 6 to period 8.
   ___ c. 2400 to 2600 thousand dollars.
   ___ d. 2300 to 3100 thousand dollars.

R8. Actual total expenses show the same trends as...
   ___ a. Actual total revenues.
   ___ b. Budgeted total expenses.
   ___ c. Salary expenses.
   ___ d. Patient Revenues.

R9. In each reporting period, salaries are about...
   ___ a. half of total expenses.
   ___ b. equal to patient revenues.
   ___ c. three quarters of total expenses.
   ___ d. double the amount in the first period.

please turn the page
R10. Salary costs are forecasted to...

___ a. increase monthly to the end of the year.
___ b. decrease steadily.
___ c. hold at a constant cost.
___ d. increase again.

R11. Patient Revenues are forecasted to...

___ a. double.
___ b. triple.
___ c. have a slightly higher average.
___ d. equal the difference between salaries and total expenses.

R12. Total expenses or revenues are forecasted to decrease.

___ a. true.
___ b. false.

RT4

TIME: __:__:__

RT13. Should the Mercy Hospital board be concerned with the forecasted financial position?

___ a. yes
___ b. no

What reason would you give for your answer?

___ a. The goal is to have a balanced budget.
___ b. Expenses and revenues are just slightly higher than the budget.
___ c. The forecasted deficit is too large.
___ d. Other??

RT14. Is there enough detail in the information presented?

___ a. yes
___ b. no

TR5

TIME: __:__:__

please turn the page
ND11. I feel the DOT GRAPH presented the information....

<table>
<thead>
<tr>
<th>VERY CONFUSINGLY</th>
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ND12. The readability of the DOT GRAPH was....

<table>
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ND13. The DOT GRAPH....

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Please turn page...
A.9. GRAPH TWO CUMMULATIVE STRATEGIC REVIEW

TS1

TIME: __:__:__

Choose the best answer by placing an X in the space provided:

S1. It is forecasted the year-end cumulated total expenses will be

___ a. higher than the budgeted expenses.
___ b. higher than total revenues.
___ c. higher than budgeted revenues.
___ d. all of the above.

S2. Salary expenses now are almost 18 million dollars. At year end, it is forecasted Salary costs will total almost......

___ a. 30 million dollars.
___ b. 37 million dollars.
___ c. 360 thousand dollars.
___ d. 400 thousand dollars.

S3. Patient revenues reach about $2,500,000.00 in reporting period...

___ a. period 2.
___ b. period 5.
___ c. period 8.
___ d. period 12.

S4. Cumulated total revenues equal cumulated total expenses....

___ a. for year to date.
___ b. at forecasted year end.
___ c. in the budgeted year-end.
___ d. from period 1 to period 7.

S5. It is forecasted the hospital will end the year on a ....

___ a. deficit. How much?_______
___ b. surplus. How much?_______
___ c. a zero balance.

TS2

TIME: __:__:__

please turn the page
S6. The greatest difference between cumulated revenues and cumulated expenses is reported in.....
   ___ a. period 5.
   ___ b. period 6.
   ___ c. period 7.
   ___ d. period 8.

S7. The forecasted total expenses are......13 times the total actual expenses for the first period.
   ___ a. more than
   ___ b. less than
   ___ c. the same as

S8. The difference between total revenue and total expenses is greater for...
   ___ a. actual year to date.
   ___ b. forecasted year end.

S9. The difference between budgeted revenue and budgeted expense is greater for....
   ___ a. actual year to date.
   ___ b. forecasted year end.

S10. From period 7 to period 8 the difference between revenues and expenses has...
    ___ a. increased.
    ___ b. decreased.
    ___ c. stayed the same.
    ___ d. reversed.

S11. How much of the total years revenue has been used to date?
    ___ a. 50 percent.
    ___ b. 60 percent.
    ___ c. 70 percent.
    ___ d. 80 percent.
S12. As the year progresses, cumulated Patient Revenues and Salary Expenses tend to......
   ___ a. fluctuate every reporting period.
   ___ b. maintain the same trends.
   ___ c. increase 10% each reporting period.
   ___ d. decrease towards year end.

S13. Explain the present financial state of Mercy Hospital, as you would to a new board member.

SG14. What is your general impression of Mercy Hospital's finances?
   Things are going....
      ___ a. very well.
      ___ b. satisfactorily.
      ___ c. poorly.

TS4
TIME: __:__:__

SG15. As a Board Member of Mercy Hospital, would you vote to continue support for the actions of management?
   ___ a. yes
   ___ b. no

Comment: ____________________________

SG16. Should the Board of Mercy Hospital ask that financial information be presented in....
   ___ a. Bar/line graphs.
   ___ b. Dot Graphs.
   ___ c. other

TS5
TIME: __:__:__
[Mark your judgement of the BAR/LINE graph with an X]

FB/L11. I feel the BAR/LINE graph presented the information....

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Please turn page...
A.10 PART THREE: Evaluation of Formats

The following questions relate to how you completed the exercises and how you felt about the tasks. Please think about the questions you were asked, the reports you reviewed and how you went about answering the questions.

E1. You were provided with a piece of scratch paper. How did you use that piece of paper? (Check all that apply.)

___ a. I wrote numbers on the paper.
___ b. I did math computations on the paper.
___ c. I used the paper as a ruler.
___ d. I did not use the scratch paper.
___ e. Other

E2. How were you able to determine what the difference was between revenues and expenses?
(Check one response which best describes how you chose the answers with each format.)

___ a. guessed.
___ b. estimated the values and compared numbers.
___ c. imagined a straight line compared to the angles on the graph.
___ d. looked at the patterns of the bars and dots.
___ e. Other

E3. Concerning the questions you were asked to answer, rate your impression of the level of difficulty. (Check the one which best describes your reaction to the tasks.)

EXTREMELY DIFFICULT EASY
(1) (2) (3) (4) (5)

E4. Were you interested in the subject matter?

Bored No Interest Mild Interest Interested Very Interested
(1) (2) (3) (4) (5)

E5. Do you feel that you could remember the financial information presented in the exercises?

Not at All Today Tomorrow Next Week Next Month
(1) (2) (3) (4) (5)
The information has been presented to you in two types of graphs; a combination BAR/LINE GRAPH and a DOT GRAPH. Check the response which best describes your evaluation of the two graphical formats.

E6. How accurately do you feel the DOT GRAPH presented the information?

- Inaccurate (1)
- Somewhat (2)
- Accurately (3)
- More accurate (4)
- Most accurate (5)

E7. How accurately do you feel the BAR/LINE GRAPH presented the information?

- Inaccurate (1)
- Somewhat (2)
- Accurately (3)
- More accurate (4)
- Most accurate (5)

E8. My overall satisfaction with BAR/LINE GRAPHS for making decisions is...

- Ineffective (1)
- Somewhat effective (2)
- Effective (3)
- More effective (4)
- Most effective (5)

E9. My overall satisfaction with DOT GRAPHS for making decisions is...

- Ineffective (1)
- Somewhat effective (2)
- Effective (3)
- More effective (4)
- Most effective (5)

E10. When doing the exercises in this experiment did you prefer...

- a. dot graph
- b. combination bar/line graphs

E11. As a board member, how would you prefer to have the financial information from your organization presented to you?

- a. dot graph
- b. combination bar/line graphs
- c. tables of numbers
- d. other
### A.11 Assignment to Groups

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<th>Treatment #</th>
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<td>28</td>
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<td>29</td>
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<td>30</td>
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<tr>
<td>39</td>
<td>2</td>
</tr>
<tr>
<td>40</td>
<td>2</td>
</tr>
</tbody>
</table>
APPENDIX A.12.

MONTHLY PACKAGE GIVEN TO BOARD OF DIRECTORS IN SIX B. C. HOSPITALS CONTAINED PAGES OF VARIOUS FORMATS, BUT NO FINANCIAL GRAPHS.

HOSPITALS:   #1  #2  #3  #4  #5  #6
TOTAL PAGES   9   10   11  14  17  21
PAGES OF TABLES  7   8  11  9  15  7½
  BALANCE SHEET:  X   X   X   X   X   -
  STATEMENT OF
  OPERATIONS:    X   X   X   X   X   X
% OF REPORT
IN TABLES:  78%  80%  100%  64%  88%  38%

EXPLANATORY
TEXT PAGES   3   2   0   1   2   1
PAGES OF GRAPHS  3x4   0   0   4   0   12½
FINANCIAL GRAPHS  0   0   0   0   0   0

Board members ...  
were expected to read: categories + numbers
  reference notes or numbers/notes
were given: totals, variances, differences, percents,
to find: comparisons, trends, history
  to note: exceptions, sameness, subtotals
to judge veracity of information, whether new policies had
  to be suggested.
  and to relate to past and verify forecasts
A.13. Analysis of The Graphicacy Test:

Pretest Proficiency of Search:

An examination of the means in Table 17, shows that the bar/line format produced slightly higher mean-scores with the simple data in both pretests.

<table>
<thead>
<tr>
<th></th>
<th>GROUP I</th>
<th>GROUP II</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PRETEST</td>
<td>GRAPH FORMAT</td>
</tr>
<tr>
<td></td>
<td>ONE</td>
<td>DOT/LINE</td>
</tr>
<tr>
<td></td>
<td>TWO</td>
<td>BAR/LINE</td>
</tr>
</tbody>
</table>

Pretest - Completion Time:

On the two occasions of the pretest, the bar/line format took slightly longer to read than the dot/line graphical format as is shown in Table 18.

Table A2

A Comparison of Total Time to Complete Pretest One and Pretest Two

<table>
<thead>
<tr>
<th></th>
<th>GROUP I</th>
<th>GROUP II</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td>GRAPH_FORMAT</td>
</tr>
<tr>
<td></td>
<td>ONE</td>
<td>DOT/LINE</td>
</tr>
<tr>
<td></td>
<td>TWO</td>
<td>BAR/LINE</td>
</tr>
</tbody>
</table>
Pretest - Preference for format:

In a comparison of the means of the two groups, reported in Table 19, the bar/line graphical format produced higher total Preference ratings for both Pretests; and the dot/line format was rated higher only for readability on the second pretest.

Table A3

<table>
<thead>
<tr>
<th>Pretests - Preference Ratings of Graphs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>ONE</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>TWO</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

Pretest - Statistical Analysis Results:

In statistical analysis, none of the differences between the means reached a level of significance to indicate there was a statistical difference between the two groups when they read either graphical format in the pretests.
A.14 Analysis of Covariance with the pretests as covariates.

The correlation coefficients between the pretest responses and the Graph One and Graph Two responses were low. Some were statistically significant at the .05 level, but none were above .8, showing a high relationship.

With Graphs One and Two, using the parallel Graphicity Test as a covariate, revealed that groups are significantly different in the regression. This violates an essential assumption of correlation analysis. The slope of the regression lines are not parallel, and so the graphicity tests cannot be used in an analysis of covariance.

Table A4

| TASK ONE - MEANS AND STANDARD DEVIATIONS* FOR PROFICIENCY OF SEARCH AT THREE LEVELS |
|---------------------------------|----------|----------|
| SEARCH LEVELS                   | GROUP I  | GROUP II |
| PROFICIENCY OF SEARCH           | DOT/LINE | BAR/LINE |
| LEVEL 1 - SEARCH FOR DETAILS    | 2.3      | 2.7      |
| LEVEL 2 - SEARCH FOR RELATIONSHIPS | 2.85    | 3.45     |
| LEVEL 3 - SEARCH FOR TRENDS     | 3.8      | 4        |
| COVARIATE - PRETEST ONE         | 8.45     | 8.85     |
Table A5

TASK ONE - PROFICIENCY OF SEARCH AT THREE LEVELS WITH PRETEST ONE

PROFICIENCY OF SEARCH AS A COVARIATE

---

**EFFECT . . WITHIN+RESIDUAL Regression**

Multivariate Tests of Significance \((S = 1, M = 1/2, N = 16 1/2)\)

<table>
<thead>
<tr>
<th>Test Name</th>
<th>Value</th>
<th>Exact F</th>
<th>Hypoth. DF</th>
<th>Error DF</th>
<th>Sig. of F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hotellings</td>
<td>.307</td>
<td>3.59</td>
<td>3</td>
<td>35</td>
<td>.023*</td>
</tr>
</tbody>
</table>

Multivariate Effect Size and Observed Power at .05 Level

<table>
<thead>
<tr>
<th>Test Name</th>
<th>Effect Size</th>
<th>Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hotellings</td>
<td>.044</td>
<td>.15</td>
</tr>
</tbody>
</table>

Univariate F-tests with \((1,38)\) D. F.

<table>
<thead>
<tr>
<th>Variable</th>
<th>MSe</th>
<th>F</th>
<th>p</th>
<th>Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>PROFICIENCY OF SEARCH:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LEVEL 1 - DETAILS</td>
<td>2.36842</td>
<td>.67556</td>
<td>.416</td>
<td>.16093</td>
</tr>
<tr>
<td>LEVEL 2 - RELATIONSHIPS</td>
<td>2.09211</td>
<td>1.72075</td>
<td>.197</td>
<td>.24686</td>
</tr>
<tr>
<td>LEVEL 3 - TRENDS</td>
<td>1.18947</td>
<td>.33628</td>
<td>.565</td>
<td>.05691</td>
</tr>
</tbody>
</table>

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Univariate F-tests with \((1,37)\) D. F.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Error MS</th>
<th>F</th>
<th>Sig. of F</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 LEVEL 1</td>
<td>1.47</td>
<td>10.67379</td>
<td>.002*</td>
</tr>
<tr>
<td>1 LEVEL 2</td>
<td>1.84</td>
<td>6.11220</td>
<td>.018*</td>
</tr>
<tr>
<td>1 LEVEL 3</td>
<td>1.12</td>
<td>3.22166</td>
<td>.081</td>
</tr>
</tbody>
</table>

---

**EFFECT . . GROUP**

Multivariate Tests of Significance \((S = 1, M = 1/2, N = 16 1/2)\)

<table>
<thead>
<tr>
<th>Test Name</th>
<th>Value</th>
<th>DF</th>
<th>Error DF</th>
<th>Sig. of F</th>
<th>Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hotellings</td>
<td>.03409</td>
<td>3</td>
<td>35</td>
<td>.755</td>
<td>.12</td>
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</table>

**EFFECT . . GROUP (Cont.)**

Univariate F-tests with \((1,37)\) D. F.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Error MS</th>
<th>F</th>
<th>Sig. of F</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 LEVEL 1</td>
<td>1.47670</td>
<td>.43359</td>
<td>.514</td>
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<tr>
<td>1 LEVEL 2</td>
<td>1.84403</td>
<td>1.21836</td>
<td>.277</td>
</tr>
<tr>
<td>1 LEVEL 3</td>
<td>1.12377</td>
<td>.14926</td>
<td>.701</td>
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</table>
Table A6

TASK TWO - MEANS AND STANDARD DEVIATIONS* FOR PROFICIENCY OF SEARCH AT THREE LEVELS

<table>
<thead>
<tr>
<th>SEARCH LEVELS</th>
<th>GROUP I</th>
<th>GROUP II</th>
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</thead>
<tbody>
<tr>
<td>PROFICIENCY OF SEARCH</td>
<td>BAR/LINE</td>
<td>DOT/LINE</td>
</tr>
<tr>
<td>LEVEL 1 - SEARCH FOR DETAILS</td>
<td>2.3</td>
<td>2.7</td>
</tr>
<tr>
<td>LEVEL 2 - SEARCH FOR RELATIONSHIPS</td>
<td>2.85</td>
<td>3.45</td>
</tr>
<tr>
<td>LEVEL 3 - SEARCH FOR TRENDS</td>
<td>3.8</td>
<td>4</td>
</tr>
<tr>
<td>COVARIATE - PRETEST ONE</td>
<td>9.4</td>
<td>9.05</td>
</tr>
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</table>

Table A7

TASK TWO - PROFICIENCY OF SEARCH AT THREE LEVELS WITH PRETEST TWO PROFICIENCY OF SEARCH AS A COVARIATE

EFFECT .. WITHIN+RESIDUAL Regression
Multivariate Tests of Significance (S = 1, M = 1/2, N = 16 1/2)

<table>
<thead>
<tr>
<th>Test Name</th>
<th>Value</th>
<th>Exact F</th>
<th>Hypoth. DF</th>
<th>Error DF</th>
<th>Sig. of F</th>
<th>Power</th>
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</thead>
<tbody>
<tr>
<td>Hotellings</td>
<td>.33047</td>
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<td>.017*</td>
<td>.78</td>
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</table>

Univariate F-tests with (1,37) D. F.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Error MS</th>
<th>F</th>
<th>Sig. of F</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 LEVEL 1</td>
<td>.27692</td>
<td>2.27417</td>
<td>.140*</td>
</tr>
<tr>
<td>2 LEVEL 2</td>
<td>.83288</td>
<td>.64040</td>
<td>.429</td>
</tr>
<tr>
<td>2 LEVEL 3</td>
<td>1.23576</td>
<td>5.88875</td>
<td>.020*</td>
</tr>
</tbody>
</table>

EFFECT .. GROUP
Multivariate Tests of Significance (S = 1, M = 1/2, N = 16 1/2)

<table>
<thead>
<tr>
<th>Test Name</th>
<th>Value</th>
<th>Exact F</th>
<th>Hypoth. DF</th>
<th>Error DF</th>
<th>Sig. of F</th>
<th>Power</th>
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<tbody>
<tr>
<td>Hotellings</td>
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<td>5.01279</td>
<td>3</td>
<td>35</td>
<td>.005*</td>
<td>.88</td>
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</table>

Univariate F-tests with (1,37) D. F.

<table>
<thead>
<tr>
<th>Variable</th>
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<th>F</th>
<th>Sig. of F</th>
</tr>
</thead>
<tbody>
<tr>
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<tr>
<td>2 LEVEL 2</td>
<td>.83288</td>
<td>13.80600</td>
<td>.001*</td>
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<tr>
<td>2 LEVEL 3</td>
<td>1.23576</td>
<td>7.54459</td>
<td>.009*</td>
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</table>
**Table A8**

**TASK TWO - THE EFFECT OF GRAPHICAL FORMAT ON PREFERENCE FOR FORMAT WITH PRETEST PREFERENCE AS A COVARIATE:**

<table>
<thead>
<tr>
<th>Test Name</th>
<th>Value</th>
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<th>Hypoth. DF</th>
<th>Error DF</th>
<th>Sig. of F</th>
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</thead>
<tbody>
<tr>
<td>Hotellings</td>
<td>.35614</td>
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<td>.015*</td>
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Multivariate Effect Size and Observed Power at .05 Level

<table>
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<th>Power</th>
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</thead>
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<tr>
<td>Hotellings</td>
<td>.263</td>
<td>.80</td>
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**EFFECT...WITHIN+RESIDUAL Regression**

Univariate F-tests with (1,36) D. F.

<table>
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<th>Variable</th>
<th>MSe</th>
<th>F</th>
<th>p</th>
<th>Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMPLETENESS</td>
<td>1.04968</td>
<td>4.87470</td>
<td>.034*</td>
<td>.571</td>
</tr>
</tbody>
</table>

Univariate F-tests with (1,36) D. F.

<table>
<thead>
<tr>
<th>Variable</th>
<th>MSe</th>
<th>F</th>
<th>p</th>
<th>Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>PREFERENCE OF FORMAT:</td>
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<tr>
<td>CLARITY</td>
<td>.65000</td>
<td>9.84615</td>
<td>.003*</td>
<td>.86254</td>
</tr>
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<td>CLARITY - with covariate</td>
<td>.64574</td>
<td>8.49429</td>
<td>.006*</td>
<td>.80773</td>
</tr>
<tr>
<td>READABILITY</td>
<td>.53553</td>
<td>10.50369</td>
<td>.002*</td>
<td>.88344</td>
</tr>
<tr>
<td>READABILITY - with covariate</td>
<td>.51505</td>
<td>8.85067</td>
<td>.005*</td>
<td>.82345</td>
</tr>
<tr>
<td>COMPLETENESS</td>
<td>1.26316</td>
<td>2.85000</td>
<td>.100</td>
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<tr>
<td>COMPLETENESS - with covariate</td>
<td>1.04968</td>
<td>4.43826</td>
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</table>
A. 15 LETTERS OF PERMISSION FROM J. HARD AND H. WAINER
A 16. Experimental Raw Data

DATA.THE

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<th>10 11 12</th>
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<td></td>
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</tbody>
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01 1 50 F Y 1 . . . . . . . . . . . . 03 Y 15 084 N . . . Y 1 T 4
0047 C A D A A 0200 C A B B B 0327
3 3 2
0407 C B C C A 0508 D B A B B 0550
4 4 2
0853 3 1 4 2 . A 1237 C B D A D
1713 C A C C B 2040 B A . B 2220
3 3 4
2230 D A C C B 1000 3046 A A B B
3354 D B B C B 3811 A W A . 3900
YY Y N N N Y N
3 4 4
02 2 38 F Y 1 1 . . . . . . . . 1 1 01 Y 03 024 N . . . N T 3
0137 C A D A A 0257 C A B B B 0612
4 3 2
0727 B B C C A 0850 D B A B B 1016
3 3 1
1320 3 1 . . 2 4 A 1720 C B D A D
2126 B C C C B 2434 B A . B 2605
2 3 3
2711 D A C B C . . . 3312 D C A B
3759 A B B X B 4305 A W C W 4540
Y N Y Y N N N N
1 2 2
A B . . . A . 3 4 1 2 3 2 1 B . . . D W
03 1 45 F Y 1 1 . . . . . . . . . 1 1 02 Y 08 060 Y . . . Y G . 3
0110 C A D A A 0230 C A B B B 0327
5 4 1
0414 B B C C A 0508 D B A B B 0554
4 4 1
0940 3 1 4 . . 2 A 1240 D B D A D
1603 C C C C B 1909 A A . B 2026
2 2 3
2102 B A D C A $SMA 2349 A A A A
2631 D B B C B 2933 A W A . 3019
Y N N N Y N Y N
3 3 2
112 47 FY 1. 1. 1. 11. 01 N . . 180 Y 3 . Y . T 2
0141 C A D A A 0314 C A B D B 0530
4 4 1
0625 B B C C A 0732 D B A B B 0843
3 3 1
1147 3 . 4 2 1 A 1617 D B D A D
2052 A C C D B 2440 B A . A 2624
3 3 2
2700 D A C D A 25 T 3814 D A B A
4443 C B B X C 4835 B . A . 4905
Y N N N N N N N
1 1 4
A B . D . W B . 3 3 4 1 3 3 1 B . B C .

121 41 M Y 1 1 1 . . . . . . . . . 05 Y 34 28 156 Y 3 2 1 Y G T 4
0008 C A D A A 0149 C A B B C 0252
4 4 1
0735 B B C C A 0837 D B A B B 0948
4 4 1
1209 3 . 4 2 1 A 1554 D B D A D
1857 C C C C B 2142 B A . B 2314
3 3 2
2432 B A C C C . . . . 2853 A A A A
3211 D B B C B 3647 A . C W 3739
Y Y Y Y N N N N
2 3 2

132 44 FY 1 1 1 . . . . . 1 1 . Y . 03 062 Y 3 . . Y . T 3
0150 C A D A A 0320 C A B B B 0450
4 4 3
0552 B B C C A 0725 D B A B B 0832
4 3 1
1312 3 1 4 2 . A 1608 D B D A W
2045 C C C W B 2315 B A . B 2530
2 3 4
2725 A A D W C . . . . 3240 D W B W
3548 A C B . B 3719 A . A . 3746
N N N N N Y N .
1 2 W
. . . D . . C . 3 4 3 2 3 3 1 B . B .

141 31 FY 1 1 . 1 . 1 . . . 11 . N . . 360 Y . 2 . Y . T 5
1551 C C C C B 1925 A D W B 2222
2 2 5
2303 A A C C C .... 2836 D A A A
3116 D C B X C 3942 B W C W 4131
Y Y Y N N N .
1 2 5
A . C . . B . 3 4 3 2 3 3 2 B A B C . W

18 1 30 M Y 1 . . . . . . . . . . . . 1 1 . Y 44 . 312 Y . . 1 Y G T 3
0126 C A D A C 0309 B A B A B 0526
3 4 1
0700 B B C C A 0925 D B A B B 1059
2 3 2
1352 . . . . A 1636 C C D C .
2259 . . C C A 2103 A C . B 2803
2 3 3
2949 . A A D A $200 3920 A . .
4210 D B B . C 4528 B . C W 4638
. . . . . . .
2 2 3
. . . D . . C . 3 3 3 2 2 1 3 A A . . D W

19 2 52 M Y 1 . . . . . . 1 1 1 . . . . 03 Y . 05 001 N . . . N . . 4
0035 C A D A A 0159 C A B B B 0300
4 4 2
0345 B B C C A 0432 D B A B B 0517
5 5 1
0726 3 . 4 2 1 A 1010 D B D A D
1205 C C C C B 1340 A D W B 1452
3 3 3
1528 D A C A A $100 1934 A A . B
2104 D D B C A 2452 A W A . 2530
Y N Y Y Y N N .
3 3 3

20 2 45 F Y 1 . . . . . . 1 1 1 . . . . N . . . 001 N . . . N . . 4
0057 C A D A A 0230 C A B B D 0535
4 4 1
0622 B B C B A 0808 . B A B B 0812
4 4 1
1254 3 . 4 2 . A 1844 D B D A D
2149 C C C C A 2416 B A . B 2522
4 4 2
2613 D A D A A 1000 3020 C B B B
3542 B C B C B 4018 A W A . 4118
Y N Y Y Y N N P
221

2212

173
0447  B  B  C  C  A  0542  D  B  A  B  B  0617
4  4  2
0835  3  1  4  2 .  A  1131  C  B  D  A  B
1406  C  C  C  C  B  1540  B  A . B  1635
2  2  2
1711  C  A  C  A  A ....  1951  A  A  A  B
2104  B  B  A  C  B  2335  A . C  W  2450
Y  Y  N  N  N  N  N  N .
2  2  2
. . . D . . B . 3 4 1 2 3 2 1 B . . C .
25 1  28  M  Y  1 . . . . . . . . . 1 1 03  Y  30 30 180  Y  3  2 1  Y . T  4
0101  C  A  D  A  A  0159  C  A  B  B  D  0323
4  4  1
0415  C  B  C  C  A  0515  D  B  A  B  B  0616
3  3  2
1012  3  2  4 . 1  A  1314  C  B . C  A
1651  C  A  C  C  A  1940  A  D  W  B  2042
1  1  3
2202  D  .  C  B  A  8000  2727  A  . B  B
3013  C  C  B  .  B  3402  .  C  W  3454
N  N  N  N  Y  N  .
1  2  3
A  .  . . . A  . 2 4 1 2 2 2  W  . . D  W
26 2  47  F  Y  1 1 1 1  . . . . . . . 03  Y . 22 001  N  . . Y  . T  4
0114  C  A  D  A  A  0456  C  A  B  B  B  0716
4  4  4
0811  B  B  C  C  A  0915  D  B  A  C  B  1032
4  4  4
1338  3 . 4 2 1  A  1458  . B  D  C  B
1936  C  C  C .  B  2203  A  A . B  2251
2  3  3
2404  . . . . . . . 2704  . .
2820  C  B  C  X  C  2947  B  W  C  . 3042
Y  N  N  N  N  Y  N .
1  1  5
A  B  C  . . E  W  4 3 1 1 4 2 1 B . B  C  D  W
27 2  38  M  1  . . . . . . . . . 01  Y  . 25 180  Y  3  . . Y  G  T  4
0003  C  A .  A  A  0249  C  A  C  B  C  0357
3  4  2
0450  B  B  C  C  A  0542  D  B  A  B  B  0625
3  4  2
0843  .  . 3 2 1  A  1157  C  B  D  C  D
1456  C  C  C  D  B  1727  B  A . A  1816
3  4  2
1756 . A D . C .... 2256 . . . 
2341 . . . C B 2516 A W A . 2700
N N Y N N N N P
2 3 5
... D . . C . 3 3 1 1 4 4 1 B . B . . W
28 2 31 F Y 1 1 . . . . . . . . . N . . 216 Y 3 2 . Y . T 3
0138 C A D A A 0309 C A B B B 0409
5 5 1
0541 B B C C A 0653 D B A C A 0804
5 5 1
1030 . 1 3 2 4 B 1519 D C D A B
1813 C C C C B 2009 B B . B 2048
3 3 2
2139 D A D . A 38 T 2520 B C B B
2803 A A A C B 3118 A W A . 3248
Y N N Y N N N N
2 3 4
... D . W D . 3 5 2 2 5 5 2 B . B ...
29 1 50 F Y 1 1 . 1 . . . . . . . . Y . 10 180 Y . 1 Y . T 2
0036 C A D A A 0145 C A B B B 0242
5 5 1
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4 4 1
0857 3 1 4 . 2 A 1246 C B D A A
1511 C C C C A 1736 A A . A 1855
2 3 2
2030 D A D D A .... 2428 A C A B
2802 D B B C C 3150 B W B W 3252
Y Y Y N N N N .
2 3 2
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30 2 42 F Y 1 . . . . . . . . . . Y 25 . 012 Y 3 2 1 Y G T 4
0007 C A D A A 0119 C A B B D 0234
5 4 1
0321 B B C C A 0414 D B A C B 0450
5 4 1
0706 3 . 4 2 1 A 1003 D C D A B
1241 C C C D B 1412 A A . A 1457
3 3 1
1622 . A C A C .... 1821 D . A A
1935 A A B C C 2150 B . A . 2204
Y Y Y N N N N N
2 2 3
... C . . . D . 3 4 3 2 4 5 2 B . B ...
31 1 55 M Y 1 . . 1 . . . . . . . . N . . 084 Y 3 . . Y . T 2
0106 C A D A A 0224 C A B B B 0328
4 4 2
0430 B B C C A 0544 D B A B B 0630
4 4 2
0936 3 2 4 . 1 A 1220 C B D A D
1547 C C C C B 1714 B A . B 1855
3 3 2
1945 D A C D A 1MIL 2334 A C B A
2607 D B B C B 3042 A W C W 3229
Y Y Y N N N N P
3 2 2
. . D . . D . 3 3 5 3 4 2 2 A A . C D W
32 2 56 F Y 1 1 1 1 . 1 . . . . . 02 N . . 042 N . . Y . T 1
0113 C A D A A 0206 C A B B D 0508
4 4 4
0519 B B C C A 0637 D B A B B 0739
4 3 4
0941 3 . 4 2 1 A 1220 D B D A D
3 3 3
2210 D A C D A $100 2734 A B A A
2934 A B C C B 3213 . W A W 3256
N N Y N N Y N P
3 3 3
33 1 44 F Y 1 . . 1 . . . . . . . . N . . 072 Y 3 . . Y . T 1
0154 C A D A A 0258 C A B B C 0511
3 3 1
0639 B B C C A 0825 D B A . B 1002
4 4 4
1403 3 . 1 2 . A 1810 D B W C W
2327 C C W D B 2901 B B . A 3000
3 3 3
3100 A A C W B NEG 3900 A C . B
4258 D C B . W 4539 W W C . 4622
N N N N N Y N .
3 3 3
34 2 47 M Y 1 . . 1 . 1 1 . . 1 1 02 N . . 036 Y 3 . . Y . T 4
0150 C A D A A 0348 C A A B B 0458
4 4 2
0540 B B C C A 0640 B B A B C 0815
3 3 3
1109 3 2 4 1 . A 1512 D B D C W
2240 C C C D B 2639 B B . A 2734
3 3 2
2856 D A C C C .... 3238 W A W W
3712 A C B C A 4143 A . A . 4209
Y Y Y N N N N P
3 3 3

. . . . . W B . 3 3 2 2 4 4 1 B . B . .

35 2 33 F Y 1 . . 1 . 1 . . . . . . N . . 300 Y 3 . . Y G T 4
0104 C A D A A 0537 C A B A C 1144
3 3 4
1336 B B C C A 1608 D B A B B 1859
3 4 4
2116 3 . 4 2 1 A 2927 D B D A D
3728 C C C C A 4459 A D . B 4840
4 4 4
6139 D W W W W .... 6455 W B W W
6805 D C B . W 7250 B W C W 7502
. . . . . . . .
2 3 3
A B C . . B W 3 3 2 2 3 2 1 B . B . D W

36 2 49 F Y 1 1 . 1 . 1 . . 1 1 1 5 Y 03 05 012 Y . 2 1 Y . T 5
0117 C A D A A 0223 C A B B B 0356
5 5 1
0455 B B C C A 0536 D B A A B 0624
4 4 1
0938 3 . 4 2 1 A 1046 C B D A D
1343 C C C W B 1610 B B . A 1649
4 3 1
1857 . W C W C .... 2458 W W A A
3039 C B B X A 3403 A W A . 3440
Y N Y N N Y N .
1 1 W
. . . D . W B . 4 4 3 2 5 5 1 B . B C . .

37 1 21 F Y 1 1 . . . . . . . . . Y . 20 072 N . . . N . T 1
0002 C A B D B 0120 A B B A C 0225
4 3 2
0541 D B A C A 0639 A B B B . 0808
3 3 2
1339 3 1 . 4 2 . 2314 C C D A B
2850 A A C C B 3149 . A . A 3249
3 3 3
3407 B B A A A 13 3935 A A A A
4140 A B C C B 4335 A W A . 4432
DATA FORMAT:

YN N N N N N
2 3 4

. . . . . . W D . 3 5 4 1 2 2 W . . C . .
38 2 13 M Y . 1 . . . . . . . . . . Y . 30 060 Y . . . Y . T 3
0147 B C A A A D 0347 A A B B C 0504
3 4 3
0843 A B C A A 1012 B B B C B 1113
3 4 3
1430 . 1 3 2 4 A 2506 A A C B A
3255 A C B C B 3711 A B . A 3805
3 3 2
4103 B A A A A 1000 4945 D C A A
5532 A D C X A 5801 A . C . 5832
N N N N N N N P
3 3 3
A . . . . . B . 3 4 3 2 2 3 3 A . . C . .
39 2 23 F Y 1 . . 1 . . . . . . 03 Y 02 03 120 Y . 2 . N . T 3
0112 C A D A A 0232 C A B B B 0407
5 4 1
0458 B B C C A 0655 B B A C B 0810
3 4 2
1449 . . . . A 2504 C B D C B
2912 C C C D A 3419 B A . B 3515
3 3 3
3545 A A A B C .... 4045 A C A B
4602 C B A X B 4945 A . C . 5002
N N N N N N N P
3 3 2
. . C . . . D . 3 4 4 2 2 . 2 B . B . D W
40 2 47 M Y 1 1 . 1 1 1 1 . . . . 04 Y : 15 156 Y 3 . 1 Y . T 4
0052 C A D A A 0158 C A B B B 0254
3 4 1
0333 B B C C A 0436 D B A B B 0610
. .
0810 3 1 4 2 . A 1023 D B D C W
1338 C C C D A 1548 A A . B 1630
2 3 2
2219 D B B C B 2418 A . A . 2436
N N Y N N N N P
1 1 1
"correct answers"

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**Explanation of Coding:**

- IF LEFT BLANK PUT ".", OR IF 2 ANSWERS ARE MARKED PUT " . "
- IF YEARS GIVEN ARE LESS THAN SPACES PUT "0" EG 9 YEARS = 09 24 MONTHS = 024
- IF "YES" PUT "Y", IF NO PUT "N"
- IF WRITTEN COMMENTS ARE GIVEN PUT "W", OR ? PUT "W"
- FOR QUESTION "S5. HOW MUCH...." PUT IN AMOUNT GIVEN (4SPACES) $ = RIGHT ANSWER SMALL AMOUNT, 100,000 200,000
- FOR TIMING - USE SUBJECT'S NUMBERS OR ESTIMATE BETWEEN MINE AND SUBJECTS'S OR USE MY TIMES

- S13 COMMENT ON EXPENSES AND REVENUE | YEAR END TRENDS, FORECAST, OR DEFICIT | BUDGET | SALARY | PATIENT REVENUES | NEGATIVE COMMENTS ABOUT GRAPHS | QUESTION FORECAST | (Y/N)
- 98% AGREEMENT BETWEEN Raters. 8 DISAGREEMENTS ON 320 RATINGS
- STATE FINANCIAL OUTLOOK (P/N/.) P=Positive, N=Negative, . = NOT STATED

- WROTE DOWN ALL WRITTEN COMMENTS
- WROTE DOWN ALL POSSIBLE ORAL COMMENTS
ASKED SUBJECTS FOR "FINAL COMMENT"

13 LINES PER SUBJECT
LINE 1 27 2 13 3 3 4 13 5 3
   6 13 7 12 8 3 9 12 10 11
   12 8 13 21

TOTAL 142 X 40 SUBJECTS = 5680

LINE 1
ID 1-2, GROUP 4, BIRTH YEAR 6-7, GENDER 9, VISION 11,
EDUCATION: HIGH SCH 12, CERTIF 14, C SPEC 16, BA 18,
BASPEC 20, MASTERS 22, MSPEC 24, PHD 26, PHDSPEC 28,
OTHER 30, 0TH SPEC 32,
TOTAL EDUCATION /11 (ONE PHD : /9; ONE SUBJECT NOT HIGH
SCHOOL GIVE 1 FOR EACH LEVEL OF EDUCATION AND 1 FOR ALL
FINANCIAL OR ADMINISTRATION SPECIALITIES)
FINANCE COURSES 34-35 0-15 TOTAL =118 AVG 2.7 GR1=64 GR2=54
   0=14 GR1=7;1=6;2=4;3=5;4=3;4=3;7=1;10=3;15=1
WORK EXPERIENCE 36 Y OR N GROUP1 =12 YES GROUP 2=14 YESSES
YEARS IN FINANCE OR ACCOUNTING 37-38
YEARS IN ADMINISTRATION 39-40
MONTHS ON BOARD 42-44
EXECUTIVE POSITION 46 Y OR N
CHAIRMAN 48 3 IF YES
TREASURER 50 2 IF YES
FINANCE COMMITTEE 52 1 IF YES
RECEIVE MONTHLY STATEMENTS 54 Y OR N
GRAPHS 56 G IF YES
TABLES 58 T IF YES
PERCEIVED FAMILIARITY WITH GRAPHS 60 1-5

TIME: TOTAL FROM 22 TO 74 MIN. AVERAGE FOR GROUP 1 = 38.2 MIN.