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Recommended Citation

Dull, Richard B. and Hess, Traci J., "Using Scientific Visualization to Improve Financial Decision Making" (1996). *AMCIS 1996 Proceedings*. 321.
<http://aisel.aisnet.org/amcis1996/321>

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Using Scientific Visualization to Improve Financial Decision Making

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Visualization and its effectiveness in improving business decision making have been the subject of much research over the past two decades. Within the realm of accounting, there have been several studies that have attempted to determine the effectiveness of visualizations (DeSanctis & Jarvenpaa, 1989; Kaplan 1988). The conclusions from this research have been mixed, with no consensus as to whether visualization improves accounting decision making. There have also been studies relating the suitability of visual displays of data to the type and complexity of the decision encountered (Vessey, 1991; Sen, 1992). These studies examined the subjects in a controlled environment that did not address the effects of visualization on attention and memory, or the complexity level of the information being visualized.

The benefits of visualization when considering the volumes of data and interference present in financial decision making would appear to be an ideal association. There is, however, an absence of information visualization efforts within the financial decision making arena. The fields of engineering, physical sciences and mathematics have explored scientific visualization as an interdisciplinary study of "mechanisms in computers and in humans which allow them in concert to perceive, use and communicate visual information" (McCormick, DeFanti and Brown, 1987). The purpose of our research is to establish a cognitive framework for the use of visualization within the problem representation component of financial decision making. The proposed study will be one of the few, if not the first, attempts to use scientific visualization tools for financial information visualization purposes. The establishment of such a framework would provide significant theoretical and practical contributions to the fields of information systems and accounting by outlining a conceptual model for the use of information visualization in the analysis of business data.

Potential Benefits of Scientific Visualization

Cognitive research in accounting has noted the importance of attention and memory in financial decision making (Libby and Trotman 1993). The related issue of information overload has been largely unaddressed in accounting research (Birnberg & Shields, 1984). Visualization can be applied to problem space construction to address attention and memory issues that affect the quantity and quality of information retrieved from long-term memory.

Visualization also provides a means to counter the limitations of short-term memory. A method to increase the amount of information an individual can process is the concept of recoding or chunking (Miller, 1956). Scientific visualization tools provide a method to recode financial information into fewer and more meaningful units of information. Thus these tools can provide an efficient approach to recode large, complex data sets and to assist the accounting profession in overcoming information overload. Many scientific visualization tools allow the user to view the numerical form of the data, as well as view the visualization of the data, concurrently. The two representations of the same data provide a rehearsal effect that can assist the decision maker in copying the contents of short-term memory to long-term memory.

The visualization of the data can also assist the decision maker in producing a mental representation of the problem set. Decision making research has demonstrated that individuals create a subset of the problem

from the problem representation and the problem-solving task, and use this subset to produce the problem solution (Gentner & Franks, 1983). The visualization achieved through these tools represents an encoded unit, rich in information, composed of multiple units of financial data. The mental imagery produced by the visualization tool can assist the decision maker in accumulating a more accurate, complete mental representation of the problem to be solved. Visualization, however, will not provide the expected benefits in reasoning abilities if the complexity of the data does not require visual reasoning assistance.

Applications of Visualization to Financial Decision Making

It is almost universally accepted that one purpose of a financial information system is to accumulate, summarize and communicate a firm's economic data for the use of those making decisions regarding the firm. Visualization can be a means to summarize data within one's eyespan to increase the effectiveness of the decision making process (Tuft, 1990). We believe that the intersection between visualizations and financial systems can eventually be used to provide a more effective means for conveying the information needed to make many types of financial decisions.

There are many areas of financial decision making that appear to be ideal for visualizations. Several studies, in a variety of decision making scenarios, have tried to identify efficiencies to be gained through the use of two dimensional graphs. The effectiveness of graphs versus numerical data in financial forecasting has been examined by DeSanctis & Jarvenpaa (1989). Additionally, Goldwater & Fogarty (1995) examined the impact of information format in cash flow analysis and projections. Stock investment decisions based upon financial data presentation in either a graphical or tabular format have also been evaluated (Sen & Boe, 1990). Using two dimensional graphs, these experiments produced inconclusive results. The authors suggest that the presentation methods that were used may be less than optimal. We suggest that inclusive results were obtained due to the low complexity level of the information visualized. Today's visualization tools can accommodate more complex data sets (Zhang and Whinston, 1995), and thus address the cognitive limitations of two dimensional representations.

Selection of Visualization Tools

It should be noted that visualization is not limited to graphs of the data being presented. The technique of presentation is important and must be developed to prevent a misrepresentation of the data. Many techniques, based upon implementation, can enhance or hide information. For example, it has been suggested that bar graphs frequently obscure more information than they provide (Wolff & Yaeger, 1993). We are in the early stages of the evolution of information visualization, and there are no comprehensive guidelines for matching the type of visualization to the problem representation. Most studies that have examined the structure of the visualization and the data that it represents have been related to physical data rather than business information (Larkin & Simon, 1987). Classification research efforts have been made in this direction (Lohse et al. 1994). Our selection of visualizations will take into consideration the categories established in their research.

Proposed Study

This study will examine the effects of visualization on memory and reasoning within the problem representation component of financial decision making. We will examine three experimental conditions of data representation: 1) tabular representation, 2) two dimensional graphic representation and 3) three dimensional graphic representation. These representations will be presented in an interactive multimedia environment. The subjects will be asked to perform a financial forecasting task and will be tested for forecasting accuracy and memory of the data. We expect the results from this study to provide evidence that information visualization will improve memory for both two and three dimensional representations. Additionally, visualization of three dimensional representations should improve reasoning abilities.

Conclusion

This research will provide a cognitive-based framework for the use of information visualization of financial information. The framework's development will be based on issues related to the effects of visualization on memory and reasoning ability. The framework will represent a component of a comprehensive methodology for using information visualization in many aspects of financial decision making.

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