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Fitting Graphical DSS to Task Characteristics

Alan R. Dennis
University of Georgia, Athens

Traci A. Carte
University of Georgia, Athens

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Alan R. Dennis and Traci A. Carte
Department of Management
Terry College of Business
University of Georgia, Athens GA 30602

Abstract

Previous research has found the use of graphical Decision Support Systems (DSS) to be more effective than tabular DSS in some decision situations, but not in others [8, 9]. This paper presents the results of two laboratory experiments testing the hypothesis that the features provided by graphical DSS may best "fit" some tasks, while those of tabular DSS best fit other tasks. The first experiment, which examined decision outcomes, found that a tabular DSS better fit a less complex task, while a graphical DSS better fit a more complex task with high information load in which decision makers needed to understand relationships among data elements. The second experiment, which examined decision processes, found that decision makers using graphical DSS tended to use less information in making their decisions than those using tabular DSS.

Several researchers have suggested that task characteristics effect the outcomes of technology use [e.g., 12]. Graphical and tabular DSS present the user with different problem representations which emphasize different problem aspects. Performance may be improved or impaired depending on how well the representation's emphasis coincides with the problem, or how well the representation "fits" the problem [2, 5, 6, 8]. A second aspect of "fit" is cognitive fit. Cognitive fit occurs when the processes required to act on the problem presentation are similar to those required to act on the problem [13]. In other words, graphical DSS better fit problems which require an understanding of the whole problem area and relationships among the data ("spatial" problems), while tabular DSS better fit problems which require specific, discrete information ("symbolic" problems).

The first objective of this paper is to examine whether graphical DSS better fit tasks with certain characteristics while tabular DSS better fit tasks with other characteristics. The second objective is to examine the effects of graphical and tabular information display on decision processes. This paper presents the results of two laboratory experiments.

The first experiment examined decision outcomes as they relate to the fit between DSS and task. We used four measures which have been advocated in previous graphics research: decision quality, decision time, decision confidence, and satisfaction with the DSS [8, 12]. We hypothesized that significant interactions would occur between DSS type and decision quality, decision time, decision confidence, and satisfaction with the DSS.

A two by two factorial design was used, crossing the type of DSS (graphical or tabular) with the type of task (complex, less complex). The task involved using a GIS to determine the optimal location of a fast-food restaurant. Task A required subjects to consider each available region independently, while Task B asked subjects to consider relationships with adjacent regions when arriving at a decision. Due to the greater number of relationships and higher information load, Task B was considered to be a more complex task [3, 4]. Fifty-six graduate business students served as subjects and were randomly assigned to one of the four experimental treatments. The subjects were trained to use the GIS, and a performance based reward system was used to provide performance incentive. The results provided tentative support for the argument that a tabular DSS better fit a less complex task, while a graphical DSS better fit a more complex task with a high information load in which decision makers needed to understand relationships among data elements.

The second experiment examined decision processes. An unexpected result of our first experiment was the amount of time required to complete the task. Decision makers using the tabular DSS took longer for both tasks, although we anticipated they should take less time for Task A. One explanation may lie in the decision process used. The selection of decision processes can be affected by the perceived costs and benefits of their use [1, 10, 13]. Decision makers may have chosen processes that they perceived would provide the lowest costs and highest benefits. Data collected from open-ended questions on post-session questionnaires in experiment 1 suggested that subjects may have perceived a higher cost to information acquisition using graphical DSS. This perception of higher cost may be accurate given that the graphical DSS typically took longer to display information than the tabular DSS (6-7 seconds longer in experiment 1). We hypothesized that decision makers using graphical DSS would use less information.

A second possible explanation for the difference in decision time may be that subjects using graphical DSS used different processes regardless of cost. Two processes could have been used, the subject could adopt an analytical strategy using numerical information or quantitative information, or the subject could pursue an intuitive strategy using approximations for the true numerical information or qualitative information. Worksheets used in experiment 1 suggested that subjects using the graphical DSS may have been more likely to use qualitative data while subjects using the tabular representation may have been more likely to use quantitative data. Similar effects have been noted elsewhere [7]. We hypothesized that decision makers using a graphical DSS will be more likely to use qualitative data.

A two by two factorial design was used, crossing the type of DSS (graphical or tabular) and the system response time (short delay or no delay). The task from experiment 1 was used. Sixty-three graduate business students served as subjects and were randomly assigned to one of the four experimental treatments. Subjects were asked to record the number of data points used to arrive at the decision and whether qualitative or quantitative. The number of data points entered on the sheet was simply counted to provide a measure of the number of data points used. The form of information on the sheet, whether qualitative (e.g. "high") or quantitative (e.g. 95), was coded using a zero-

one variable to produce a measure of qualitative/quantitative processing. The reliability of these measures was determined to be 98% using concurrent verbal processing tracing. The experiment found that decision makers using graphical DSS tended to use less information in making their decisions than those using tabular DSS, and they were more likely to use qualitative data or an intuitive approach.

As with any research, there are limitations to this study's conclusions. They apply within this experimental context, using these forms of DSS support for similar tasks. The ability to generalize these findings to the managerial use of graphical and tabular DSS has, in our opinion, been strengthened by the use of a performance-based reward system, commercially available DSS, and graduate students, many of whom had managerial experience. Nonetheless, the issue of external validity must always be raised in the use of laboratory experiments. Without presuming that all issues have been completely addressed, we note that most prior experiments examining the effects of graphical versus tabular information presentation on the processes and outcomes of decision making have used students [e.g., 2, 9] and that experimental comparisons have found graduate business students to be appropriate surrogates for managers in similar business decision making situations [11].

Our recommendations to DSS developers and users from these experiments are to consider the needs of the task in terms of complexity, information load, the need to understand relationships among data elements, and the cognitive processes. Graphical DSS may best fit complex tasks with high information load where it is important to understand data relationships while tabular DSS may best fit tasks which require specific numerical values. This study provides tentative support for these recommendations. Given these results, and that the same DSS may be used for multiple problems, the best design strategy may be to provide the user with the ability to easily view the data in both graphical and tabular format.

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