Impact of visualization type and contextual factors on performance with enterprise resource planning systems

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Abstract

We studied the use of two types of graphic information visualization to support human operators performing tasks using enterprise resource planning systems (ERP). We compared the original display design of a commercial ERP system with a prototype information visualization design. A simulated supply chain was used to test the hypothesis that graphical visualization can improve the performance of the human operator using ERP systems for supply chain management. Tasks from the production and purchasing domains were tested in the experiment in which experienced and inexperienced human operators had to perform tasks of an easy, moderate, and difficult nature. Analysis of the results revealed that the two types of graphical visualization significantly reduced response time, particularly with inexperienced users performing difficult tasks. Our results imply that some graphic information visualization displays for ERP systems can increase the probability of a successful implementation and enhance the capabilities of the human operators.
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1. Introduction

Enterprise resource planning (ERP) systems are designed to enhance the competitive ability of organizations by providing management with an information infrastructure that includes a common database, communication capabilities, a common model base and some workflow management capability (Riggle, 2000). These systems support the management of the whole organization and the interface between organizations collaborating in the supply chain management (Simchi-Levi, Kaminski, & Simchi-Levi, 2000). In this paper we address the issue of effective and efficient information presentation to the users of ERP systems.

There are huge reported investments in ERP systems. By the end of the 20th century the total revenues of ERP vendors were $14.8 Bn (Computerworld, 1998). The huge investment and the mixed results of ERP implementation projects motivated efforts to improve the probability of success. Major companies have

implemented ERP systems, for example Hewlett Packard, Monsanto, Nestle, Microsoft and IBM. Companies have implemented different software packages selecting different modules for implementation according to the needs of the organization and the required balance between flexibility and standardization. Along with success stories, there are reports on failures – ERP implementation projects that are late, projects that are over budget and projects that do not achieve the expected results (Davenport, 1998). FoxMeyer Drug claims that the decision on implementation of the ERP system has brought the company to financial failure. Mobil Europe has invested hundreds of millions of dollars in the assimilation of the system and, in the end, did not succeed in finishing the implementation. Dell Computer discovered that the system is incompatible with the new management manner in the form of decentralization. Applied Materials found itself involved in significant changes as a result of implementing the ERP system. Dow Chemical was involved in an implementation project which lasted 7 years with an investment of half a billion dollars that ended in failure. The huge investment in ERP systems, the significant failure rate and the potential effect of a failure in such projects, motivated research aimed at the critical success factors of ERP projects. In this paper we focus on one such factor – the user interface. More specifically, we explore and test ways of conveying information to the user that can achieve better efficiency in their interaction with the system.

2. Information display in ERP systems

Implementation of ERP systems is a non-trivial organizational change. Users must learn the processes embedded in the system as well as the user interface composed of numerous screens. Users of an ERP system receive information about the current state of the system (e.g. the current inventory levels and standing customer orders), helping them in the planning process or alerting them about a deviation from a preset value (e.g. a late customer order or a delay of a supplier of raw material). Based on the information the operator has to decide if and how to react. The common information display in ERP systems is tabular – information is presented in the form of tables on the screen. Often, the user may have to retrieve and collect data from several screens or tables in order to make the proper decision.

Although the design of these screens is improving as new versions of ERP systems are released, most of the user interfaces are still based on forms and tables. There have been suggestions (e.g. Cleveland & Mcgill, 1984; Tufte, 1983, 1990) that displaying information graphically is superior and more effective for quantitative data sets. In addition, research has addressed the advantage of a given display type – tabular or graphic – for a given task (e.g., Mayer, Shinar, & Leiser, 1997). However, in the case of ERP systems, data from many and various sources often need to be integrated into a coherent visual display that requires going beyond the limitations of tables or individual data graphs to convey the overall state of the system and support decision making. One possible solution for such a need is the presentation of information in graphical information visualization; however, such an approach is not commonly used.

Information visualization can be broadly defined as a computer-aided process that aims to transform multidimensional or abstract data into visual-spatial forms. This can enhance data exploration such as simple overview and zooming into information items, or revealing complex hidden trends, relations, and patterns in the data (e.g. Chen, 2004; Shneiderman & Plaisant, 2004; Spence, 2001). In general, information visualization is concerned with mapping data into visual-spatial forms that can be easily recognized and understood by the human user (e.g., Bederson & Shneiderman, 2003; Card, Mackinlay, & Shneiderman, 1999). In this paper we focus on the use of specific forms of information visualization in an ERP system and its impact on user performance.

Data in an ERP system such as the description of a product is typically hierarchical and could be composed of components and sub-components. In addition, such data is numeric, quantitative and it conveys information of quantities. While usually displayed as numbers in tables, two graphic visualizations can be considered to convey such information: the Hyperbolic Tree (e.g. Lamping, Rao, & Pirolli, 1995; Pirolli, Card, & Van Der Wege, 2001) and the Treemap (e.g. Golberg & Helfman, 2005; Kobsa, 2004; Shneiderman, 1992). The Hyperbolic Tree is most appropriate for information that is layered or hierarchical. For example, the hierarchical structure of a product can be easily displayed using this visualization. Pirolli et al. (2003) found that users visually searched through a tree hierarchy faster and more accurately compared to the traditional hierarchical tree visualization. The Treemap is most appropriate for information that is quantitative and there is a need to convey to the user the magnitude and differences in quantities. For example, the quantitative description of