Improving Dynamic Decision Making through HCI Principles

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INTRODUCTION

CSBILEs allow the compression of time and space and provide an opportunity for practicing managerial decision making in a non-threatening way (Issacs & Senge, 1994). In a computer simulation-based interactive learning environments (CSBILEs), decision makers can test their assumptions, practice exerting control over a business situation, and learn from the immediate feedback of their decisions. CSBILE's effectiveness is associated directly with decision-making effectiveness; that is, if one CSBILE improves decision-making effectiveness more than other CSBILEs, it is more effective than others. Despite an increasing interest in CSBILEs, empirical evidence to their effectiveness is inconclusive (Bakken, 1993; Diehl & Sterman, 1995; Moxnes, 1998). The aim of this article is to present a case for HCI design principles as a viable potential way to improve the design of CSBILEs and, hence, their effectiveness in improving decision makers' performance in dynamic tasks. This article is organized as follows: some background concepts are presented first; next, we present an assessment of the prior research on (i) DDM and CSBILE and (ii) HCI and dynamic decision making (DDM); the section on future trends presents some suggestion for future research. This article concludes with some conclusions.

BACKGROUND

Dynamic Decision Making

What is dynamic decision making (DDM)? Dynamic decision-making situations differ from those traditionally studied in static decision theory in at least three ways:

- A number of decisions are required rather than a single decision.
- Decisions are interdependent.
- The environment changes either as a result of decisions made or independently of them both (Edwards, 1962).

Recent research in system dynamics has characterized such decision tasks by multiple feedback processes, time delays, non-linearities in the relationships between decision task variables, and uncertainty (Bakken, 1993; Hsiao, 2000; Sengupta & Abdel-Hamid, 1993; Sterman, 1994).

We confront dynamic decision tasks quite routinely in our daily life. For example, driving a car, flying an airplane, managing a firm, and controlling money supply are all dynamic tasks (Diehl & Sterman, 1995). These dynamic tasks are different from static tasks such as gambling, locating a park on a city map, and counting money. In dynamic tasks, in contrast to static tasks, multiple and interactive decisions are made over several time periods whereby these decisions change the environment, giving rise to new information and leading to new decisions (Brehmer, 1990; Forrester, 1961; Sterman, 1989a, 1994).

CSBILEs

We use *CSBILE* as a term sufficiently general to include microworlds, management flight simulators, learning laboratories, and any other computer simulation-based environments. The domain of these terms is all forms of action whose general goal is the facilitation of decision making and learning in dynamic tasks. This conception of CSBILE embodies learning as the main purpose of a CSBILE (Davidsen, 2000; Lane, 1995; Moxnes, 1998; Sterman, 1994). Computer-simulation models, human intervention, and decision making are considered the essential components of a CSBILE (Bakken, 1993; Cox, 1992; Davidsen, 1996; Davidsen & Spector, 1997; Lane, 1995; Sterman, 1994).

Under this definition of CSBILE, learning goals are made explicit to decision makers. A computer-simulation model is built to represent adequately the domain or issue under study with which decision makers can induce and experience real worldlike responses (Lane, 1995). Human intervention refers to active keying in of the decisions by decision makers into the computer-simulation model via a decision-making environment or interface. Human intervention also arises when a decision maker interacts with a fellow decision maker during a group setting session of a CSBILE or when a facilitator intervenes either to interact with the simulated system or to facilitate the decision makers.

DDM AND CSBILEs

Business forces, such as intensifying competition, changing operating environments, and enormously advancing technology, have made organizational decision making a complex task (Diehl & Sterman, 1995; Moxnes, 1998; Sterman, 1989b), and all challenge traditional management practices and beliefs. The development of managerial skills to cope with dynamic decision tasks is ever in high demand. However, the acquisition of managerial decision-making capability in dynamic tasks has many barriers (Bakken, 1993). On the one hand, the complexity of corporate and economic systems does not lend itself well to real-world experimentation. On the other hand, most of the real-world decisions and their outcomes hardly are related in both time and space, which compounds the problem of decision making and learning in dynamic tasks.

However, computer technology, together with the advent of new simulation tools, provides a potential solution to this managerial need. For instance, CSBILEs are often used as decision support systems in order to improve decision making in dynamic tasks by facilitating user learning (Davidsen & Spector, 1997; Lane, 1995). CSBILEs allow the compression of time and space, providing an opportunity for managerial decision making in a non-threatening way (Issacs & Senge, 1994).

In the context of CSBILEs, how well do people perform in dynamic tasks? The literature on DDM (Funke, 1995; Hsiao, 2000; Kerstholt & Raaijmakers, 1997; Qudrat-Ullah, 2002, Sterman, 1989a, 1989b) and learning in CSBILEs (Bakken, 1993; Keys & Wolf, 1990; Lane, 1995; Langley & Morecroft) provides almost a categorical answer: very poorly. Very often, poor performance in dynamic tasks is attributed to subjects' misperceptions of feedback (Diehl & Sterman, 1995; Moxnes, 1998; Sterman, 1989b). The misperception of feedback (MOF) perspective concludes that subjects perform poorly because they ignore time delays and are insensitive to the feedback structure of the task system. The paramount question becomes the following: Are people inherently incapable of managing dynamic tasks? Contrary to Sterman's (1989a, 1989b) MOF hypothesis, an objective scan of real-world decisions would suggest that experts can deal efficiently with highly complex dynamic systems in real life; for example, maneuvering a ship through restricted waterways (Kerstholt & Raaijmakers, 1997). The expertise of river pilots seems to consist more of using specific knowledge (e.g., pile moorings, buoys, leading lines) that they have acquired over time than in being able to predict accurately a ship's movements (Schraagen, 1994). This example suggests that people are not inherently incapable of better performance in dynamic tasks but that decision makers need to acquire the requisite expertise. Thus, in the context of CSBILEs, equating learning as a progression toward a prototypic expertise (Sternberg, 1995) is a very appropriate measure. Then, the most fundamental research question for DDM research seems to be how to acquire prototypic expertise in dynamic tasks. A solution to this question effectively would provide a competing hypothesis to MOF hypothesis: people will perform better in dynamic tasks if they acquire the requisite expertise. We term this competing hypothesis as the acquisition-of-expertise (AOE) hypothesis. The following section explains how the human-computer interface (HCI) design may help to acquire prototypic expertise in dynamic tasks.