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THE EFFECTS OF COGNITIVE FEEDFORWARD AND FEEDBACK ON THE PERCEIVED USEFULNESS AND EASE-OF-USE OF COMPLEX MODELS

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Abstract

This paper tailors Davis et al's (1989) Technology Acceptance Model to the acceptance of complex Management Science/Operations Research (MS/OR) models. Narrowing the focus of TAM to this domain allows the development of explicit, theorized relationships from cognitive feed forward and feedback to perceived usefulness and ease-of-use. This theorized relationship indicates that DSS designers should use feedforward (training) and feedback (intermediate results) to reduce the effort and ambiguity associated with using complex models. A validating survey confirms that training and intermediate outcome measures may be the most useful types of cognitive feedforward and feedback for this problem domain.

Keywords: Cognitive feedforward and feedback information; decision support systems; decisional guidance; technology acceptance model

Introduction

This study is designed to help answer the question: "What factors affect the perceived usefulness and perceived ease of use of complex Management Science/Operations Research (MS/OR) models?" As the complexity of today's business environment increases, analysts are faced with more and more difficult problems. Management Science/Operations Research has developed many complex models that could benefit analysts if they were used. Unfortunately, these models are not widely used. Even the majority of enterprise resource management packages, such as SAP and Oracle Applications, use only simple models for decision support.

Singh and Singh (1997) refer to this phenomenon as the complexity ceiling for MS/OR models. They state that "often the potential gain to an organization can be enhanced through increasing the complexity of the decision making model(s). However, increasing complexity often leads to increased decision making effort, thereby resulting in diminished use." The effort versus accuracy/complexity tradeoff is tipped in favor of less complexity and less accuracy. The bumper sticker "Hard work has a future payoff. Laziness pays off NOW" succinctly sums up conventional wisdom.

The Technology Acceptance Model

Davis et al's (1989) Technology Acceptance Model (TAM) indicates that an analyst will use a complex model if the analyst is convinced of the usefulness and/or ease-of-use of the complex model (see Figure 1). Unfortunately, the determinants of perceived usefulness and perceived ease-of-use are identified only as external variables. This does not provide very much guidance with respect to how DSSs should be designed in order to break, or at least raise, the complexity ceiling for MS/OR model usage.

There is a substantial body of research demonstrating that when decision-makers are confronted with complex situations, they adopt strategies that minimize effort. This tendency conflicts with attempts to get decision makers to use more complex, and more accurate, models. Payne et al. (1993) state there are three necessary conditions for decision makers to change their strategies. First, they must be dissatisfied with their current strategy. Second, the decision makers must believe a better decision-making strategy exists. And third, they must be enabled to use the new strategy. Therefore to change a decision-maker's strategy, or in this case, the model that he/she uses to reach a decision, it is necessary to induce these three conditions.
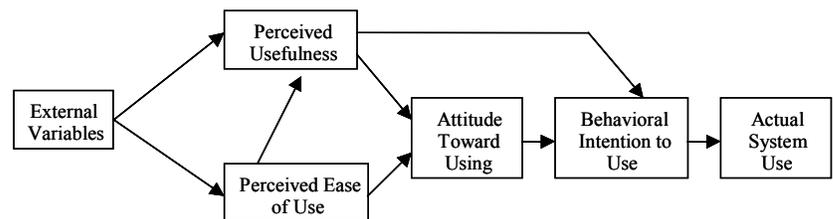
Figure 1. The Technology Acceptance Model

Cognitive Feedforward and Cognitive Feedback

Cognitive feedforward and feedback have been found to be very helpful in motivating (Annett 1969) and enabling decision makers to implement new decision strategies. Following is a brief review of the cognitive learning literature and a discussion of its applicability to decision aids.

In the cognitive learning paradigm, there is an important distinction between knowledge and skill -- knowing and doing. To break the complexity ceiling, decision makers need to both understand the general framework of the model and be able to implement the model. The ability to correctly implement the model in a specific environment requires skill beyond understanding the general framework. Learning operators that have been shown to be useful in achieving the skill to appropriately use a model are feedforward and feedback.

Feedforward is generalized task information that is provided before making a decision, usually in the form of instructions or training on a relevant decision model (Björkman 1972). It is "generalized information pertaining to the input cues of an analysis that is provided to users prior to the performance of an analysis" (Dhaliwal and Benbasat 1996, p. 348). Instead of expecting decision-makers to discover a model based on the results of decisions, the model is given to them before any decisions are made. Part of feedforward is enabling decision makers to correctly implement the new model. This enablement leads to a higher perceived ease of use and also perceived usefulness through the training that in turn can lead to a better acceptance of technology.

Cognitive feedback is information about the decision making process. An important distinction should be made between cognitive feedback and outcome feedback. Outcome feedback is "knowledge of results" (Björkman 1972, p. 152). There have been several studies that suggest outcome feedback alone does not result in more accurate decision making. People have a bias toward "confirmatory evidence, assumptions about causality, and disregard of negative information" (Brehmer 1980, p. 223) that prevents them from accurately interpreting outcome feedback. This is especially true for complex tasks where decision makers can find many excuses for why their decisions failed.

Cognitive feedback, like outcome feedback, is presented after the decision has been made, but also includes an explanation of the decision outcome. "Cognitive feedback provides information that clarifies case specific outcome feedback. It uses outcome feedback as the starting reference point for improving the decision maker's understanding of the task" (Dhaliwal and Benbasat 1996, p. 349). Providing cognitive feedback should increase the decision maker's understanding of the new decision making strategy and thereby additionally enable the decision maker to correctly implement the new strategy. This enhances the perceived ease-of-use and usefulness of a DSS.

Figure 2 shows a TAM model that has been tailored to the domain of complex MS/OR models. The theorized relationships from cognitive feedforward and feedback to perceived usefulness and ease-of-use are explicitly identified in Figure 2. Cognitive feedforward (training) can create dissatisfaction with the current solution by showing that a better solution exists; reduce the time, cognitive effort and uncertainty required to perform a task by offering decisional guidance; and reduce outcome ambiguity by

demonstrating the benefits of the new solution. Cognitive feedback (intermediate results) can decrease process ambiguity by providing feedback on whether the process is being implemented correctly, and can reduce outcome ambiguity by showing the improvement in outcomes that occurs as the process is implemented.

The assumptions underlying Figure 1 and Figure 2 are quite different. The TAM model assumes that use of the system is voluntary. Our situation is one in which some system and some model must be used. What is voluntary is use of the complex model. The objective is to understand how to design the DSS in such a manner as to motivate the user to choose to use the complex model.
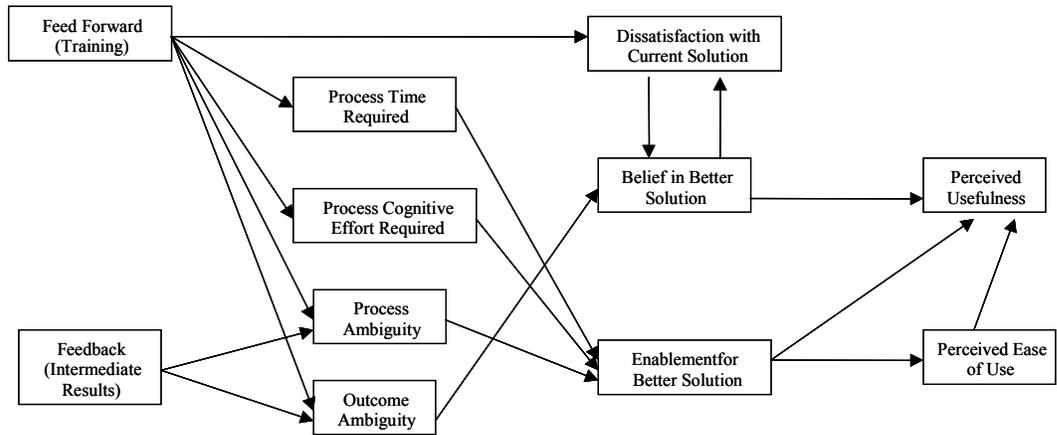

Figure 2. A Tailored TAM Model

Validating Survey and Future Research

A survey was conducted to determine the types of cognitive feedforward and feedback that are most likely to affect the perceived usefulness and ease-of-use of a DSS designed to support individual investment decisions. The domain of individual investment decisions was selected because it is an area where MS/OR models have been available for some time, but appear to be especially underutilized. The objective of the survey is to discover, for this problem domain, why complex models are not being used. The implications for DSS designers are very different depending on whether the impediment is a lack of dissatisfaction with simple models, a lack of belief that better models exist, or a lack of enablement for using the complex models. The type of feedforward and feedback that should be incorporated in the DSS can be determined only after the impediments to use are identified.

The survey shows that individuals are using only the most basic of (MS/OR) models to help make investment decisions, and suggests that training and forecasted outcome measures may be the most useful types of cognitive feedforward and feedback for this problem domain. The goal of this research-in-progress paper was to develop explicit, theory-based relationships from cognitive feedforward and feedback to perceived usefulness and ease-of-use. The goal of the future research is to explicitly identify the type of training and intermediate results that are most likely to increase the perceived usefulness and ease-of-use of complex MS/OR models.

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