Divergent Inference in Dynamic Decision Making

Jinwoo Kim and **Hun-Joon Park**
Cognitive Information Engineering Lab
Department of Business Administration
Yonsei University, Seoul, 120-749, Korea
jinwoo@bubble.yonsei.ac.kr

Introduction

People make decisions about various dynamic problems, ranging from very simple to extremely complex ones (Brehmer 1990; Diehl & Sterman 1995). This study proposes a framework of dynamic decision making based on the theory of scientific discovery in dual spaces (Klahr & Dunbar 1988). Two experiments using computer simulated management games were conducted to examine the relationship between the search strategies in the dual spaces and final performances in decision making.

Mental Model and Dynamic Decision Making

Brehmer (1990) views dynamic decision making as the process of achieving control over a system in order to produce a desired outcome. In order to control a system, a decision maker must have a mental model of the dynamic system it seeks to control. Mental models are the mechanisms whereby humans are able to generate descriptions of the system's purpose, explain system functions, and predict future system states (Rouse & Morris, 1986).

Our framework views dynamic decision making as a search process in dual problem spaces. Whereas scientific discovery involves the hypothesis and experimental spaces, dynamic decision making involves the model and decision spaces. In the decision space, people make judgments and choices based on the mental model. In the model space, people search for an appropriate mental model using the INFERENCE operator. The INFERENCE expresses a relation not explicit in the problem descriptions (Johnson-Laird & Byrne, 1991). We hypothesize that generating alternative hypothetical relations by INFERENCE is crucial for avoiding traps in dynamic decision making, because alternative relations produced by divergent inferences aid people to construct more comprehensive mental models, and thereby prevent people from making haphazard and irrational decisions.

Experiment Design and Results

In the first experiment, we use two business simulation games. One is simpler, having two clearly differentiated states, normal and impasse. The other is more complex, because there is no clear beginning of an impasse phase, but rather a gradual worsening as would occur in real life. Subjects were randomly allocated either to a Single (one person) or Pair (group of two people) group, and asked to play either the simple or the complex game. All experimental sessions were videotaped for concurrent verbal protocol analysis.

Results from the first experiment exhibit interesting interaction effects between the complexity of problems and the Single/Pair groups. In the simple problem, the Pair group significantly outperformed the Single group [$t(10) = 2.23$, $P(|t| \geq T) = 0.0156$], whereas the variance was not as significant for the complex problem. We can explain this interaction with the diversity of inferences made by subjects. For the complex problem, no significant difference was found between Single and Pair groups in terms of the diversity of inferences. However, for the simple problem, subjects' behavior differed depending on the two phases. In the normal phase, there was no difference between the Single and Pair groups. However, in the impasse phase, Pair groups made significantly more diverse INFERENCES ($t(10) = 2.7680$, $P(|t| \geq T) = 0.01$).

In the second experiment, two different methods for increasing the diversity of inferences were tested with the complex problem. One such method is to force the subjects to infer divergently. For each trial, the experimenter asked subjects to think of at least three different ways in which their decision would affect the other entities. The second method is to provide subjects with a map which shows the possible inferences that can be made. The results indicate that whereas direct enforcement is an effective way of improving performance ($F(3,18)=13.22$, $Pr > 0.002$), the map does not have any impact on the final performance of the subjects.

In summary, the diversity of inferences turns out to be a critical factor in dynamic decision making, and only a very strong manipulation, such as direct enforcement, can help to increase the diversity on complex problems.

References

Brehmer, B. (1990) Strategies in real-time dynamic decision making. In R. Horgarth (Ed.), *Insights from decision making*. Chicago: Univ. of Chicago, 262-279.

Diehl, E. & Sterman, J. (1995). Effects of Feedback Complexity on Dynamic Decision Making. *Organizational Behavior and Human Decision Processes*, 52 (2), 198-215.

Johnson-Laird, P. N. & Byrne, R.M.J. (1991). *Deduction*. Hillsdale, NJ: Erbaum.

Klahr, D. & Dunbar, K. (1998). Dual Space Search During Scientific Reasoning. *Cognitive Science*, 12:1-48.

Rouse, W. & Morris, N. (1986). On Looking Into the Black Box: Prospects and Limits in the Search for Mental Models. *Psychological Bulletin*, 100 (3). 349-363.