Interaction Analysis of Computer-Mediated Group Decision Making A Methodology

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There has been remarkable growth in GDSS research throughout the past decade. The research findings as well as the developments in technology in this area are well-documented in several reçent studies (Dennis, George, Jessup, Nunamaker, & Vogel, 1988; Kraemer & King, 1988; Pinsonneault & Kraemer, 1989).

Computer-Mediated Group Decision Making

With few exceptions, most GDSS research has been oriented toward investigating the effects of GDSS and other situation variables on group outcomes such as quality of decisions or group consensus. Very few studies have focused on the group process. Those that have are far from an in-depth analysis of the process itself.

While GDSS research has largely ignored the process of group interaction, many small group scholars have long been interested in the role that the process in face-to-face settings may play in determining whether a group will arrive at a low- or high-quality decision. Many of the efforts have led to the general conclusion that is clearly reflected in Huber's (1984b) often cited equation:

Actual Decision-making Effectiveness
= Potential Decision-making Effectiveness
- Process Losses
+ Process Gains

However, few have actually measured the "process variables" of group decision making. Despite the efforts of a number of researchers, it has yet to be demonstrated with any degree of certainty, what is going on when a group is interacting and what kind of relationship exists between group interaction processes and group decision-making outcomes (Hewes, 1986).

In short, there is very little doubt that empirical efforts need to be directed toward determining whether a systematic relationship exists between group decision-making outcomes and the micro- and macro-level patterns of interaction. The following diagram depicts a conceptual model for research.

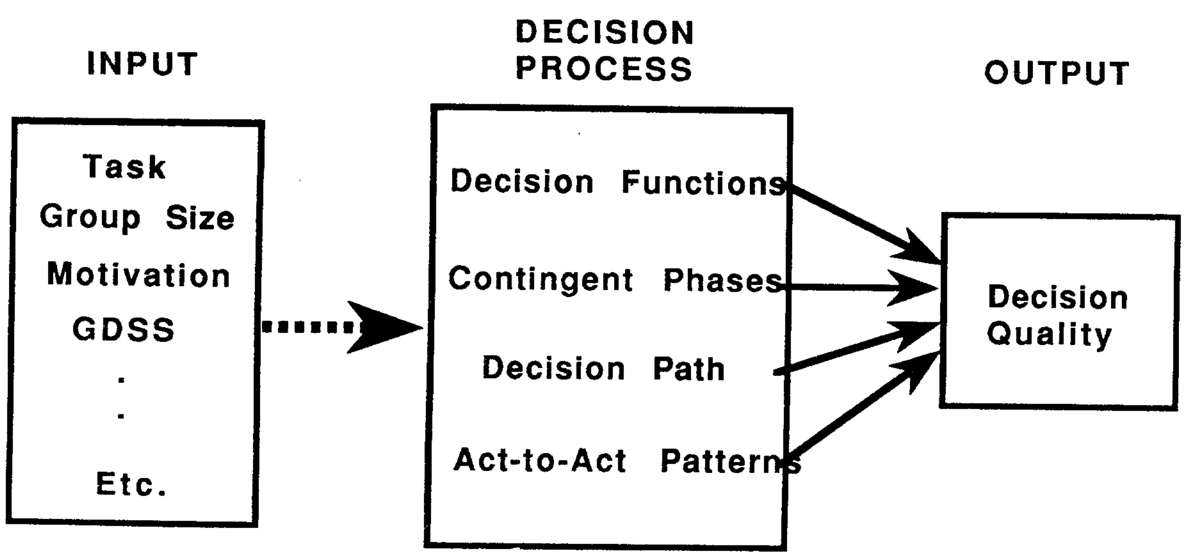

Figure 1. A Conceptual Model

Interaction Analysis

Interaction analysis was posed as a most effective technique for measuring the group process. Interaction analysis is a general method for analyzing the content of communicative behaviors by breaking down the whole of interaction into its component acts.

The analysis of group interaction is a complex undertaking, which naturally creates a concern with methodology.The interaction analysis includes Markov chain modeling of communication process; coding systems for coding interaction data; and measures of process variables. It is hoped that this instrument would not only bring more rigor to a study of this kind but also facilitate follow-up research to utilize a tested instrument.

Markov Chain Modeling

The interaction is typically represented by the conditional probability of moving from one category to another in a specified unit of time regardless of who makes the remark:

$$\text{Prob}(X_b \text{ at } t \mid Y_a \text{ at } t-n \neq \text{Prob}(X_b \text{ at } t) \qquad (1)$$

That is, the odds (Probability) of a behavior X being performed by a person B at some time t, given that person A performed behavior Y at some earlier time, t-n, does not equal the odds that B would perform X regardless of A's earlier behavior.

In the Interaction Analysis, the collection of random variables is the set of discrete, mutually exclusive, and exhaustive categories of communicative acts. Their sequential relationship, as they are vividly reflected in the above definition of interaction, can be studied in terms of the interdependence and limiting behavior of these categories on each other over time.

Interaction data will be captured in "transition matrices" of Markov chains, where the left edge indicates the category of communicative act performed at some point in time t-n, and the top edge indicates the category of act performed some number (n) of time periods in the future (t), perhaps by a different identified person. Entries in these transition matrices are conditional probabilities of the form described in Equation 1. Under certain testable assumptions (homogeneity, stationarity, and specified order), data described in this fashion accurately capture the communication process. The advantage of knowing that a process closely resembles a discrete Markov chain is the resulting ability to predict the distribution of coded utterances at any point in the future.

Coding Systems

Two coding systems are used to identify two aspects of group communication, task process behavior, and behavior reflecting working relationships in the groups. A coding system that will index task process behavior is a modified version of Poole's Decision Functions Coding System (DFCS) (Poole & Roth, 1980):

Analyze Problem (P)
Build Evaluation Criteria (C)
Generate Alternative Solutions (A)
Evaluate Alternatives (E)
    Confirm Evaluation (ECON)
    Evaluate Positive Consequences (EPOS)
    Evaluate Negative Consequences (ENEG)
Establish Operating Procedures (O)

For the classification of working relationships, Poole and Roth's Working Relationships Coding System (WRCS) is used:

Focused Work (FW)
Critical Work (CW)
Conflict (CO)Integration (IN)

Anderson-Goodman Tests

To conclude that group decision-making processes can be modeled as discrete Markov chains, three assumptions are tested: stationarity, order, and homogeneity (Hawes & Foley, 1976). Twenty two coded group sessions were used for the Anderson-Goodman tests of these assumptions.

First, data being mapped onto a discrete Markov chain must be stationary; transition probabilities are assumed to be stationary across time. The nonsignificant results for each of the 22 group sessions indicate that the interaction process within each of the 22 sessions was stationary over time. That is, the patterns of interaction among the group members in each of the 22 group sessions were stable and did not vary throughout the course of the decision-making process.

The second assumption to be tested is that data mapped onto a discrete Markov chain are of the first order. The alternative hypothesis is that the string of coded messages is a second or higher order. The significance of the test for "first-order" clearly indicates that in all 22 groups the sequencing of verbal behaviors is not random. Knowing the preceding code better enables the prediction of the next code as opposed to guessing.

The third assumption to be tested is that data mapped onto a discrete Markov chain are homogeneous; there are no radically different subgroups being modeled. Stated another way, the initial probability vector, V, and the transition matrix, M, are assumed to represent all subgroups in the sample. The results suggest that the ten groups within the effective set possessed interaction patterns which were similar to each other and, likewise, the twelve groups within the ineffective set possessed interaction patterns which were similar to each other.

Measures for Independent Variables

Measures for Decision Functions

Decision functions are identical with the six categories of the Decision Function Coding Systems (DFCS) :P, C, A, EPOS, ENEG, and O.

Suppose $\{X , n=0, 1, 2, \ldots \}$ is a Markov chain with a state space $s = \{1, 2, \ldots , m\}$. Let m be 6 for six decision functions. Let n_{ij} be the number of transitions from function i to function j. Let P_{ij} (i, j = 1,2,3, ... , m) denote the stationary transition probability matrix of the Markov chain.

In discussing a finite m-state chain, the n-step transition probabilities are denoted as

$$p_{ij}^{(n)} = p(X_n = j \mid X_0 = i) \quad .$$

It can be shown that for an irreducible, aperiodic, m-state finite Markov chain, the transition probability matrix, $\mathbf{P}^{(n)} = p_{ij}^{(n)}$, approaches a matrix that has every row equal; each row being identical with the stationary vector $\mathbf{v} = [v_1, v_2, \ldots, v_m]$. The qualities v_j are referred to as steady-state probabilities or limiting probabilities. They do not depend on $\mathbf{p}^{(0)}$, unconditional probabilities of the initial states. Since they describe the long-run behavior of the process and can be interpreted as the long-run proportion of time the group spends in state j or decision function j; the v_j are taken to be measures for decision function variables.

<u>Measures for Contingent Phases</u>

Each contingent phase is defined when a message is coded as a combination of task and relational categories of the coding systems described above. The Decision Function Coding Systems (DFCS) includes five task categories: P, C, A, EPOS, ENEG, and O. The Work Relational Coding System (WRCS) includes four categories: FW, CW, CO, and IN.

Since each message is coded by these two coding systems (DFCS and WRCS), twenty-four possible combinations of the two categories are independent variables: problem analysis in focused work (PFW), problem analysis in critical work (PCW), ... through operating procedure in integration (OIN). These 24 contingent phases comprise the state space of a Markov process: s = {1, 2, ... , m}, where m is 24 for the same number of contingent phases. Through the same procedure described in the previous section, the long-run proportion of time the group spends in state j or contingent phase j are calculated to be measures for contingent phase variables.

Measures for Decision Paths.

There is another operationalization of this independent variable to answer the second research question—decision path. Decision path is a "logical" sequence of the decision phases through which a group is followed.

In order to determine the sequence of phases, a method is employed, which uses Pelz's statistic Gamma (1985). As a measure of ordinal relationship, the Gamma (G) is computed:

$$G = (P - Q) / (P + Q)$$

where

G = measure of ordinal relationship (precedence and separation),
P = frequencies that phase i precedes phase j ,
Q = frequencies that phase i follows phase j.

A positive Gamma would indicate that phase i precedes phase j, while a negative Gamma would indicate that j precedes i. .

Group Decision Support System

MACCOLS (Macintosh Collaboration System) is a baseline group decision support system developed using HyperCard and its programming language HyperTalk. This level 1 GDSS provides a local area decision network (LADN) through which decision-making process of small groups at different sites (such as their offices) are supported. Basically, MACCOLS collects information on "cards" which are the homes of several different things: fields to contain informations, buttons that activate programmed functions, links to other cards, and any background graphics for the cards.

Users of MACCOLS do most of the work on the main card (typing, editing, sending, receiving and retrieving messages).The main screen of the system is shown in the following figure.

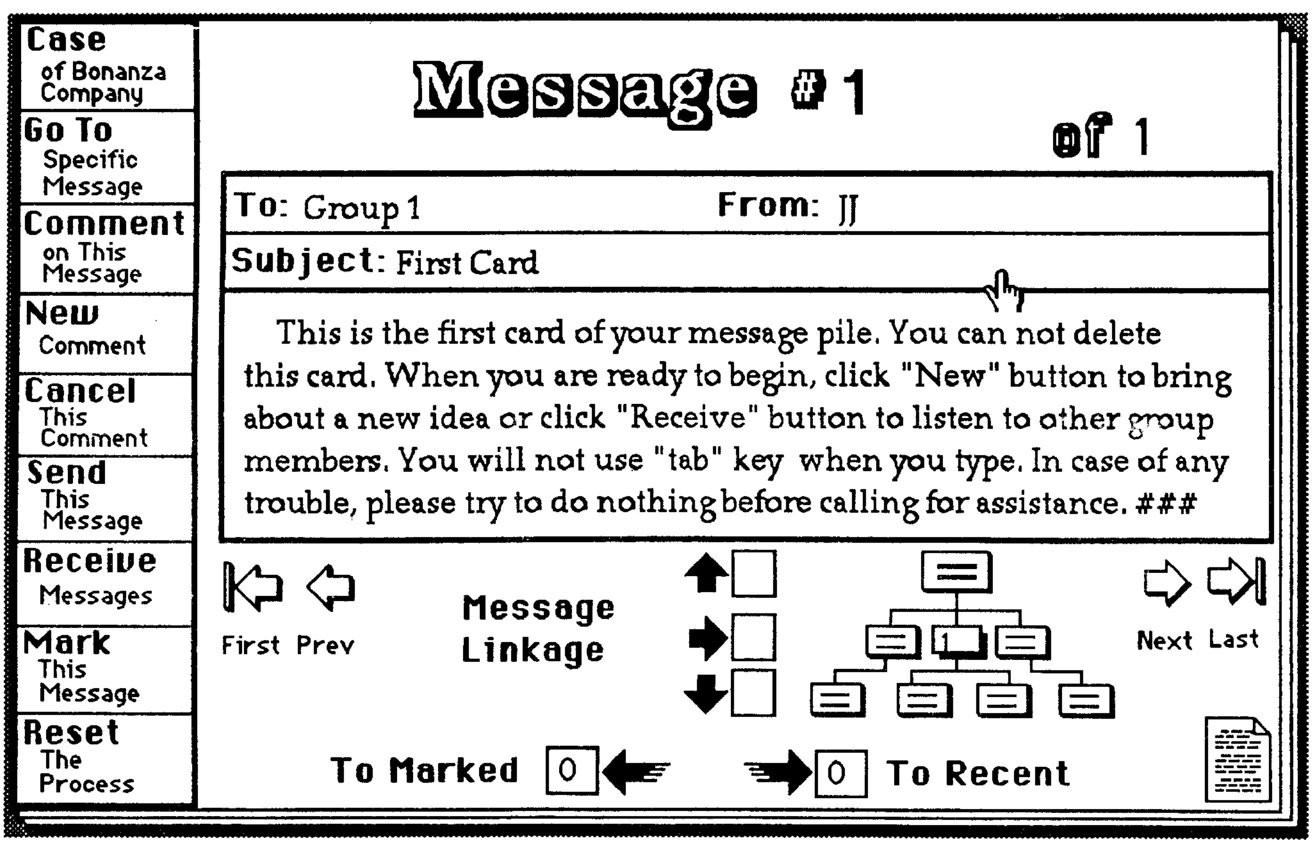

Figure 4. A sample screen of the group decision support system