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ABSTRACT

This paper offers a model that integrates chaos theory and cybernetics, which can be used to describe the structure of decision making within small groups. The paper begins with an overview of cybernetics and chaos. Definitional characteristics of cybernetics are reviewed along with salient constructs, such as goal-seeking, feedback, feedback rules, and operating rules. The paper then offers an overview of chaos theory, focusing on the four tenets of chaotic systems: (1) seemingly random behavior; (2) sensitivity to initial conditions; (3) mixing in finite time; and (4) underlying order. A discussion of the integration of cybernetics and chaos is then offered in the paper. The paper next examines the shared characteristics of cybernetics and chaos, and the paper proposes a new model of communication called cyberchaos. According to the paper, the cyberchaotic model could be applied to decision making groups because (1) information is central to such groups; (2) the structure of decision making is complex; and (3) scholars have identified patterns of convergence and divergence within decision making groups. The paper also discusses 10 principles of cyberchaos. Following the description of the model, the paper advances an argument regarding the use of cyberchaos to detect complex information patterns in decision making groups. Contains a table and 43 references. (RS)

Chaotic Feedback Loops within Decision Making Groups: Towards an Integration of Chaos Theory and Cybernetics

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Abstract

This paper begins with an overview of two theories: cybernetics and chaos. Definitional characteristics of cybernetics are reviewed along with salient constructs, such as goal-seeking, feedback, feedback rules, and operating rules. An overview of chaos theory is then offered, focusing on the four tenets of chaotic systems: (1) seemingly random behavior, (2) sensitivity to initial conditions, (3) mixing in finite time, and (4) underlying order. A discussion of the integration of cybernetics and chaos is offered. The shared characteristics of cybernetics and chaos are examined, and a new model of communication called cyberchaos is proposed. The ten principles of cyberchaos are discussed. Following the description of the model, an argument is advanced regarding the use of cyberchaos to detect complex information patterns in decision making groups.

The objective of this paper is to offer a model that integrates chaos theory and cybernetics, which can be used to describe the structure of decision making within small groups. To meet the proposed objective, the following discussions are offered: (1) overview of cybernetics, (2) overview of chaos theory, (3) integrating cybernetics with chaos theory: cyberchaos, and (4) applying cyberchaos to decision making groups. The paper begins with an overview of cybernetics.

Overview of Cybernetics

In the 1940's, a new theory labeled "cybernetics" emerged. Since that time, numerous articles and books have been devoted to cybernetic theory. In addition, scholars have developed and maintained journals that publish manuscripts on cybernetics only. The following section reviews the defining characteristics of cybernetic theory and examines salient concepts.

Definition and Purpose

Rapoport (1968) states that "cybernetics is the science of communication and control" (p. xix). The way in which communication serves to control the behavior of a given system is the essence of cybernetics. Wiener (1953) explains the centrality of control in within the science of cybernetics:

> "Control...is nothing but the sending of messages which effectively change the behavior of the recipient. It is this study of messages, and in particular of the effective messages of control, which constitutes the science of Cybernetics" (p. 105)

Control within a system is exercised through communication, more specifically through feedback. Feedback serves to regulate and direct system behavior. Bertalanffy (1962) explains that feedback is the basis of cybernetics: "Cybernetics, based upon the principle of feedback or circular causal trains provides mechanisms for goal-seeking and self-controlling behavior" (p. 3).

Cybernetic theory presents a unique way of explaining behavior and motivation, focusing on feedback and environment. Cybernetic theory rejects popularly held explanations of motivation and behavior, such as behaviorism, psychoanalysis, Gestalt psychology, and symbolic interactionism. Shibutani (1968) explains how cybernetic theory differs from other theories of behavior and motivation: "Behavior is seen not as response to stimulation, as relief from tension, nor as the accomplishment of symbolized intent; it is something that is constructed in a succession of self-correcting adjustments to changing life conditions" (p. 331).

Although constructed originally to describe the behavior of machines, cybernetics provides the framework for analyzing the behavior of a many complex systems, including groups. Deutsch (1948) asserts that cybernetic theory transcends the behavioral descriptions of machines and can be applied in most, if not all, communication contexts:

> It now seems possible to analyze and describe the common patterns of behavior of self-modifying communications

> networks in general terms, apart from the question of whether their messages are transmitted and their functions carried out by circuits of electric current in an electronic device, by chemical and neural processes inside a living body, or by spoken, written or other communications between individuals in an organization, group, nation, or society (p. 510).

Salient Concepts

Cybernetic theory, like all other theories, focuses on "certain aspects...at the expense of others" (Littlejohn, 1992, p. 21). Below is a discussion of the concepts encompassed by cybernetic theory.

Goal-Seeking. Behavior within a cybernetic system is directed at achieving one or more goals. Because a cybernetic system is goal-directed, behavior is viewed as purposeful rather than random (Rosenblueth, Wiener, & Bigelow, 1943).

Feedback. A cybernetic system uses feedback as the primary mechanism for goal-achievement. Furthermore, the feedback process allows a system to be self-directed. Feedback, according to cybernetic theory, is viewed as "a communications network which produces action in response to an input of information and includes the results of its own action in the new information by which it modifies its subsequent behavior" (Deutsch, 1948, pp. 390-391). In general terms, feedback is a communication process whereby some or all of the output of a system is used as an input for the system in some way to regulate behavior.

Feedback in a cybernetic system is characterized as either negative or positive. Negative feedback serves "to restrict outputs which would otherwise go beyond the goal" (Rosenblueth, Wiener, & Bigelow, 1943, p. 19). Negative feedback is an error correcting mechanism essentially, a message to the system that it is deviating from its goal.

Positive feedback signals the system to deviate from a given state of equilibrium (Maruyama, 1963, p. 164). The function of positive feedback is to amplify a deviation within the system. Maruyama (1963, p. 166) provides the following geological example to illustrate positive feedback:

> Take, for example, weathering of rock. A small crack in a rock collects some water. The water freezes and makes the crack larger. A larger crack collects more water, which makes the crack still larger.

Positive feedback processes have been equated to concepts such as escalation, and the vicious circle or spiral (Buckley, 1967).

Quantity of Information. Rapoport (1968) states "...quantity of information is central in cybernetics" (p. xix). Cybernetics, however, does not examine the meaning of information, instead it examines the amount of information in the system at a given time. As Rapoport (1968) explains: "...quantity of information is unrelated to the meaning of the information, its significance, or its truth" (p. xix). The function of information within a system is to reduce uncertainty (Shannon & Weaver, 1949). Information allows the system to reduce the number of ways (or decisions) in which a goal may be obtained.

Structure, function, and evolution. Cybernetic theory can be considered an extension of general systems theory and, therefore, includes the concepts of structure, function, and evolution (Rapoport, 1968). The structure of a cybernetic system refers to the "means by which it is enabled to receive, to store, to process, and to recall information" (Rapoport, 1968, p. xx). The function of a cybernetic system is defined as "the way in which...the system responds by behavior outputs to sensory inputs from the environment" (Rapoport, 1968, p.xx). The evolution of a cybernetic system refers to the way in which both structure and function change over time.

Operating Rules. Cybernetic theory examines rules established by a system regarding the use of information, the role of feedback, and management of system memory. Cadwallader (1959, p. 156) listed seven system rules that are central to cybernetic theory:

1. rules or instructions determining the range of input;
2. rules responsible for the routing of the information through the network;
3. rules about the identification, analysis, and classification of information;
4. priority rules for input, analysis, storage, and output;
5. rules governing the feedback mechanisms;
6. instructions for storage in the system's memory;

7. rules regarding the synthesis of information for the output of the system-especially those concerned with the matter of usual or novel output.

Although the list does not contain all rules relevant to communication within a given system, it provides the parameters for information management within the cybernetic system.

To summarize, cybernetics is the study of control within a self-governing system. Feedback is the vehicle by which control is exerted. Feedback can signal the a system either to deviate (positive feedback) or return to a previous state (negative feedback). Information is vital to the study of cybernetics in that it reduces uncertainty. To manage information effectively, cybernetic systems develop, maintain, and revise rules relevant to the processing of information.

Overview of Chaos Theory

Chaos theory was developed to describe the behavior of complex adaptive systems. The function of chaos theory is to discover latent patterns in systems that are characterized both by uncertainty and by constant change. Because the goal of chaos theory is to discover patterns, the selection of the word "chaos" in its title might be misleading because it implies a lack of patterning or structure. Perhaps that is why many refer to this branch of investigation as non-linear dynamics rather than chaos theory. The search for patterns in complex systems, however, is by no means unique to chaos theory. In fact, the search for patterns or structure within a system is a fundamental component of general systems theory (Bertalanffy, 1962).

Chaos theory departs from traditional system views by looking for a new category of patterns that are seemingly random, yet contain an underlying order. In addition, chaos theory differs from other scientific models in that it does not attempt to determine the causes (i.e. independent variables) which produce complex behavior. Instead, chaos theory abstracts the underlying structure of the system (Hobbs, 1993).

In short, chaos theory describes the patterns inherent in a complex system rather than isolate predictive variables or causal order. To understand chaos theory, it might be useful to understand the properties of chaotic systems. Keaten, Nardin, Pribyl, & Vartanian (1994) outlined four tenets which capture the properties of chaotic systems: (1) seemingly random behavior, (2) sensitivity to initial conditions, (3) mixing in finite time, and (4) underlying order.

Seemingly Random Behavior

The behavior of chaotic systems is characterized as <u>seemingly</u> random because it produces patternless or aperiodic behavior (Feigenbaum, 1983). However, the underlying structure is deterministic (Hunt, 1987). In a deterministic system, "the state of the system ...is a definite function of its state at the preceding moment" (Hunt, 1987, p.132). The discovery that a deterministic system produces aperiodic behavior has led to questions regarding widely accepted definitions of randomness

(Wegman, 1988). Before the advent of chaos theory, randomness and aperiodic behavior were thought to be synonymous terms. Some scholars suggest that the chasm between determinism and randomness has been bridged by chaos theory because a deterministic system can produce behavior that is aperiodic and seemingly random (Hunt, 1987; Wegman, 1988).

Sensitivity to Initial Conditions

The second characteristic of chaotic systems is known as sensitivity to initial conditions (Eckman & Ruelle, 1985), meaning that a small change in the initial position of a chaotic system produces exponential differences as the system moves through time. Sensitivity to initial conditions has been popularly referred to as the "butterfly effect", which posits that a butterfly flapping its wings influences the weather on a very small scale, which over time effects a large divergence in the weather pattern (Stewart, 1993, p. 141). In the general case, one of two points following equal paths through time may be subjected to minor perturbations in such a manner as to cause a significant divergence in paths. These two points would then begin to mix in finite time.

Mixing in Finite Time

Hobbs (1993) states that a system is mixing in finite time if "given any perturbation, no matter how small, there exists a finite amount of time after which the location of the unperturbed system is probablistically irrelevant to the location of the perturbed system" (p.124). One way of quantifying the phenomena of mixing in finite time is to analyze the amount of shared variance between the perturbed and unperturbed system as both systems evolve (Keaten et al., 1994).

Mixing in finite time, also known as exponential instability (Batterman, 1993), is a common characteristic of chaotic systems. In fact, Batterman (1993) argues that exponential instability is a necessary condition for a system to be classified as chaotic. Batterman (1993) does not argue, however, that exponential instability is a sufficient characteristic for classifying a system as chaotic.

Underlying Order

Although chaotic systems are characterized by aperiodic or seemingly random behavior, they possess an underlying order. Every chaotic system contains unique boundaries that give the system structure and order. The boundaries of a chaotic system constitute what is formally known as a strange attractor (Shuster, 1988). For an explanation of strange attractors as well as other types of attractors see Keaten et al. (1994).

Chaotic behavior is depicted visually in phase space (Ditto and Pecora, 1993, p. 80). Phase space "refers to the domain in which the system operates. It provides an arena for the system's performance; it is the home of a system's attractor" (Priesmeyer, 1992, p.18). Phase space is based upon state space. That is, when plotted in state space, each data point represents an individual state, or potential initial condition, of the system.

Phase space, then, is the evolution through all potential states (Tufillaro, Abbott, Reilly, 1991, p. 11).

Strange attractors appearing in phase space are indeed strange because of two fundamental properties. Ruelle (1991) explains that appearance and sensitive dependence on initial conditions distinguishes the strange attractor from other attractors:

> First, strange attractors look strange: they are not smooth curves or surfaces but have "non-integer dimension"...next, and more importantly, the motion on a strange attractor has sensitive dependence on initial condition. (p. 64)

The chaotic attractor never intersects itself, because returning to a point already visited would create a motion that would repeat itself in a periodic loop (Gleick, 1987, p. 140).

The irregularity of the motion of a strange attractor is an artifact of stretching and folding (Stewart, 1993, p. 143). Motion on an attractor stretches and folds. That is, motion will stretch to the bounds of the attractor, but eventually will have to fold back upon the attractor once the bounds are attained. "Although points close together move apart, some points far apart move close together" (Stewart, 1993, p. 143). The constant stretching and folding forces points to <u>mix in finite time</u>.

Ruelle (1991) refers secondly to the notion of initial conditions (p. 64). As noted previously, the method in which a chaotic system behaves is highly dependent on initial conditions. In other words, sensitivity to initial conditions suggests that each input "evolves into an overwhelming difference in output" (Morris, 1992, p. 331). This is where the "butterfly effect" marks a chaotic system. That is, if "small perturbations remain small...instead of cascading upward through the system...the cycles would be predictable--and eventually uninteresting" (Gleick, 1987, p. 23).

Integrating Cybernetic Theory and Chaos Theory: Cyberchaos

Like all theories, both chaos theory and cybernetic theory exclude certain concepts. Cybernetics describes, in detail, the variables (i.e. quantity of information) and processes relevant to system behavior; however, cybernetics does not provide a framework for describing complex, seemingly random behavior. Chaos theory, on the other hand, provides a framework for describing behavior that is complex and seemingly random; however, it does not provide a conceptual framework or specify variables for study. By combining cybernetics and chaos, researchers will have a framework which both specifies salient variables and provides a method for detecting complex patterns.

The theoretical integration of cybernetics and chaos theory is justifiable for a number of reasons: (1) shared theoretical foundation, (2) shared utility, and (3) overlapping descriptions of system behavior.

Shared theoretical foundation. Both cybernetic theory and chaos theory were constructed using the constructs of general systems theory (Bertalanffy, 1962). Therefore, both theories focus on constructs such as structure, function, and evolution.

Both theories subscribe to general system principles, such as nonsummativity and wholeness. In addition, both cybernetics and chaos theory examine patterns of behavior without identifying meaning, which is a key characteristic of general systems theory. Fisher (1978, p. 212), when describing systems theory, points out that internalized phenomenon are not the focus of study: "introspection of self, along with such internalized phenomena as perceptions, attitudes, images, and values, take on less significance..."

Shared utility. Both theories have been used to examine patterns of behavior present in complex adaptive systems (Levine & Fitzgerald, 1992). Cybernetic theory has explained a plethora of systems, including machines, biological systems, organizations, and individual human behavior (Rapoport, 1968). Chaos theory, like cybernetic theory, has been applied to a wealth of systems. Scholars from a variety of disciplines, such as political science, medicine, astronomy, economics, physics, biology, and meteorology, have used chaos theory to understand complex behavior (Dresden, 1992).

Overlapping descriptions of systems behavior. The final commonality between cybernetics and chaos rests in the overlapping descriptions of system behavior. Cybernetics focuses on self-regulation through positive and negative feedback loops. Chaos theory examines seemingly random behavior produced by stretching and folding. When examined carefully, a remarkable parallel can be seen between cybernetic and chaotic descriptions of system behavior.

As discussed earlier, behavior within a chaotic system is characterized by the concepts of stretching and folding (Stewart, 1993). Stretching or divergence refers to movement away from a point of attraction. In direct contrast, folding or convergence refers to movement toward a point of attraction. The oscillation between stretching and folding within a system generate chaotic behavior, formally known as a strange attractor.

Behavior within a cybernetic system is regulated by feedback. Feedback is classified as either positive or negative. Positive feedback is described as deviation away from a goal state, referred to as entropy. Positive feedback has been characterized as a deviation amplifying mechanism. Negative feedback is an error correction mechanism which signals the system to return to a specified goal state, sometime referred to a negative entropy.

If one equates a goal state with a point of attraction, descriptions of behavior found in cybernetic and chaotic theory are identical essentially. Positive feedback is essentially a stretching motion within the system. Behavior of this type is characterized as divergent, or moving away from a goal state or point of attraction. Negative feedback is the antithesis of positive feedback. Behavior is characterized as convergent, or moving toward a goal state or point of attraction.

Table one illustrates the similarities of cybernetic and chaotic descriptions of behavior by placing the descriptions into one of two categories, referred as type I and type II motion.

Table One

Two General Types of System Behavior

Type I Motion	Type II Motion
Positive Feedback (Cybernetics)	Negative feedback (Cybernetics)
Entropy (Cybernetics)	Negative entropy (Cybernetics)
Stretching (Chaos)	Folding (Chaos)
Divergence (Chaos)	Convergence (Chaos)

In summary, the integration of cybernetics is justified for a number of reasons. First, cybernetics and chaos are complimentary theories. Cybernetics provides the subject matter for study (information patterns) and chaos provides a method for complex pattern detection. Second, cybernetics and chaos adopt a systems view, focusing on constructs such as structure, function, and evolution. Third, both theories have been used to describe a wide variety of systems. Forth, and finally, cybernetics and chaos focus on the same type of system behavior, divergence and convergence.

Using the concepts of both cybernetics and chaos, the following model of cyberchaos is advanced. Cyberchaos focuses on complex patterns of information within a system.

Model of Cyberchaos

By combining the salient characteristics of both cybernetics and chaos theory, a model of "cyberchaos" can be created. The following is a description of the ten principles of cyberchaos. The origin of each principle is noted parenthetically.

1. The function of information is to reduce uncertainty. Information within a cyberchaotic system refers only to ideas that reduce the number of acceptable alternatives. Therefore, information concerning the opinions of system members is not included in the conceptualization of information. That is not to say that system members' opinions do not influence the amount of information. In fact, opinions might trigger a positive or negative feedback loop. (Information theory: Cybernetics).
2. Quantity of information is the primary variable of study. Of particular interest to cyberchaotics are the changes in the quantity of information over time. (Cybernetics).
3. Communication serves a regulative function in that it signals the system either to increase information (positive feedback/divergence/entropy) or to decrease information, referred to as either negative feedback, convergence, or negative entropy. (Regulation and Control: Cybernetics).
4. Feedback loops are not viewed as dichotomous. Instead, feedback loops contain information as to how much of an increase or decrease is desired by the system. Feedback, therefore, is viewed on a continuum ranging from generate

information to eliminate information. (Nature of feedback: Cybernetics).

5. Patterns generated by increases and decreases in quantities of information are dynamic and can possess both linear and nonlinear elements. Small changes in information quantity can escalate into large changes (Sensitivity to initial conditions: Chaos theory).

6. Information patterns are produced by to opposing forces: divergence and convergence. Patterns are the result of information processing rules developed by or placed upon the system. (Operating rules: Cybernetics).

7. System behavior is unpredictable. Although short-term prediction of system behavior might be accurate to a certain degree, the accuracy of prediction is an inverse function of elapsed time. (Mixing in finite time: Chaos theory).

8. Although the pattern of information amounts increase and decrease may be produced by a large number of variables, the pattern itself can be described using a small number of nonlinear combinations of variables. (Underlying order: Chaos theory).

9. A systems maintains boundaries relevant to information generation and storage. For example, if a system generates too much information during a positive feedback loop (i.e. divergence, entropy) the system will reach information overload or saturation forcing the system into a negative feedback loop (convergence/negative entropy), causing the

system to decrease the amount of the information (System boundaries: Chaos theory).

10. The boundaries of a system generate a strange attractor. The attractor is a phase-space artifact of changes in information quantity. (Strange attractor: Chaos theory).

The cyberchaotic model, described above, is limited in its scope. The model excludes the internal phenomena related to communication as do other system based models. The cyberchaotic model focuses on the content dimension of communication (Watzlawick, Beavin, & Jackson, 1967) and does not measure the direct impact of variables relevant to the relational dimension. Despite the limitation, the true test of a model rests in its utility. The following section will present an argument for the use of cyberchaos to explain the structure of decision making in small groups.

Applying Cyberchaos to Decision Making Groups

The cyberchaotic model might serve as a tool for uncovering the complex and dynamic structure of decision making groups. Decision making groups are an ideal context for the application of the cyberchaotic model for a number of reasons: (1) information is central to decision making groups, (2) the structure of decision making is complex, and (3) scholars have identified patterns of convergence and divergence within decision making groups.

Centrality of information

Scholars agree that "information is crucial to decision making" (Rothwell, 1994, p. 155). Kelley and Thibaut (1969) stated that the ability to collect and store information is the single most important determinant of decision making quality. Hirokawa (1992) asserts that the "information available to a group plays an important role in all phases of the critical reasoning process" (p. 173).

Complex Structuring

For many years, researchers have tried to describe the structure of decision making (see Applebaum, 1992). Early models of decision making characterized structure as linear (Bales & Strodtbeck, 1951; Bennis & Shepard, 1956; Fisher, 1970; Tuckman, 1965). More recent research, however, has shown that the linear model is overly simplistic (Krueger, 1979; Poole, 1981, 1983; Scheidel, 1986). Sheidel (1986, p. 130) cites the limitations of simplistic models and advocates a complex view of decision making:

> An overly simplified view of human decision-making may prevent us from studying the tradeoffs faced by genuine social groups...In sum, the argument here is that a more complex view of the small decision-making group...can lead to improved theoretical development and understanding.

Evidence of Cyberchaotic Behavior

In a surprising number of studies, researchers have reported patterns that correspond closely to cyberchaotic behavior.

Recall that cyberchaotic behavior is characterized by oscillations between convergence and divergence. For example, Scheidel and Crowell (1964, p. 143) describe idea development as consisting of "reach-test" types of motion:

> Group thought seems to move forward with a "reach-test" type of motion, that is, one participant reaches forth with an inference which seems to be elaborated at length with movement of clarification, substantiation and verbalized acceptance.

The motion described in the above quotation is identical to divergence-convergence. The selection of the term "reaching" by Scheidel and Crowell (1964) suggests a deviation from the existing condition of the system, which is remarkably similar to the description of a positive feedback loop. Scheidel and Crowell (1964) also found that the divergence-convergence pattern was highly unpredictable. In short, Scheidel and Crowell describe idea development as a highly unpredictable sequence of convergence and divergence. This description fits well with the principles of cyberchaotic behavior (see principles six and seven of Cyberchaos).

Another example of cyberchaotic behavior in decision making groups was discovered by Krueger (1979). She found that groups with initial conditions that were similar evolved and concluded in vastly different ways. She found group communication was characterized by nonlinear patterns of change. Krueger (1979) was describing the second tenet of chaos theory, sensitivity to initial conditions, which states that a small change in the initial position of a chaotic system produces exponential differences as the system moves through time.

Rothwell (1994) described a ripple effect in small groups which parallels closely the notion of sensitivity to initial conditions, which posits that a small change in the system can produce a large change over time. Rothwell (1994, p. 29) uses the analogy of a pebble tossed into a pond to explain the ripple effect: "a pebble tossed into a pond disturbs the water and forces adjustment."

Another example of cyberchaotic behavior was described by Scheidel (1986). He reported that divergent and convergent thinking are central to group decision making. Scheidel (1986, pp. 117-118) described the process of divergences during small group decision making as:

> ...an activity of searching for and generating ideas. In this mode, ideas are developed, analyzed, examined, explored, expanded, and unfolded...The habits of mind employed are those related to searching and invention, information sharing, and the suspension of judgment. Divergent thinking is a cumulative process.

The description of divergent thinking provided by Sheidel (1986) is identical to the description of a positive feedback loop, in which a system increases its quantity of information. The antithesis of divergent thinking is convergent thinking.

Scheidel (1986, p.118) explained convergent thinking by describing the nature of activity and habits of mind:

> It is an activity of comparing and evaluating ideas. In this mode ideas are classified, narrowed, refocused, selected, eliminated, and synthesized...The habits of mind employed are those related to an application of norms, standards, and criteria.

Scheidel (1986) provided a rich description of the convergence and divergence process in small groups. He outlined the function of communication during both processes. Scheidel (1986) did not provide, however, a model that explains the patterns generated by convergence and divergence during decision making.

When examining time spent in either positive or negative feedback loops, empirical evidence suggests that groups spend a minority of time in positive feedback loops. Bales (1970) estimates that one-forth of a group's time is spent generating information. Perhaps this is why some groups mandate positive feedback loops. One example of a positive feedback loop or divergence is referred to as brainstorming (Scheidel, 1986). Brainstorming is a prototypical example of a positive feedback loop or divergence. The sole function of brainstorming is to generate ideas or information (Seibold, 1992).

Summary

Although the above discussion describes evidence for cyberchaotic behavior, it is by no means exhaustive. Many scholars, including the ones described above, have attempted to explain the complexity of human interaction. However, the models they employ have been limited by overly simplistic assumptions.

In short, an argument has been given for the application of cyberchaos to decision making groups. The model serves to identify complex patterns related to information quantities. Like all models, a number of concepts are excluded from the cyberchaotic model. However, the goal of the model is not to explain all aspects of group decision making. Instead, the model provides a theoretical framework for the analysis of groups which has been identified as a major gap in the group literature. As Applebaum (1992, p. 145) states:

> ...we have barely scratched the surface in attempting to understand how the process of group decision making operates. A major gap in our literature appears in decision making...We lack a single generalized theory to describe the phasic structure during decision making.

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