The Potential

Group Problem-Solving via Computer Conferencing: The Realizable Potential

Don Beckwith

Abstract: While computer conferencing has been in vogue for a number of years, its most promising potential — group problem-solving — has yet to be realized. Instead, the medium is used almost exclusively for electronic mail (the transmission of private messages between users), electronic bulletin boards (the public dissemination and discussion of information and ideas), and topic discussions. Though the research and experience-based literature offers — in bits and pieces — relevant suggestions to overcome this problem, still needed are a) a model of group problem-solving, b) a set of comprehensive, testable principles designed to facilitate group problem-solving, and c) an interaction process analysis instrument that could be used in research of a group problem-solving technology appropriate to computer conferencing. This paper attempts to satisfy such needs.

INTRODUCTION

The realized and unrealized potentials of computer conferencing are many. In its chameleon-like, distance-limiting applications it can be used as: a) a fast, private message system between two or more users; b) an updatable, public information dissemination and exchange system; c) a closed or open electronic forum for discussions of issues and interests; and d) a means of bringing together diverse and dispersed elements of a collective intelligence to create original processes and solutions to substantial social problems.

Computer conferencing has the capability of bringing like-minded and not so like-minded individuals together for a variety of socially worthwhile interactions which can range from information exchange, through social interaction, to purposeful change through group problem-solving.

THE PROBLEM

In all applications of newer media those potentials that are easiest to implement receive the highest level of realization. Just as CAL and interactive videodisc have gravitated

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to the more easily applied programmed learning model rather than to the more difficult-to-apply learner-creative and learner-controlled interactive applications, so too has computer conferencing, thus far in its short history, allowed the easier applications to predominate. The predominant applications, while easier to implement, are obviously fulfilling needs. Three of the largest computer conferencing networks boast impressive usage figures: The Conferencing System (CoSy) at the University of Guelph has 400 off-campus users, subscribers in 28 countries, and about 250 active conferences; the Electronic Information Exchange System (EIES) at the New Jersey Institute of Technology has 2500 worldwide participants; and the PARTICIPATE system at the New York Institute of Technology has 60 faculty members who use computer conferencing to tutor external students (Kaye, 1985).

But to limit the medium primarily to electronic mail, bulletin board-type information exchanges, and topic discussions is perhaps to divert energies from the development and application of a unique potential of computer conferencing, namely creative group problem-solving. While electronic mail, bulletin board and discussion applications (as their names suggest) are improved variations of existing technologies (cutting through time and distance constraints), the type of group problem-solving that could be effected via computer conferencing could go beyond merely providing an improved variation of existing problem-solving technology, to the creation of an original problem-solving technology.

The ease or difficulty lies not in how complex or simple the various applications are. Rather, it is a matter of whether or not preliminary ground work has been done. If an application of a newer medium is just a new form of an old technology, the implementation is rather simple, for the operating principles and procedures have already been worked out and debugged. For example, a computerized mail service (electronic mail) will tend to follow such established older technology principles as addresses, mailboxes, filing by classification, private reading, return addresses, and so on. Similarly, when putting a bulletin board on a conferencing system, we know from experience with the older technology to make the information readable, classified by topic, updatable, and scanable; and to provide mechanisms for keeping track of read messages, responding to messages, and so on. Likewise a computer conference discussion tends to follow the established guidelines of the older technology of face-to-face meetings, such as having moderators, leaders, rules of appropriate interaction, and summaries.

The process of putting an old technology into a new medium is simplified because we can concentrate on including all the good elements of the extant technology and at the same time look for ways in which the new medium can improve upon these. Thus the computer conferencing applications of electronic mail, bulletin boards and discussions can provide the same services as the established media, only faster and with a greater capacity for manipulatable information. When an older medium (e.g., the postal service, bulletin boards, newsletters, face-to-face meetings) is satisfactorily providing a service, a newer medium can focus its energies on improving the existing service. When an older medium, however, is not providing a satisfactory service, a newer medium must focus its energies on creating an original means to satisfy the desired ends. The newer medium of computer conferencing may be the only current means for effecting satisfactory group problem-solving. Group problem-solving may very well be the unique application of computer conferencing.

The forces mitigating against successful group problem-solving using older technologies are many, not the least of which is the almost impossible task of assembling all of the people with the required expertise for as long as the process takes. Even more difficult is structuring the interchange of ideas so that: a) early ideas are not lost; b) ideas are

meaningfully built upon; c) more forceful individuals do not monopolize the focus, content, and solutions; d) the appropriate expertise is tapped at the appropriate time; e) there is a systematic and systemic building of successive approximations to the problem solution; f) creativity is not lost to rationality; and g) there is time to digest, rethink, reword, and restructure emerging ideas and information.

WHAT IS PROBLEM SOLVING?

Since the term *problem-solving* has been used to describe a host of activities, from simple arithmetic sums and moral dilemmas to world peace efforts, with its critical attributes and potential applications changing according to the level and intensity of purpose, the following operational definitions are offered. It is suggested that yet a higher form of problem-solving may be effected through computer conferencing.

Traditional Definitions

One of the earliest definitions of problem-solving still has validity: Dewey (1910) describes problem-solving as a procedure that includes a) presentation of the problem, b) problem definition (distinguishing essential features of the situation), c) hypothesis formulation, and d) successive hypothesis verification until one is found that achieves the problem solution.

While this definition implies creativity in the product of problem-solving, more recent definitions imply creativity in both the product and the process of problem-solving. For example, Gagné and Briggs (1979) offer that problem-solving is the ability to solve real or intellectual problems by applying complex rules created from simpler rules. In perhaps a more elegant definition, Gagné (1985) suggests that, "problem-solving may be viewed as a process by which the learner discovers a combination of previously learned rules and plans their application so as to achieve a solution for a novel problem situation" (p.178).

Toward a Potential Definition/New Definition

Though the above-mentioned definitions sufficiently describe problem-solving behavior conducted by the individual with access to the older technologies, they cannot begin to describe the type of problem-solving that is possible through groups with access to the newer technology of computer conferencing.

Example. To illustrate the type of group problem-solving that might be possible through the imaginative application of a potential technology for computer conferencing, the following account is offered (Beckwith, 1986b): A few years ago I was teaching a graduate course in Interactive Technology, designed to analyze some of the newer media's potential for facilitating learning. The course concentrated on the newer media of videodisc, computer conferencing, teleconferencing, and video conferencing. With a limited (next to nonexistent) budget, I had to come up with ways of simulating each of the newer media so that the learners could experience them enough to analyze and evaluate their potential worth and application to the teaching-learning process. How to simulate computer conferencing, with no computers that could be inexpensively or quickly networked, was causing a problem. At that time the primary application of computer conferencing was that of an asynchronous bulletin board through which participants could send and receive messages. The idea of using a real bulletin board was suggested. From a cluttered storage area came an

old, portable 4 x 6 ft. bulletin board on wheels. This was positioned in a hallway corner, giving access to the students before, after and during class. A stack of 3 x 5 index cards and thumbtacks were provided.

The assigned group problem-solving task was to create appropriate and innovative applications of the newer technologies in order to improve learning in formal and informal settings. The task was to be completed by the end of the semester. Within a very short time the bulletin board was rapidly being covered with cards, each card with a number, a topic, a message/comment, and a signature. Some cards were addressed to the writer of a prior message. These responses, if space allowed, were positioned next to the the message being responded to. When space did not allow such positioning, some of the students connected the related messages (cards) with red cardboard arrows. Experts were introduced through citations and quotes. From time to time someone would rearrange the cards by topic areas, using arrows to cross-index related comments between topics.

While the messages were interesting, with most of the ideas contained within coming from the students' outside readings, they didn't seem to be leading toward task completion. Rather, by the end of three weeks we had a bulletin board filled with disparate bits of information, all related in some way to the educational potential of the newer media, but with no creative focus. There it sat for two weeks — a seeming eternity. Occasionally a student would reread the cards, attempt a partial rearrangement.

Then it happened. The cards disappeared, being replaced by a large sheet of paper that covered the entire bulletin board. An idea, unsigned, unnumbered, without a designated topic, was written near the middle. Then it happened again. Someone crossed out part of the idea, substituting other words and adding another idea. From that point on the bulletin board was never the same; group creativity and problem-solving had taken over, had replaced information exchange. Some ideas were cut out, others edited, others repositioned, still others partly or completely covered up by clean paper or other ideas. The size of the bulletin board expanded by using the adjacent walls and by tacking or taping ideas to the frame so that they dangled to the floor. Some ideas were added marginally, others on huge sheets of added paper. Ideas were cut, spliced, edited, amalgamated, expunged (some to reappear time and again in different form or in a different location). Most of all, ideas were being built upon. A group focus and purpose took hold. Information explosion was replaced by idea implosion.

What emerged, in a very short time, was a very sophisticated story board for a video production dealing with the issue at hand. Taped to the floor was a production schedule and roles assigned to each class member. The group had successfully created an original process to effect an original product. It is hoped that this example illustrates, albeit in a crude way, how a new technology applied to computer conferencing (if only a simulation) may be capable of effecting an innovative type of problem-solving. It is further hoped that the example will provide a sufficient context for the proposed definition that follows.

A definition of group problem-solving. Group problem-solving is the mutual creation of an original, synergistic and synectic process — using relevant media and human and nonhuman resources — that will yield an original systemic product specifically designed to satisfy a substantial and verified social need that has not been sufficiently satisfied through traditional means.

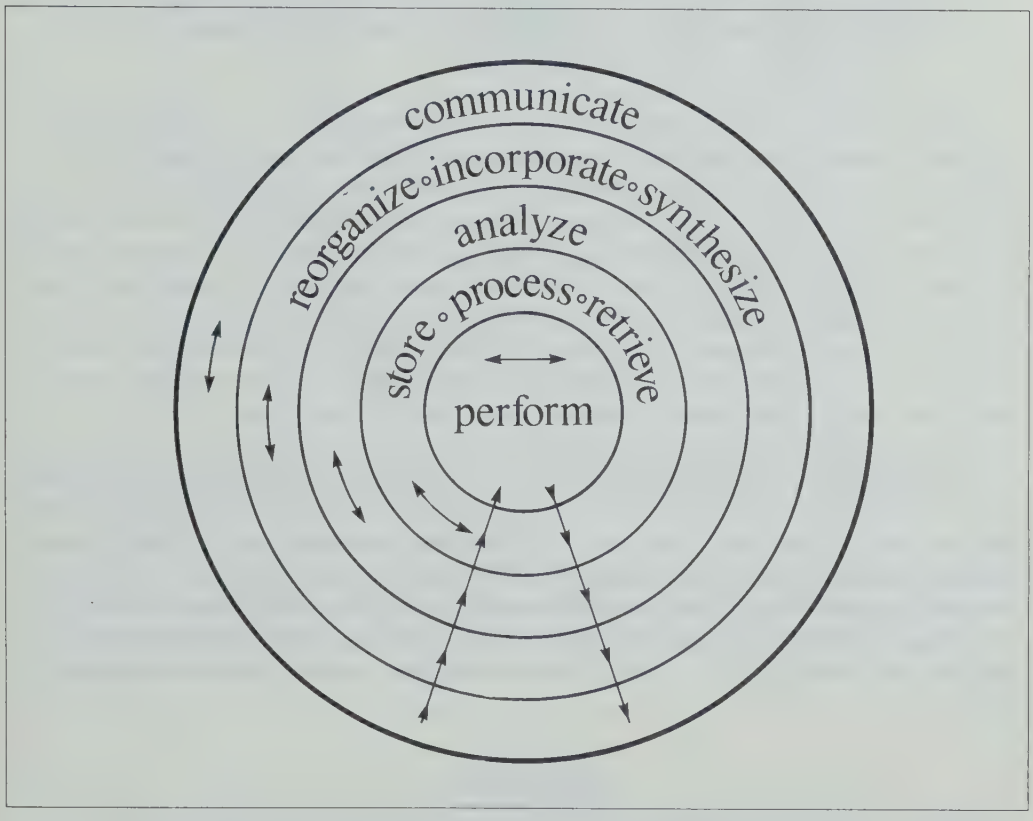
It is this type of group problem-solving that computer conferencing may have the unique potential to effect. The types of problems to be addressed by group problem-solving are not those that can be solved with existing problem-solving technologies. Rather, they

are the types of problems that the older technologies have been unable to satisfactorily resolve.

A Model of Group Problem-Solving Behavior

Group problem-solving is, of course, an interactive process. The interaction takes three forms: between group members, between individual members and information (in this case, the information inputted to the computer conferencing system), and within each member of the group. Beckwith (1983, 1984) has developed a model to depict these interactions. Within the interactive process five behaviors — a) performing, b) storing/processing/retrieving, c) analyzing, d) reorganizing/incorporating/synthesizing, and e) communicating — must be successfully integrated by each individual within the group (see Figure 1).

FIGURE 1. *The Interactive Group Problem-Solving Process: The Individual.*



The interaction may occur between any two or more of the five behaviors, or within a single behavior, or both within and between simultaneously. This same range of interactions may also occur within an individual, between individuals, and between individual and information simultaneously. During the group problem-solving process the interactive behaviors may take a variety of forms. Some examples follow:

1. *Performing* — a) absorbing and manipulating new information; b) learning interactive skills; c) imitating others' modeled performances; d) trying out new and

modified cognitive and valuing strategies; e) effecting temporary closure on successive approximations to the problem solution;

2. *Storing/processing/retrieving* — a) controlling and applying information related to the process of problem-solving; b) absorbing and manipulating new information; c) absorbing and manipulating feedback on performance;
3. *Analyzing* — a) discovering the interactive and interdependent components of performances of self and others; b) studying current thinking and introspective processes;
4. *Reorganizing/incorporating/synthesizing* — a) piecing together seemingly unrelated bits of information from performances, storage, analysis, or communication; b) building, from extant and potential information and process bits, toward a problem solution; and
5. *Communicating* — a) sharing successful and unsuccessful strategies; b) reacting and responding to others' strategies; c) verbalizing thinking and introspective processes; d) imaging potential realities.

If the problem-solving process is complex for the individual, it is even more complex for a group. During the process the group is trying to create a purposeful system (i.e., a solution) from a set of existing and potential components. This involves a number of sophisticated procedures. The group must be able to: a) image a purposeful system from any set of given and potential components; b) analyze relationships between components (at their interface points) in order to determine the status quo (an analytical/deciphering procedure) and the ideal (an imaging procedure); c) develop, test and modify hypotheses about existing and potential relationships between components; d) analyze relationships within components (e.g., humans, resources, information); and e) build successive approximations toward this ideal (i.e., the problem solution). (See Figure 2 on next page).

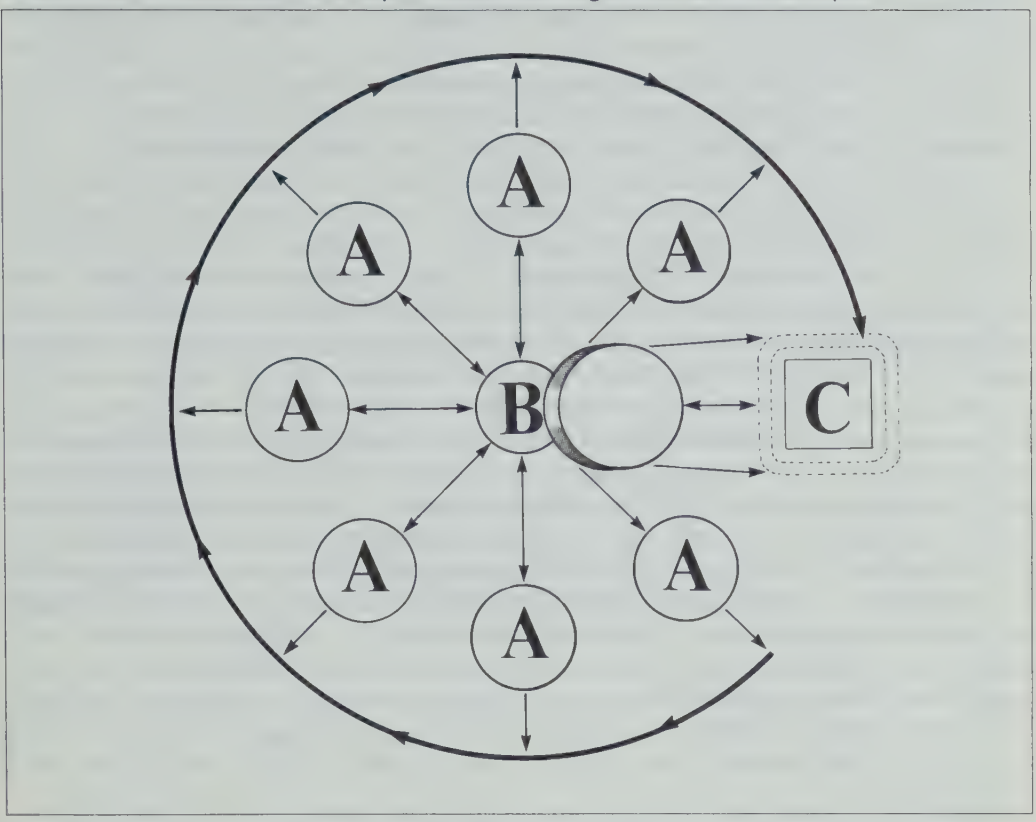
Just as within the individual, these procedures, or parts thereof, may occur simultaneously. The benefit of group problem-solving is that not every member of the group must be a master of each procedure. In fact, even the behaviors that interact within the individual during the problem-solving process may be learned and/or fine-tuned as the group proceeds toward its goal. With the appropriate group membership and appropriate use of computer conferencing, worthwhile, efficient and effective group problem-solving (the type of problem-solving that is a transfusion of the ideal into the status quo rather than a series of band-aids, each attending to the seeming most pressing need of the moment) can become reality.

TRANSITION

Thus far this paper has attempted to look generally at the unrealized potential of computer conferencing; and, specifically, at the nature of group problem-solving, an application that could prove to be the unique potential of computer conferencing.

Using this as a foundation, the paper will now present a) the ideal (i.e., how the researchers and developers in the field of computer conferencing envision the ultimate potential of this newer medium); b) the status quo (i.e., where we are now in relation to the ideal); and c) constraints (i.e., possible human and system obstacles that lie in the path leading from the status quo to the ideal). Finally, the paper will present d) a set of principles

FIGURE 2. *The Interactive Group Problem-Solving Process: The Group.*



Note: A = Each member of the group. B = The status quo at any frozen point (the problem state and relevant information. C = The ideal at any frozen point (the evolving solution).

for computer conferencing, designed to facilitate passage from the status quo; over, around and through the constraints; to the ideal; and e) an interaction analysis instrument, designed to operationalize the principles and serve as a research tool to aid in the further study of group problem-solving through computer conferencing.

THE IDEAL

We have a medium in front of us that is capable of bringing together large numbers of uniquely-held individual skills, ideas, abilities, attitudes, and values, and affording those participating the opportunity to collectively and purposefully manipulate, build upon, create from, collapse and expand those abilities, skills, ideas, attitudes, and values; this in order to, in a relatively short period of time, create viable and acceptable solutions to social problems, be they local, national or international. Regardless of the nature or size of the problem to be addressed, the necessary expertise in theory, practice, leadership, subject matter, catalysis, moderation, idea generation, creativity, politics, experience, realism, idealism — from wherever — can be brought together. Regardless of the size of the

participant input to the problem-solving conference, the capacity to purposefully control, govern, edit, manipulate, keep in manageable communicative form, build upon, direct and focus is all there. Regardless of the type of problem addressed, the results will more than compensate for the technological expenditure, for computer conferencing applied to collective problem-solving offers the opportunity for users to link their own uniqueness with that of others in order to achieve some mutually satisfying, worthwhile, altruistic goals.

The realization that computer conferencing is not achieving its potential has been shared recently by a number of devotees. It has been said that this newer medium has not yet found its proper niche (Humphrey, 1986) and that its best advantage must be exploited for its potential unique educational applications (Kaye, 1985). Boyd (1986) has suggested that such an advantageous exploitation might be epitomized by a cooperative search for truth (as described by Habermas, 1973), a democratic experience enjoyed by geographically separated adult learners. This type of application could yield a collective wisdom through the non-simultaneous interactions of computer conferencing participants (Stevens, 1986). A particular desirable outcome has been predicted by Kott (1986) who suggests that computer conferencing could be applied in business and industry to create a new corporate paradigm, one in which authoritarian management would yield to a networking, people-oriented management, thereby increasing the probability of the organization reaching its goals and objectives.

Two comments on a recent CoSy conference suggest some computer attributes which are essential for outcomes such as these to be realized: "I am looking forward to the system that makes intuitive leaps with a bunch of material and helps the thinker look for new patterns, new relationships, etc." (A. Augur, computer conference comment, April 19, 1985); "What I'm looking for is a computer programme that helps me perceive — or think in a fashion — things I have never seen before" (C.S. Hunter, computer conference comment, April 19, 1985).

THE STATUS QUO

While the group problem-solving ideal has been clearly envisioned, the status quo reflects only limited success toward this goal. The fact that the three most difficult applications of computer conferencing to implement — i.e., group product creation community decision-making, and inter-community networking (E. McCreary, computer conference comment, September 24, 1986) — happen to be the three applications which come closest to reflecting group problem-solving, provides little comfort, especially when the evidence suggests that the major efforts in computer conferencing are going into the easier-to-implement applications. In reporting on the proceedings of a recent computer conferencing workshop held at the University of Guelph, Humphrey (1986) relates that one critic compared current applications to those found in citizen band radio discussions and pen pal letters. Nevertheless, there has been some progress made toward the ideal.

Limited Success Toward Group Problem-Solving

There appears to be a general satisfaction with efforts to incorporate aspects of group problem-solving, among those few who have ventured toward the ideal. The International Institute for Applied Systems Analysis, for example, has created some successful group projects (e.g., experiments and reports) via computer conferencing (Umpleby, 1986c). EIES developers are satisfied that achieving consensus and joint preparation of working group

reports are facilitated by computer conferencing (Kaye, 1985). Qualitatively-based research conclusions have been offered as guidelines by those who have attempted to achieve group problem-solving through computer conferencing structures. According to Turoff and Hiltz (1983) successful reaching of consensus has been facilitated by a) the election of a leader, b) the continued suggestion of compromises, c) leadership attempts at getting the group's ideas and focuses together, and d) a pushing toward research-based decisions. These suggestions, however, tend to imitate some of the successful methods applied in face-to-face meetings and may be seen as methods which foster efficiency rather than effectiveness. The researchers also feel, by insisting upon participant anonymity (in the form of a real or pseudonymous first name only), that the EIES computer conferences have been successful in reducing the common biases toward age, ethnicity, physical image, political status, sex and social class, and thereby increasing the focus upon important social goals and how the group may work together for the achievement of these goals. They have found, for example, that comments and suggestions by experts and novices within a given field receive equal attention and are judged on their intellectual and/or practical merits alone.

In exploratory studies designed to compare the abilities of face-to-face meetings and computer conferences to effect consensus decision-making, Hiltz, Johnson, & Agle (1978) reported significantly higher incidence of "tension release", "agreement" and "disagreement" behaviors in face-to-face participants, and significantly higher incidence of "asking for opinions" behavior in computer conference participants. The results may suggest that a more cooperative type of problem-solving may be required in computer conferencing. The researchers also note that members of a computer conference cannot so readily impose sanctions against deviant or unpopular comments as can their counterparts in face-to-face meetings. This minimization of sanctions would appear to be essential if all necessary components of the collective intelligence are to provide their unique inputs.

In the opinion of Umpleby (1986b), some of the techniques used by Turoff and Hiltz in their EIES course *Human Communication and Computers* seem to offer the promise of facilitating group problem-solving behavior. For example, the course includes: a) interactions between two instructors holding differing opinions and/or representing differing disciplinary backgrounds; b) downloading of comments by alternative authors in the guise of guest lecturers; c) inputting a wide range of views in order to provoke comments; and d) relating a course topic to a current controversy in order to stimulate discussion.

Stevens (1986) reports that new capabilities such as branching topics into sub-topics and further branching into sub-sub-topics (which may then be selectively and productively joined) is already yielding increases in productivity, innovation and personal satisfaction in trial groups.

While these guidelines will be helpful in achieving closer approximations to group problem-solving, there are many constraints yet to be overcome.

Constraints

Constraints seem to fall into two categories: constraints of inappropriate or insufficient technological structure, and constraints of human habit, fear or limited perception.

Constraints of human habit, fear or limited perception. One persistent human habit that can have a deleterious effect on group problem-solving is that of calling in an expert for the "right" answer or solution. This may take the form of inviting an expert to participate and set things straight, the downloading of "correct" answers or viewpoints from a printed source, or referring other participants to a source that contains the "appropriate"

conclusions. Almost invariably, the act of calling on an expert seems to have a stultifying effect on the open, democratic process, and by giving credence to one participant (the expert) over others, a false sense of closure and a deadening of interactivity ensue (Beckwith, 1986a). Anonymity, on the other hand, enables the quality of ideas, rather than the status of the sender, to be fairly assessed (Beckwith, 1986b; Boyd, 1986; Turoff and Hiltz, 1983).

The notion that whatever we input to a computer conference is our own property, not to be violated (Turoff and Hiltz, 1983), is an idea that when implemented may very well preclude group problem-solving or a collective intelligence, but, as Vinson (1986) relates, participants seem to worry about others stealing their ideas. Vinson concludes that until copyright issues to determine who owns what are worked out, few scientists will be willing to take part in serious computer conferencing work. On the other hand, it seems reasonable to suggest that a collective intelligence can only become reality if all ideas belong to the collective, not the individual.

Vinson (1986) tells of a computer conferencing application that failed because more attention was paid to how the hardware works, rather than to how people work. Fear and paranoia led to its demise. Conclusions include, for example, that putting all participants on equal footing (be they managers or line workers) may cause discomfort to those near the top of the pecking order. So too may the appearance of information overload (since computer conferencing produces so much paper) fuel paranoia. Vinson notes that there seem to be strong indications that people are demonstrating a fear of losing control of: a) ideas; b) a power base; c) the rate at which they process and deal with information; and d) the process of change.

Constraints of inappropriate structure. An analysis of computer conferencing attempts at group problem-solving shows that appropriate principles and heuristics are not being applied to the task. Instead, often the principles and heuristics appropriate for electronic mail and/or bulletin boards are applied. For example, the linearity of sequentially numbered and displayed messages, which is appropriate to electronic mail, reduces the type of manipulative information control necessary for users to perform problem-solving tasks.

In a recent investigation (Beckwith, 1986a) of a large number of CoSy conferences purportedly designed to effect problem-solving, it was found that: a) the goals of the conferences were rarely met, and the conference efforts would almost invariably devolve to information exchanges, often at a very low or superficial level; b) almost without fail, messages, once followed by five or more additional entries, were lost or forgotten, never to be incorporated; c) because of an unsuitable structure for building solutions, the focus of a conference was easily shifted, often going completely off-task; and d) the labelling of participants (CoSy is not an anonymous or pseudonymous system) as illogical, extremely counter-productive, obscene, and so on, would tend to curtail future participant involvement. In a typical linear discussion, analysis is limited to: a) superficial, out-of-context reactions (often of an emotional or biased nature); and b) after-the-fact analysis, (i.e., analysis of the finished product [which often leads to a positive evaluation simply because *a* product has been created, the assumption being that it is the best that one could have hoped for]).

While more emphasis is needed on the social and organizational structures needed to support computer conferencing-based productive communication than on the hardware (Johansen, Vallee & Spangler, 1979), time and time again in our attempts to create social and organizational structures to support communication, we tighten the rules, thereby inhibiting productive communication rather than increasing it. If we are to facilitate

applications such as group problem-solving, we must loosen the existing, hardware-based structures to the point where users will be able to create their own appropriate structures. As Sprigge (1986) suggests, no computer conferencing structure is suitable for all situations. The structure appropriate for electronic mail, for example, is not appropriate for problem-solving. It should be up to the individual user to decide which of the many potential structures or combination of structures are optimum for a desired purpose. A conference designed, for example, for information sharing should not have the same structure as a conference designed for product development. But there are still computer conferencing application potentials that do not have structures yet; instead, users must make do with a structure designed for some other application. What is needed, if group problem-solving is to be realized, is a structured storage of comments that reflects how, *from each user's viewpoint,* the comments relate to each other.

For a newer technology to be qualitatively different from an older technology, it must permit its users to do new things (Kaye, 1985). Computer conferencing, using a newer technology, has the potential for being qualitatively different if it is applied as a means for satisfying a need such as group problem-solving, a need that is not currently being satisfied by older technologies.

While successful group problem-solving is a rare commodity at best, it would seem that it could be achieved via computer conferencing. What is needed is: a) an operational definition of successful problem-solving; b) a set of principles and heuristics to be followed in the application of computer conferencing to group problem-solving; and c) suggested ways of researching the effectiveness and efficiency of computer conferencing-based group problem-solving.

PRINCIPLES TO EFFECT GROUP PROBLEM-SOLVING

The Principle of Dynamism

Successful group problem-solving depends upon a dynamic (ever-changing) exchange of ideas. The interactivity of communication allows one the opportunity of modifying what someone else has said by building upon it, emphasizing some aspects, or deemphasizing others. It is this feature of a flexible, purposefully evolving language that gives the process of communication a greater importance than any single or combination of interim products. That is, the individual statements, or even groups of individual statements, sequentially strung together, become less important than the process of minds coming together through idea modification. The interim communication products (i.e., statements, questions) are only there to be changed by the process of communication. Successful communication is not, then, a frozen record of sequential ideas. Deemphasizing the notion of communication as a frozen record can facilitate the desired, dynamic interchange. (This does not, however, preclude having a frozen record in memory.) Those aspects of face-to-face communication that allow for easy idea modification and building are essential to the brainstorming and problem-solving processes.

The Principle of Anonymity

The notion of individual ownership and responsibility for ideas can foster competition, secrecy, or a fear of sharing. Anonymity, on the other hand, can promote joint ownership, positive sharing of responsibility, and the potential for group problem-solving. Individual

ownership and responsibility can inhibit secure and informal interaction, as well as preclude involvement, productive change, and group creativity. Anonymity, by contrast, especially when one is communicating in unfamiliar areas, can increase involvement and cooperation.

The Principle of Accessibility

The easier the access to ideas (communication attempts) and information, the higher the likelihood of potential user involvement. A successful communication system is user-friendly, in that if facilitates information retrieval, modification, exchange and sharing. For group problem-solving to be viable, ideas and information must be accessible to the group in *any* desired format.

The Principle of Control

Successful communication is more apt to take place if participants have a large measure of control over the communication medium. A user-oriented communication system — having a flexible format which reflects user needs — will tend to create a higher level of participation and involvement. Involvement in structuring and restructuring formats creates more of a sense of belonging. Thus an evolving system (evolving from user needs) ensures continued interest and participation.

If one can interact with information (regardless of the format) one can control that information. If one can control information, one can learn from and apply that information. The more interaction potential is inherent in the format, the more meaningful learning and application is likely to take place. Through control, a purposeful building incorporation of ideas and information is possible.

The Principle of Catalysis

In order for dynamism, anonymity, accessibility, and control to be maintained as an interacting set of principles, an omnipresent catalyst is necessary. At any given time the catalyst may take the form of one of the first four principles. For example, control might serve to ensure accessibility, which might serve to ensure anonymity, which might serve to ensure dynamism, and so on. The catalyst may also take the form, as needed, of any member of the problem-solving group, or any resource, information or idea provided by an individual or the system.

In an ideal group problem-solving enterprise the five principles enjoy complete, self-sustaining, systemic integration. To operationalize these principles into such an interactive system, some essential computer conferencing capabilities must be present.

Essential Capabilities of the System

These capabilities are suggested only as a starter set. If the principles are operating as intended, the addition of other essential capabilities will be directly proportional to the imagination and needs of the user group.

1. *On-line editing capability for all users, allowing the user to add to, subtract from, or otherwise modify (e.g., elaborate, emphasize, condense, rearrange, exemplify, and retransmit) any user's entry.* In other words, a user's response to a prior entry can take the form of a changed entry, in any desired format, to include text formatting, text mobility, text retrieval and linkages, branching of topics into sub-topics, and then selective topic joining and transfer of files to and from other systems.

2. *Anonymous entries or, if the user prefers, a self-selected pseudonym signature.* (Entries directed to particular pseudonyms should be possible.)
3. *Editing capability for all users, allowing them to modify the nature of the conferencing process.* For example, a user might institute a more appropriate menu or key word access system or stretch the maximum of lines allowed for an entry. In short, any system change, in an attempt to improve communication, should be encouraged.
4. *An evolving coding/classification system of key words, treed menus, and so on, to facilitate access to information of potential interest.*
5. *An on-going analysis of the types of entries that elicit the highest levels of interaction/communication/cooperation — translated weekly into revised user guidelines.* These may include voting or polling methods, assigning specialist roles to various group members, activities to increase interactive participation, user simulations, tutorial scripts to practice or imitate, and summaries.
6. *Synchronous communication.*
7. *Text search and retrieval by any access system.*

While the principles and system capabilities are deemed essential to the realization of group problem-solving, alone they are not sufficient. Also needed is some kind of formative evaluation mechanism to be used during the problem-solving process to ensure, through dynamism and catalysis, the most productive interactions. The mechanism offered is an interaction analysis instrument.

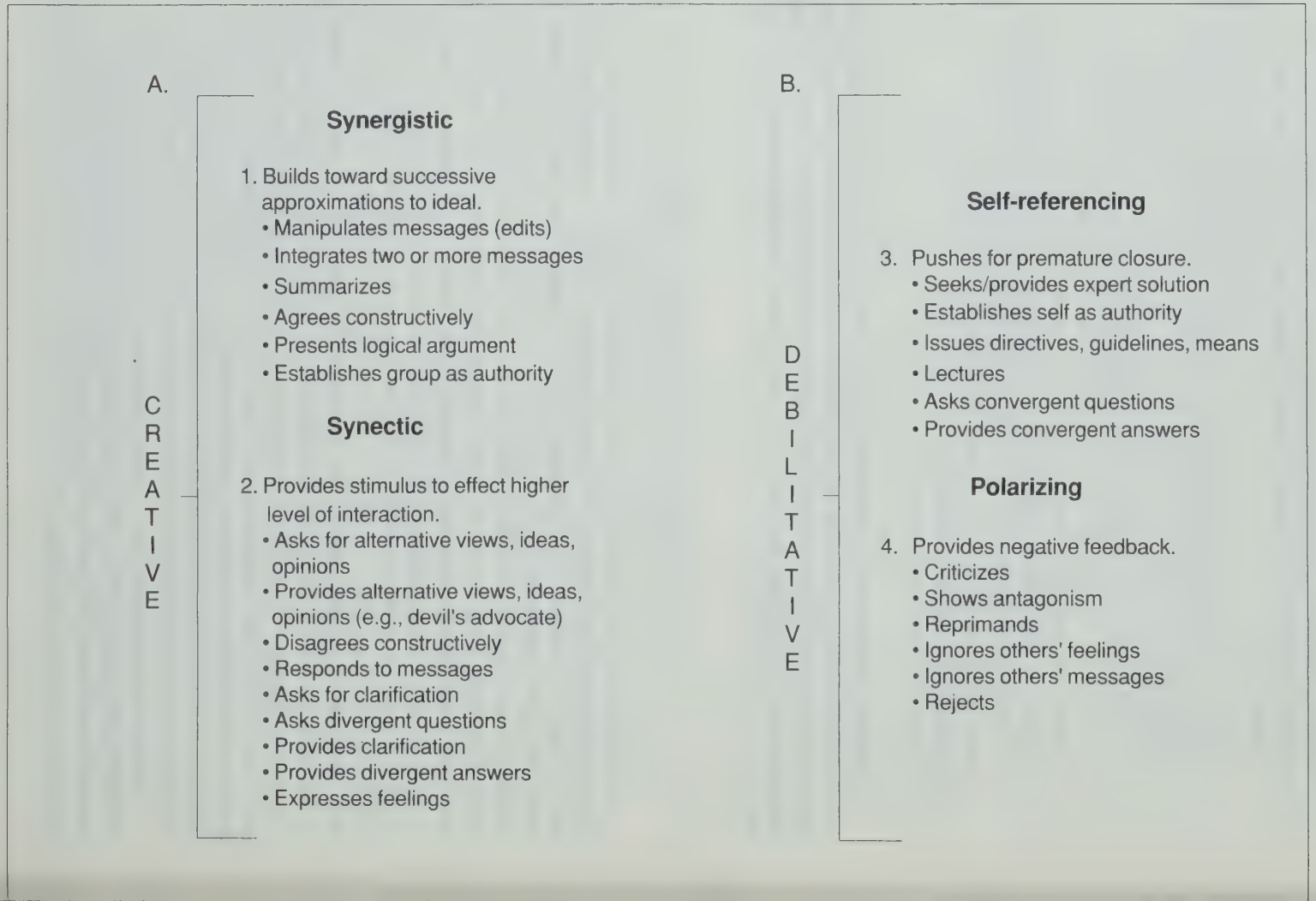
INTERACTION ANALYSIS INSTRUMENT

In order to create an interaction analysis instrument, other such instruments — namely those by Bales (1950), Flanders (1961), and Weilanders (1971) — were analyzed for their applicability. While none of the three instruments is designed specifically for computer conferencing or group problem-solving (Bales' is designed for face-to-face meeting interactions and both Flanders' and Weilanders' are designed for teacher-student interactions), each contains some classes of interactions appropriate to group problem-solving. By and large, however, since this instrument is designed specifically to analyze the process of group problem-solving, it is only tangentially comparable to other instruments (see Figure 3).

The interaction analysis instrument is divided into three categories of group interactive behaviors, labeled as creative, debilitative, and facilitative. In an ideal world only the creative category (A) — comprised of two sub-categories, synergistic and synectic behav-iors — would be necessary. The synergistic behaviors (i.e., those behaviors which converge toward consensual solution) play with and against the synectic behaviors (i.e., those behaviors which diverge toward alternative possibilitlies), thus ensuring that the group problem-solving process is dynamic and comprehensive as well as being on-task and integrative. In the real world, however, there are individual actions which tend to have a debilitating effect on creativity.

The debilitative category (B) — comprised of two sub-categories, self-referencing behaviors and polarizing behaviors — represents such individual actions. The self-referencing behaviors (i.e., those behaviors which direct individual angst and insecurities toward premature task resolution) play with and against the polarizing behaviors (i.e., those

FIGURE 3. *Categories in Interaction Analysis of Group Problem-solving Process.*



C.

FACILITATIVE

Group-referencing

5. Creates/maintains a problem-solving environment.
   - Focuses attention on relevant concerns
   - Rechannels off-task behavior
   - Provides positive reinforcement for creativity
   - Requests appropriate system changes to satisfy group process needs
   - Maintains open forum until full exploration has been achieved
   - Abates/reduces tension
   - Accepts others' feelings
   - Interjects humor
   - Releases tension

behaviors which tend to effect group dissolution through individual isolationism), thus ensuring that the group problem-solving process will not be successful.

The behaviors of the facilitative category (C), however, may be implemented to counterbalance or nullify the effects of debilitative behaviors. The facilitative category is comprised of one class of group-referencing behaviors (i.e., those behaviors which may be applied to transform debilitative behaviors into creative behaviors). Used appropriately, category C is the fail-safe mechanism.

This interaction analysis instrument may be used by a problem-solving group to provide feedback on their process toward problem solutions and to suggest possible means for removing obstacles as they arise. Applied as a formative evaluation tool, the instrument may be used to monitor, control and improve group progress. The individual group members, by focusing upon their and others' behaviors and the real and potential effects of these behaviors, will advance the proactive metacognition abilities of the group, thereby increasing the likelihood of reaching desired and desirable goals.

Seen as a testable hypothesis, the instrument may be used to research the group problem-solving process. Ethnographic research (naturalistic inquiry) might use the instrument as a coding tool to classify individual behaviors and analyze recurring correlations between behaviors or sets of behaviors. Action research might assign a group member the role of catalyst, whose task would be to use category C behaviors to transform category B behaviors to category A behaviors. Experimental design research might use category C (a set of behaviors) as an independent variable. These suggestions are put forth only as a few research possibilities, among many, that may further understanding of the group problem-solving process and the role of computer conferencing within this process.

CONCLUSION

The unique and ideal application of computer conferencing-based group problem-solving is yet to be realized. It is suggested that through the rigorous application of: a) the operational definition of group problem-solving, b) the group problem-solving models, c) the principles to effect group problem-solving, d) the essential capabilities of the system, e) the interaction analysis instrument, and f) the suggested research approaches, the unrealized ideal may become reality. A type of problem-solving that is at best rare in today's world could become a regular occurence.

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