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Group creativity and technology

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ABSTRACT

Despite the popularity of brainstorming, research has shown that verbal brainstorming is not always effective in increasing group creativity. On the other hand, its electronic counterpart, electronic brainstorming, appears to produce much better results. Is technology the panacea for group idea generation? This paper first reviews the theory of group creativity and then examines the characteristics of electronic brainstorming that makes it more effective than verbal brainstorming. From the success of electronic brainstorming, it then argues that the use of technology might be the key to overcome the space and time constraints that are commonly faced by creativity groups.

INTRODUCTION

Group work is a natural way of doing business (Johansen, 1988). Much office work occurs in groups: teams, project groups, committees, task forces, and so on. In fact, when decision-makers are faced with a genuinely important task, it is likely that a group will be assigned to the problem. Sometimes the reason is simply that one individual alone could not be expected to handle the complexity of the task (e.g., setting the strategic direction of a company or formulating a new employment policy which requires a diversity of knowledge and skills). Other times it is because decision-makers assume that the added human resources available in a group will lead

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to a higher quality product – or will at least lessen the chances that the product will be grossly defective. However, group work is a complex matter. Group interaction and performance are greatly influenced by the type and difficulty of the tasks that the group is performing (McGrath & Hollingshead, 1994). One way of supporting and facilitating group work is through the use of technology.

GROUP SUPPORT SYSTEMS

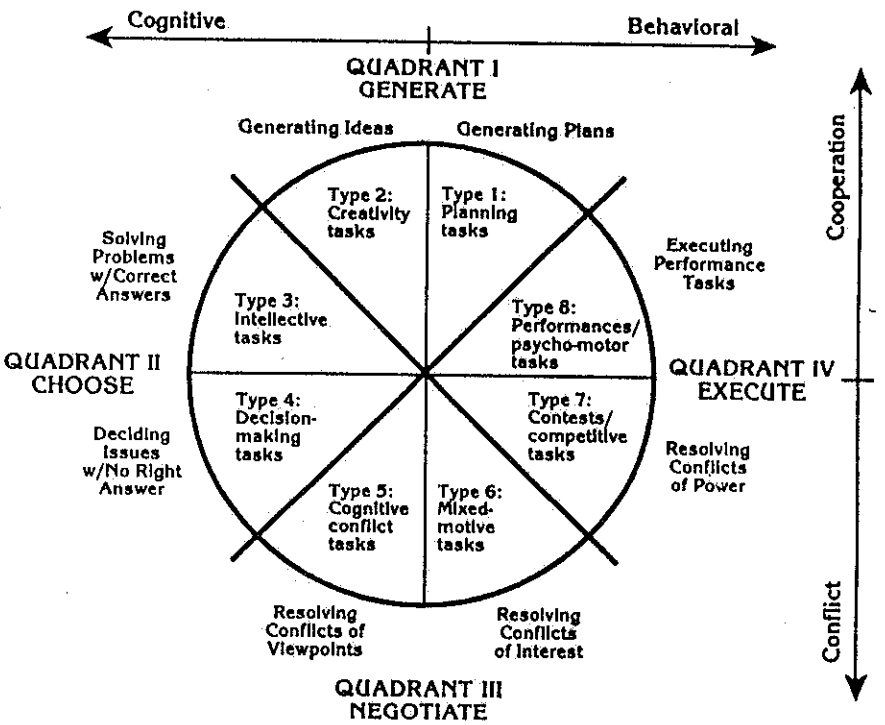
The advancement of electronic technology has made computers ubiquitous in our society. Computers are now regarded as productivity tools that are essential to efficient individual job performance. Besides the obvious and extensive impact on individual work, computers have also begun to play an increasingly important role of supporting work groups within and across organizations. Electronic systems that support work groups are collectively known as Group Support Systems (GSS).

GSS is a computer-based technology designed to assist a group of people to formulate and solve semi-structured or unstructured problems (Desanctis & Gallupe, 1987). The aim of GSS is to improve the process of group decision making by removing common communication barriers, providing techniques for structuring decision analysis, and systematically directing the pattern, timing, or content of discussion (Huber, 1984; Desanctis & Gallupe, 1987; Watson, Desanctis & Poole, 1988).

The modules of most GSS reflect the categories of a crude typology of tasks – idea generation, proposal evaluation, alternative selection and consensus seeking (McGrath & Hollingshead, 1993). This typology closely resembles the Group Task Circumplex (McGrath, 1984) which proposes that all group tasks can be categorized into four types: to generate, to choose, to resolve, and to execute (see Figure 1).

The main focus of this paper is on type 2 task (i.e., in quadrant I) in the Group Task Circumplex – the creativity task. We are interested in exploring ways of improving group creativity through the use of technology. The rest of the paper is organized as follows: Section 2 discusses the various principles of collective creativity. Section 3 analyzes the failure of verbal brainstorming and the success of electronic brainstorming. Section 4 looks at the use of technology (e.g., Group Support Systems) to support asynchronous and dispersed group creativity sessions. Section 5 concludes this paper.

FIGURE 1.

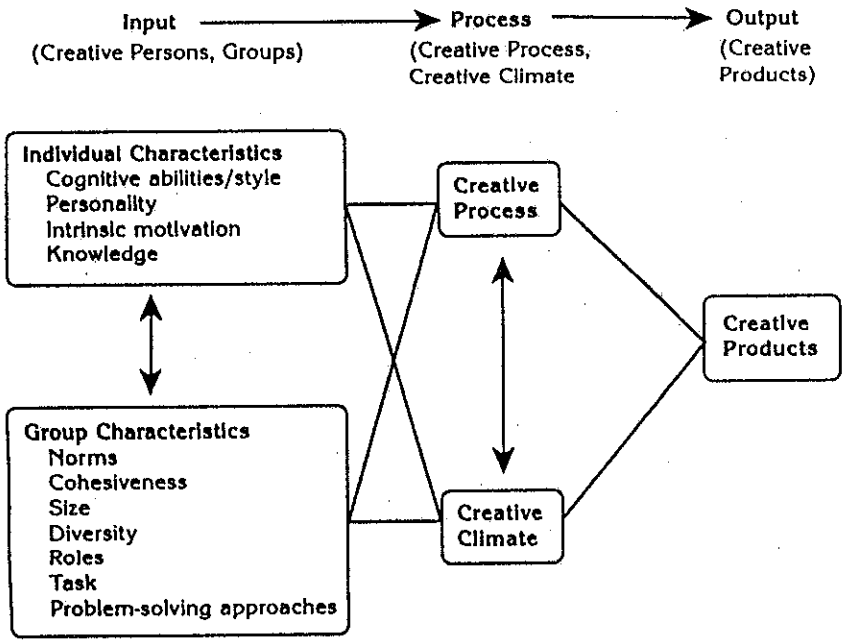


PRINCIPLES FOR COLLECTIVE CREATIVITY

Although group creativity is clearly a function of the creativity of individuals in the group (Woodman, Sawyer & Griffin, 1993), it would be naive to think that group creativity is simply the aggregate of all group members' creativity (Rubin, 1984). Other than the creative potential of each individual in the group, group creativity is influenced by time, other participants, places, settings, domain-specific knowledge and strategies that people can use individually or in groups. Taylor (1975) describes five components that must be included in the theory of creativity: person, problem, process, product, and climate. Similarly, Getzels (1975) notes that creative behavior is a function of five interactive elements: organismic constitution, personality, social institution, group influence, and cultural values. As such, group creativity performance can be viewed as the result of interactions among several important compo-

nents or dimensions of creativity. These various components or elements could be categorized into Input, Process and Output. Figure 2 diagrams the relationships among these components.

FIGURE 2.



Input

Individual characteristics that are believed to be important for explaining some aspects of creativity can be grouped into cognitive, personality, motivational orientation, and knowledge categories (Amabile, 1988; Barron & Harrington, 1981; Woodman, 1981; Woodman & Schoenfeldt, 1989).

Other than individual characteristics, social influence is another important aspect. This is determined by group characteristics such as norms, enacted roles, task assignments, group size, leadership, and degree of cohesiveness (Amabile, 1983; Stein, 1975; Kolb, 1992; Thornburg, 1991).

Diversity of the group is another important input factor. Rubenson and Runco (1992) suggest that there are instances

where group heterogeneity stimulates creativity. Simply put, they suggest that individuals of different background contribute to a group in different ways. Experienced individuals not only bring a great amount of knowledge and expertise, but also rigidity. Other individuals may bring less knowledge, but they are typically more flexible and responsive. Creative groups may be those that consists of both experienced and inexperienced individuals. These groups would have the benefits of knowledge and flexibility; and if there are several individuals with discrepant investments (e.g., in different theories), they could bring into their groups new insights and stimulate exchanges.

Process

Creativity is not just something that happens to people; it can be actively and deliberately employed, monitored, and managed. The general principle underlying many idea generation methods is in the creation of sources of variety in the participants' environment -- the greater the variety in the sources (or stimuli) of ideas, the greater the potential variety of ideas generated (Hoffman, 1959). The general strategies for creating variety include:

1. Increasing the number of idea-generating individuals;
2. Using individuals with diverse background and culture;
3. Placing individuals in varied contexts, with different sensory stimuli, varying experiences, evoking different emotions;
4. Exposing each individual to the ideas of others (i.e., cross-fertilization).

Besides creating variety, creativity can also be enhanced and nurtured (Isaksen, Puccio & Treffinger, 1993). One way to improve the group process of problem-solving groups is to train individuals in problem-solving skills (Bottger & Yetton, 1987). Another is through the use of appropriate creative process and techniques (Isaksen, Puccio & Treffinger, 1993). Choosing the wrong task-performance strategies will result in reduced group performance due to process losses (Hackman & Morris, 1975).

Group climate refers to the "shorter-term mood, attitudes and general motivation tone of a group" (Rickards, Aldridge & Gaston, 1988) and is created by the complex mosaic of individual and group characteristics. Group creative climate is an important variable in the productivity of creative prob-

lem solving groups. If group members feel "unsafe", they have less "psychological freedom" to take risks and to share their ideas. Unfriendliness, wisecracks, and witticisms cause great ideas to perish. Osborn (1957) emphasizes the need for positive, hopeful attitudes and enthusiasm for creative ideas to flourish. The tenderness of creativity is metaphorically described by Osborn (1957) as "a delicate flower." People need encouragement to build self-confidence.

Output

The ideal outcome of an idea generation session is one or more creative products. Jackson and Messick (1965) propose that the following conditions must necessarily be satisfied for a product to be considered creative:

1. The product must be unusual and appropriate in the context of norms, producing surprise and satisfaction;
2. It should transcend the conventional constraints, producing new forms, rather than improving on old ones; be stimulating;
3. It should have the property of creative "condensation," where the apparent simplicity and complexity of the solution are unified.

Similarly, Amabile (1988) defines creativity as the production of novel and useful ideas by an individual or a small group of individuals working together. According to Amabile (1983, p. 33), "A product or response will be judged as creative to the extent that (a) it is both a novel and appropriate, useful, correct or valuable response to the task at hand, and (b) the task is heuristic rather than algorithmic."

Based on these creativity principles, numerous group creativity methods have been proposed over the years to support group idea generation. Of all the creativity methods available, the most popular and well-known is brainstorming. In the next section, we will look at verbal brainstorming and its electronic analog — electronic brainstorming.

BRAINSTORMING

Brainstorming (Osborn, 1957) is the most well-known and well-researched approach for creative idea generation. A recent mail survey conducted by Fernald and Nickolenko (1993) in the Orlando area businesses shows that brainstorming is the most frequently used creativity technique.

The most important principle of brainstorming is the deferment of judgment. During brainstorming, no member of the group may criticize an idea, including the individual who suggested the idea. The second principle is that quantity breeds quality; the more ideas generated, the higher the probability that some of them will be original and useful. These principles are the basis for four rules that Osborn (1957) lays down for brainstorming sessions:

1. Criticism is ruled out.
2. "Freewheeling" is welcomed.
3. Quantity is encouraged.
4. Combination and improvement are sought.

These rules are intended to overcome the major social and motivational factors that could inhibit the generation of ideas. Osborn (1957) claims that a group that adopt his rules could generate twice as many ideas as individuals working alone. Brainstorming has now become the de facto standard for group creativity. Although early work suggested that group brainstorming was the key to effective idea generation (Osborn 1957), the idea that "two heads are better than one" soon lost favor (Nunamaker, Applegate & Konsynski, 1987). The study by Barkowski and Lam (1982) shows that subjects that worked individually produced more ideas than subjects that worked alone. The results of the study by Jablin (1981) indicate that nominal brainstorming groups produced significantly more ideas than interacting groups. The meta-analysis performed by Mullen, Johnson and Sales (1991) concludes that brainstorming groups are significantly less productive than nominal groups, in terms of both quantity and quality. The myth that larger, interacting groups are more likely than small ones to generate rare idea is also shattered by a recent study. Connolly, Routhieaux and Schneider (1993) show that there is no support for the hypothesized stimulating effect of rare ideas in larger groups. Other researchers (e.g., Taylor, Berry and Block, 1958; Dunnette et al., 1963; Dunnette, 1964; Lamm & Trommsdorff, 1973; Jablin & Sussman, 1978, Jablin & Seibold, 1978) also reported that individuals brainstorming alone produced a greater number of ideas (and, in some studies, better quality ideas) than individuals brainstorming in face-to-face groups. What is wrong with brainstorming?

PROBLEMS WITH VERBAL BRAINSTORMING

Three mechanisms were proposed by Connolly, Routhieaux and Schneider (1993) to account for the group brainstorming failure. These three mechanisms are production blocking, evaluation apprehension, and social loafing or free riding.

1. *Production blocking* refers to the problem that only one member of a group of N individuals can talk at a given moment, while N minus 1 listen (or, at least, remain silent). The silent majority appear to self-censor, forget, or get talked out of some significant number of their ideas.

2. *Evaluation apprehension* is the reluctance of members to offer poorly developed or unpopular ideas that might elicit negative responses from others.

3. *Social loafing or free riding* is the well-documented tendency of individuals to invest less effort in group projects than they do in equivalent individual work. On this account, individuals brainstorming alone work harder and produce more ideas than do individual group members, who can lie back and leave the work to others.

Diehl and Stroebe (1987) explore these three mechanisms and conclude that production blocking accounts for most of the productivity loss of brainstorming groups. Barkowski and Lam (1982) also propose that one reason for the lesser productivity of groups is production blocking. Gallupe and Cooper (1991) arrive at a similar conclusion. In a follow-up study by Diehl and Stroebe (1991) to determine the causes of production blocking, it was found that the longer a brainstorming participant has to wait to verbalize an idea, the greater the productivity loss. This effect is a function of group size. The need to have to listen to others' ideas while rehearsing one's own ideas further impairs the productivity of interacting groups.

Diehl and Stroebe (1991) conclude that production blocking occurs because of the following reasons. Participants prevented from verbalizing their ideas when they occur might:

1. Forget or suppress them because they seem less relevant later;

2. Not be able to think of other ideas during the wait time because of cognitive limitations;

3. Be exposed to other ideas which are distracting or interfere with their thinking.

According to Nagasundaram and Dennis (1993), production blocking, especially the second and third points mentioned

above, can be explained from a cognitive perspective. Newell and Simon (1972) argue that all humans are information processing systems (IPS). Two main characteristics of IPS include limited memory and serial processing. These cognitive characteristics limit the rate at which humans can perform cognitive work and the amount of information they can commit to memory at any one time. Thus, it is not surprising that production blocking occurs in verbal brainstorming.

ELECTRONIC BRAINSTORMING

Electronic brainstorming is both similar to and different from the verbal and nominal brainstorming. As in verbal brainstorming, individuals are exposed to the ideas of others, thereby increasing the sources of variety which is important for creativity. Nevertheless, because ideas are recorded electronically and are available for inspection whenever a participant chooses, a participant is freed from the need to listen to external inputs. Production blocking is, therefore, greatly reduced.

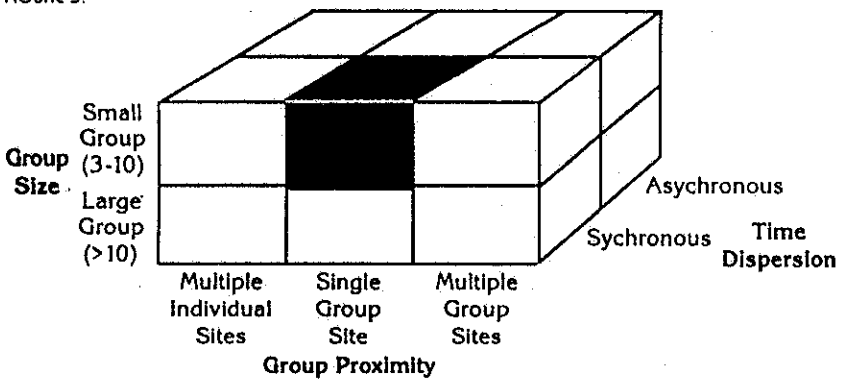
Although both verbal and electronic brainstorming groups consist of interacting individuals, there is one major difference between them. In verbal brainstorming, participants interact with one another directly whereas in electronic brainstorming, participants interact directly only with the ideas generated by others. This alleviates the problem of evaluation apprehension. Moreover, the use of anonymous input in electronic brainstorming will further reduce, if not eliminate, the problem of evaluation apprehension.

Contrary to the disappointing results of verbal brainstorming, several recent studies on the electronic version of group brainstorming produced some encouraging findings. Gallupe, Bastianutti and Cooper (1991) report that electronically interacting brainstorming groups outperform verbally interacting brainstorming and nonelectronic nominal groups in the number of unique ideas generated. Nunamaker, Applegate and Konsynski (1987) conclude that "the automated version of the brainstorming model appears to neutralize many of the group effects that have been responsible for poor performance of group brainstorming in the past." In another study, Gallupe et al. (1992) pursue the issue for a range of group sizes and find electronic groups increasingly outperforming face-to-face groups as group size increased. These show that group brainstorming works, at least in its electronic form. Could we generalize from the success of electronic brainstorming and conclude that technology is a possible solution for improving group creativity?

BEYOND FACE-TO-FACE CREATIVITY SESSIONS

There are three dimensions that can be integrated into a taxonomy of meeting environments. They are time dispersion, group proximity, and group size. As shown in Figure 3, there are a total of 12 environments according to this classification. So far, brainstorming, both verbal and electronic, is mainly used in synchronous and single group site environment (also known as face-to-face session). Moreover, the group size for these sessions is usually kept small (i.e., 3-10 participants).

FIGURE 3.



Problems with Face-to-Face Creativity Sessions

Though popular, face-to-face environment poses a number of constraints on group creativity. Firstly, in face-to-face creativity sessions, the number of individuals that can be involved in the creativity process is usually limited by the size of the meeting room and the number of individuals available at that particular time and place. These space and time constraints limit the number of participants that can be involved in the creativity session. Secondly, individuals available at the same time and the same place (for example, in a company) usually share common interests, background, knowledge, etc. In other words, we have a small homogeneous group rather that a large heterogeneous group.

As noted earlier, two of the general strategies for creating variety are to increase the number of participants and to use participants from diverse background. In the words of Falk and Johnson (1977), diverse groups are "generally seen as having more potential in developing alternative directions for approaching a problem, cross-fertilizing members' ideas and promoting creative thinking." These constraints imposed by

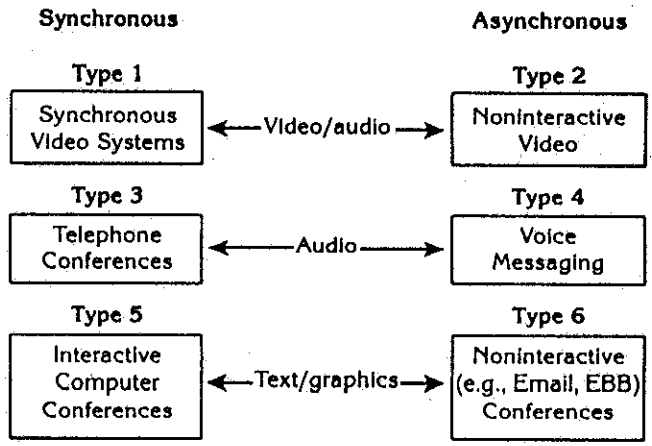
face-to-face sessions severely cripple group creativity process. What can technology do to overcome these constraints?

Technology Support for Non Face-to-Face Creativity Sessions

It has long been recognized that groups using computer and communication technologies to support their creativity sessions could transcend the time and space constraints that burden groups who meet face-to-face; namely, that all of their members must be at the same place and the same time in order to meet (McGrath & Hollingshead, 1994). Nevertheless, the capabilities provided by advanced technologies (such as GSS) have not been fully capitalized by creativity groups.

To facilitate non face-to-face sessions, six types of non face-to-face GSS have been proposed (McGrath & Hollingshead, 1993, 1994). These six types of GSS differ on two main axes. One of the axes is the temporal distribution of the group members. The other is the modalities the technology provides for communication among group members. Figure 4 shows the six possibilities that result from this two-fold classification.

FIGURE 4.



All six types of non face-to-face GSS permit (but do not require) group members to be spatially separated from one another while they are communicating. Three of these six types require that group members interact synchronously; the other three types permit group members to interact in different time periods (i.e., asynchronous communication). The three types of synchronous GSS are able to overcome the problem of

space constraint. The three types of asynchronous GSS, on the other hand, has the potential to overcome both space and time constraints.

The low cost of communication has already made audio and text/graphics modes of communication (i.e., type 3 to type 6) feasible and practical. Both interactive and non-interactive computer conferencing have been technically possible since the early 1970s, although few organizations have taken advantage of its full potential in stimulating group creativity. As for telephone conferencing and voice messaging, many software and services are readily available. For example, Northern Telecom's Meridian provides Meeting Communication Services to support audio meetings.

As for interactive and non-interactive video sessions, they will also be widely available in the near future. The proposed asynchronous transfer mode (ATM), which runs at very high speed (starting at 156 megabits per second) (Miller 1994) on optical-fiber networks, is designed to carry data, voice and video at real-time. The flexibility and speed of ATM enable it to handle not only real-time traffic like voice and video, but also more traditional data communications such as the transfer of text files (Riezenman, 1994). Within the next few years, the tremendous bandwidth provided by ATM means that the video, audio and data communication requirement needed for interactive and non-interactive video sessions will become widely available and affordable.

Overcoming Time and Space Constraints

With non face-to-face GSS, the number of participants could now be increased beyond the physical limitation of the conference room. There is also no longer the need for participants to meet in the same room for idea generation. They could each participate in the creativity session at the comfort and privacy of their desks or even homes. The availability of satellite communication further increases the range of communication. This not only "shrinks" the world but also allows cross-fertilization of ideas from cross-disciplinary contact. Participants of diverse background, culture, and expertise could now come together electronically for cross-fertilization. With asynchronous communication, the creativity process could last over a span of a few days to a few weeks to cater for the different time zones.

The advancement of electronic technology is redefining the temporal and spatial prerequisites for creativity groups. Not only has it permits the extensive, rapid, and interactive communication among individuals who are geographically

dispersed, it has also created groups (such as asynchronous groups) that would not have been possible heretofore.

CONCLUSION

Group creativity is an important research area. However, it is still a "grey" area with lots of competing theories and methodologies. The most prominent group creativity method is, undoubtedly, brainstorming. For the past thirty years, however, a sizable body of empirical data has indicated the failure of verbal brainstorming to live up to its apparent promise. Electronic brainstorming, on the other hand, appears to be more effective than verbal brainstorming and nominal group idea generation. On close examination, it seems that technology has overcome the problems of free riding, evaluation comprehension and production blocking in verbal brainstorming. Further research, however, is needed to substantiate these findings.

Riding on the success of electronic brainstorming, this paper explores ways of improving group creativity using electronic technology. It proposes the use of advanced computer and communication technologies to move group creativity sessions from face-to-face environment to distributed environment, and from synchronous sessions to asynchronous sessions (if necessary). This proposal aims to overcome the two major limitations of face-to-face creativity sessions – time and space constraints.

In summary, technology might be the key to unlock the stalemate in group creativity. Advances in technology have provided the tools and capabilities needed to expand the group creativity process beyond the horizon of face-to-face environment and verbal brainstorming. It is time to seize this opportunity and push group creativity to its next stage of development.

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