SANDIA REPORT

SAND2007-5947
Unlimited Release
Printed September 2007

Assessing the Effectiveness of Electronic Brainstorming in an Industrial Setting: Experimental Design Document

Susan M. Stevens, George S. Davidson, Courtney C. Dornburg, and James C. Forsythe

Prepared by
Sandia National Laboratories
Albuquerque, New Mexico 87185 and Livermore, California 94550

Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under Contract DE-AC04-94AL85000.

Issued by Sandia National Laboratories, operated for the United States Department of Energy by Sandia Corporation.

Available to DOE and DOE contractors from
U.S. Department of Energy
Office of Scientific and Technical Information
P.O. Box 62
Oak Ridge, TN 37831

Telephone: (865)576-8401
Facsimile: (865)576-5728
E-Mail: reports@adonis.osti.gov
Online ordering: http://www.doe.gov/bridge

Available to the public from
U.S. Department of Commerce
National Technical Information Service
5285 Port Royal Rd
Springfield, VA 22161
Telephone: (800)553-6847
Facsimile: (703)605-6900
E-Mail: orders@ntis.fedworld.gov
Online order: http://www.ntis.gov/help/ordermethods.asp?loc=7-4-0#online

SAND2007-5947
Unlimited Release
Printed September 2007

Assessing the Effectiveness of Electronic Brainstorming in an Industrial Setting: Experimental Design Document

Susan M. Stevens
Human Systems Integration

George S. Davidson
Computation, Computers, Information and Mathematics

Courtney C. Dornburg
Human Systems Integration

James C. Forsythe
Cognitive and Exploratory Systems

Sandia National Laboratories
P.O. Box 5800
Albuquerque, NM 87185-1316

Abstract

An experiment is proposed which will compare the effectiveness of individual versus group brainstorming in addressing difficult, real world challenges. Previous research into electronic brainstorming has largely been limited to laboratory experiments using small groups of students answering questions irrelevant to an industrial setting. The proposed experiment attempts to extend current findings to real-world employees and organization-relevant challenges. Our employees will brainstorm ideas over the course of several days, echoing the real-world scenario in an industrial setting. The methodology and hypotheses to be tested are presented along with two questions for the experimental brainstorming sessions. One question has been used in prior work and will allow calibration of the new results with existing work. The second question qualifies as a complicated, perhaps even wickedly hard, question, with relevance to modern management practices.

CONTENTS

Introduction

In today's highly dynamic and competitive world, it is essential that organizations generate novel ideas of high quality to develop or maintain their competitive advantages. Historically, one method of idea generation has been verbal brainstorming, a process where groups of individuals, typically in the same room, work to create and exchange ideas. Popular opinion holds that verbal brainstorming yields more (and better) ideas than the same number of individuals working alone would produce (see Furnham, 2000; Guerin, 1986; Osborn, 1957)]

Such groups have typically followed Osborn's (1957) brainstorming rules:

- the more items proposed the better,
- strive to combine and improve on others' ideas,
- the wilder the idea the better,
- do not criticize, and
- be as clear and concise as possible.

Researchers have long believed that verbal (or group) brainstorming is superior to individual brainstorming for several reasons. For example, becoming aware of and/or feeling the presence of others has been shown to provide social facilitation (Bond & Titus, 1983; Guerin, 1986; Zajonc, 1965), and exposure to other individuals' ideas often generates intellectual synergy (Madsen & Finger, 1978). In addition, claimed advantages of brainstorming include (Furnham, 2000):

- reducing dependence on a single authority figure,
- encouraging open sharing of ideas,
- stimulating participation among group members,
- providing individual safety in a competitive group,
- maximizing output for a short period of time, and
- ensuring a non-evaluative, enjoyable and stimulating environment.

However, investigations into the actual operation of groups involved in brainstorming has uncovered a number of issues, which cast some doubt, or at least caveats, on these optimistic claims.

Issues

Despite popular opinion, verbal brainstorming has been found to result in certain undesirable consequences when compared to individual, or nominal, brainstorming, where individuals brainstorm alone. As discussed below, these consequences include production blocking, evaluation apprehension and social loafing (Kerr & Tindale, 2004).

Blocking

Production blocking is an individual's inability to spontaneously interject ideas without violating group etiquette or breaking the concentration of other members (DeRosa, Smith & Hantula, 2007). That is, if one person is sharing his/her ideas, other members of the group are not able to share their ideas simultaneously. Consequently,

their ideas may be "blocked". Nijstad, Stroebe & Lodewijkx (2003) manipulated the delay within which participants were able to contribute ideas. They found that delay length negatively related to performance when the participants were blocked before entering each idea and that unpredictable delays led to fewer trains of thought. In addition, those who are silent during a brainstorming session appear to self-censor, forget or get talked out of a significant number of their ideas (Diehl & Stroebe, 1991).

Evaluation Apprehension

Another negative consequence of verbal brainstorming is evaluation apprehension, which is the tendency for people to hold back their ideas for fear that others will negatively evaluate them (Dennis, 1994; Paulus & Yang, 2000). Because verbal brainstorming involves individuals who must, necessarily, share ideas with the group, those individuals who are uncomfortable speaking in front of people, or who are afraid that others will negatively judge their ideas, may refrain from making contributions to the brainstorming session (Dennis, 1994; Dennis & Valacich, 1993; Gallupe, Cooper, Grise & Bastianutti, 1994; Paulus & Yang, 2000; Roy, Gauvin & Limayem, 1996).

Social Loafing

Finally, verbal brainstorming could result in social loafing, which is the tendency for individuals to invest less effort in group projects than they do in equivalent individual work (Connolly, Routhieaux & Schneider, 1993). Social loafing has been shown in a variety of tasks, from rope pulling to hand clapping to identifying radar signals on a computer screen (Furnham, 2000; Karau & Williams, 1993; Kravitz & Martin, 1986; Latané, Williams & Harkins, 1979). Ringlemann found that participants exerted less force when they were with a group of people than when they were alone (as cited by Kravitz & Martin, 1986). Similarly, Latané and colleagues (1979) found that average sound pressure generated by their participants' hand clapping decreased as the number of people per group increased. The researchers argued that these results are consistent with the phenomenon of social loafing (Latané, Williams and Harkins, 1979).

Can EBS mitigate problems with traditional brainstorming?

While verbal brainstorming is often a popular method for eliciting ideas from groups of individuals, the process seems to have serious limitations. To address some of these limitations, electronic brainstorming (EBS) has been proposed as an alternative. An EBS session consists of individuals interacting and exchanging ideas via a computer.

Because the members of the group exchange ideas through computer connections, several members can input ideas at the same time; thus, production blocking should not occur. Studies have shown the EBS does in fact mitigate the negative effects of production blocking (Gallupe et al., 1994; Valacich, Dennis & Connolly, 1994; Nijstad et al., 2003). Valacich and colleagues (1994) had their participants perform two different brainstorming activities. Half of the participants performed tasks in the standard EBS format. For the other half of the participants, the technology was modified so that only one person could type in a response at a time (thus introducing production blocking).

The researchers found that the standard EBS groups outperformed the production blocking EBS groups and concluded that EBS was effective at eliminating production blocking (Valacich et al., 1994).

Because EBS enables submission of responses and ideas in an anonymous fashion, evaluation apprehension can also be eliminated. Cooper and colleagues (1998) had four groups of participants brainstorm ideas about topics of a controversial nature. The groups included an anonymous EBS group, a non-anonymous EBS group (in which the participants identified which ideas were their own), a verbal brainstorming group, and an individual, or nominal, group. The researchers found that the anonymous EBS groups were the most productive overall, produced a larger number of highly controversial ideas and reported less perceived production blocking than the non-anonymous EBS groups (Cooper, Gallupe, Pollard & Cadbsy, 1998).

The research looking at social loafing and EBS has found mixed results, but some researchers have suggested that allowing participants to view others' ideas results in a decrease in social loafing, possibly because the participants may be comparing their performance to the performance of their peers (Roy, Gauvin & Limayem, 1996). Karau & Williams (1993) have suggested that "monitoring individual performance or making such performance identifiable, making tasks unique such that individuals feel more responsibility for their work, enhancing the cohesiveness of work groups, and making individuals feel that their contributions to the task are necessary and not irrelevant might reduce or eliminate social loafing" (p. 700). Furnham (2000) noted that social loafing may be less likely to occur with EBS because individuals may be assured that the ideas they contribute are logged and counted.

Finally, other advantages of EBS over verbal brainstorming include features that are advantageous to their institutions or organizations. In particular, EBS enables shorter meetings, increased participation by remote team members, better documentation via electronic recording, improved access to the meeting records and, importantly, cash savings (Furnham, 2000).

Admittedly, EBS also has some disadvantages. An EBS session could be considered less rich than a face-to-face session since the electronic medium filters out nonverbal communication. In addition, EBS can not provide rapid feedback as easily, and can reduce communication efficiency since it takes longer to type than to speak (Dennis & Valacich, 1994). However, despite these disadvantages, the literature indicates that EBS groups almost always outperform verbal brainstorming groups.

EBS compared to verbal brainstorming and individual, or nominal, brainstorming for small and large groups

While EBS has been shown superior to verbal brainstorming, the research comparing EBS to nominal brainstorming has produced rather mixed results. Some studies have found that EBS is superior to nominal brainstorming (Dennis, 1993; Dennis & Valacich, 1993; Paulus & Yang, 2000) while a few others have found that nominal

groups were superior to EBS (Barki et al., 2001; Pinosonneault et al., 1999). Still others have found no differences between the two groups (Connolly et al., 1993; Cooper et al., 1998; DeRosa et al., 2007; Dugosh et al., 2000).

Most of the research has involved fairly small groups (3-4 people); researchers who have studied larger groups (12+ people) have found that EBS was superior to nominal brainstorming (Dennis & Valacich, 1993; Dennis & Valacich, 1994; Gallupe et al., 1991; Valacich et al., 1994). Thus, it seems that EBS is superior to nominal brainstorming with large groups of people. However, the two techniques are quite similar with smaller groups of people. The studies finding EBS performance superior to nominal group performance have attributed these findings to the stimulating effect of exposure to others' ideas (Leggett-Dugosh et al, 2000; Nijstad et al, 2003; Paulus & Yang, 2000; although also see Ziegler et al, 2000 as cited by Kerr & Tindale) and the diversity and heterogeneity of those groups (Schruijer & Mostert, 1997).

Experimental Goals

To date most, if not all, of the research in this area has been performed in laboratory settings with college students. Do these same results apply to industrial settings where people brainstorm with one another about important issues on a fairly regular basis? One innovative feature of our experiment that has not occurred in previous literature is that we intend to assess brainstorming performance over a period of time. It is often the case in a real-world industrial setting that groups of individuals brainstorm ideas over the course of several days or weeks. Thus, we will be able to evaluate what happens in the real-world instead of simply what is found in a laboratory-based setting. Also, can large groups of people (100 or more, for instance) have effective computer-mediated brainstorming sessions? The answer to this question will prove very useful since verbal (or group) brainstorming sessions can be quite costly and can require a substantial investment in time. If EBS sessions attest to be just as effective (if not more so) than these face-to-face group sessions, then brainstorming electronically will be a much more efficient option.

To investigate these questions, the experiment described below was designed to be conducted at Sandia National Laboratories in the summer of 2007. Specifically, this experiment seeks to explore the effectiveness of EBS within the industrial setting of a modern, national research laboratory. Several researchers have found large EBS groups to be more effective than nominal brainstorming (Dennis & Valacich, 1993; Dennis & Valacich, 1994; Gallupe et al., 1991; Valacich et al., 1994). We anticipate using large groups of participants and expect to replicate this past research. Thus, we predict that EBS will be more effective than nominal brainstorming in our study. We also predict that the computer mediation will enable the collection of a reasonably large number of new ideas, with at least one idea per participant, on average. We will be assessing the effectiveness of EBS in an industrial setting in which employees are accustomed to brainstorming and collaborating with one another on a regular basis. Thus, we expect the EBS format to be especially effective with our participants.

However, it could be the case that EBS will not shown to be more effective than nominal brainstorming in our study. Other researchers have found nominal brainstorming groups to be as effective as or more effective than EBS groups (Barki et al., 2001; Connolly et al., 1993; Cooper et al., 1998; DeRosa et al., 2007; Dugosh et al., 2000; Pinosonneault et al., 1999). Thus, it is possible that our EBS group will not be more effective than the nominal groups. If this is the case, brainstorming might not be an effective mode of sharing ideas for an industrial setting. It could be the case that some of the disadvantages of EBS (such as those outlined above) are very prominent in an industrial setting and thus negate its usefulness.

Method

The experimental design conforms to national statues and regulations with respect to human studies. The design and all experimental materials have been approved by Sandia National Laboratories' Human Studies Review Board (HSB; Notice of Approval 6/29/2007).

Participants and Materials

Participants will be regular employees and student interns at Sandia National Laboratories (SNL). All participants will be volunteers.

The experiment will take place on a website created and managed by the experimenters. All experimental materials have been pre-approved by the institutional HSB, and are available in a separated report (Davidson, Dornburg, Stevens & Forsythe, 2007). After being shown a description of the experiment and participant rights, the registration form will explain that continuing with the registration (by creating an account) will constitute acknowledgement and acceptance of the conditions of the informed consent materials. When creating the account and userid, the participants will be asked to generate one that is anonymous and will not reveal their identity. Following this acknowledgement, demographic information will be solicited to enable assignment to appropriate experimental groups.

After registration, participants will be able to enter and view the brainstorming question, respond with ideas, and view the available responses (which may only be their own submissions if they are randomly assigned to the nominal group). Participants will be encouraged to read the brainstorming suggestions and rules for using the web site. They will also be asked to complete a satisfaction questionnaire electronically at the end of the experiment.

Procedure

An advertisement will be placed in the Sandia Daily News (an internal news source emailed daily to every Sandia employee) soliciting participants for the study at both Sandia National Laboratories in Albuquerque, New Mexico and in Livermore, California. The researchers will also send a personal recruitment email to Sandia

employees with whom they are familiar requesting participation in the study. These Sandia employees will then be asked to forward the recruitment email to other Sandia employees. In addition, a link to information regarding the study will be placed on the Sandia Internal Web. The student interns will be recruited at the annual Student Symposium held in Albuquerque, NM. All of the recruitment messages will inform employees that a study interested in electronic brainstorming will be conducted and will consist of brainstorming (either alone or in a group) via a website, and will request their participation at least once a day for four days.

Interested employees will be directed to a website that will describe the study in detail and will inform them of their rights if they decide to participate in the experiment. Those employees electing to participate will be asked to proceed through the consenting procedure as described above.

The participants will be divided into two groups: summer interns and all other employees. These groups will then be randomly divided into either EBS or nominal brainstorming groups. The summer interns, alone, will be further randomly divided into two more subgroups: one subgroup will brainstorm the same wickedly difficult problem presented to the regular employees. This problem was proposed by Sandia National Laboratories President Tom Hunter (hereafter called the Hunter Question). The other subgroup of students will brainstorm about an issue often used in previously published studies (the Thumbs Question; see Bouchard & Hare, 1970; Gallupe et al., 1991).

The regular employees will all brainstorm the *Hunter Question*:

> "Tom Hunter is interested in the contrast between two models of how organizations relate to their people. One model views people, metaphorically, as just another natural resource, and like other natural resources, to be used (read extracted) for the good of the organization. In that model obtaining people is largely a financial question and the company will derive whatever contributions it can from their skills or experience.
>
> A second model asserts that people are an asset to be continually developed and the investment in their development will yield a dividend to the organization or even to the broader society.
>
> In contrasting these two models, Tom is greatly interested in your thoughts and ideas about:
>
> - how employees establish an identity for themselves in relation to their work environment, i.e., how do they define their *we*., and
> - how to create the appropriate balance between the role of management and the sense of empowerment of employees.
>
> He would like your comments and ideas about the above two questions, and also your insights into

- what environment best supports the identification and development of leaders."

The *Thumbs Question* (Bouchard & Hare, 1970; Gallupe et al., 1991) will ask one subgroup of the student interns to:

> "Please generate ideas about the practical benefits or difficulties that would arise if everyone had an extra thumb on each hand after next year"

Because previous research has found that larger groups of people resulted in superior EBS performance (e.g., Dennis & Valacich, 1993; Dennis & Valacich, 1994; Valacich et al., 1994), we will automatically balance the group sizes during the randomization process to minimize any differential effect due to different group sizes.

When the participants log onto the website, their respective question will be displayed at the top of the screen and they will be asked to input their ideas. Those in the nominal condition will work by themselves and won't see the ideas of other participants. Those in the EBS condition will work with others and will be able to see and build on the ideas of the other members in the group.

Even though the ideas will be tagged with the submitter's userid, there should be no knowledge of the submitter's actual name since the userid will be anonymous. The first reason for tagging ideas with the submitter's userid (but not the participant's actual name) is that anonymity in group brainstorming sessions has been shown to reduce evaluation apprehension (e.g., Cooper, Gallupe, Pollard & Cadbsy, 1998. The second reason is that we hope that by disclosing to the EBS participants the performance of their peers (i.e., the number of ideas submitted by each individual and the quality of those ideas) they will be less likely to engage in social loafing (Karau & Williams, 1993; Roy et al., 1996).

Participants in the EBS conditions will also be asked to adhere to the rules of brainstorming per Osborn (1957), and will be told that abusive language and name calling will not be tolerated. The exact text of this notification will be:

> "Please think of possible solutions to the question and contribute your answers over the next four days. You are encouraged to contribute ideas at any time but we ask that you contribute at least once a day for the duration of the experiment. You will be able to see other participants' responses and add to them.
>
> Because this is a group brainstorming activity, there are specific rules we would like you to follow:
>
> - the more ideas the better
> - strive to combine and improve on others' ideas
> - the wilder the idea the better
> - be as clear and concise as possible

- do not criticize
- NO NAME CALLING OR ABUSIVE LANGUAGE

We ask that you act in a professional and proper manner. There may be ideas that you do not agree with or feel uncomfortable with, but please do not engage in any sort of inappropriate behavior. Be advised that the website will be monitored constantly throughout the experiment. ANYONE ENGAGING IN NAME CALLING OR ABUSIVE LANGUAGE WILL BE LOCKED OUT FROM THE EXPERIMENT. Please respect your fellow colleagues.

Be aware that employees of all different security levels will be participating in this experiment. It is CRUCIAL that you do NOT include any classified or sensitive information.

Also, keep in mind that you are using a DOE computer, website and server. All DOE computer rules and regulations apply to this experiment."

At the end of the experiment, the participants will be encouraged to complete a satisfaction questionnaire (modeled after Dennis & Valacich, 1993). The questionnaire will ask several questions regarding the participants' satisfaction with the experiment, along with inquires about their motivation and interest levels for the task. The exact text of the satisfaction questionnaire is available in a separate document (Davidson, Dornburg, Stevens & Forsythe, 2007).

Data Analysis Methods

We are interested in assessing both the quantity and the quality of our participants' ideas. Prior research has shown that, while an increase in idea *quantity* is generally positively correlated with better *quality* of ideas (Diehl & Stroebe, 1987; Dennis, Valacich & Nunamaker, 1990; Gallupe et al., 1992; Valacich, Wachter, Mennecke & Wheeler, 1993 all cited by Briggs et al., 1997), there are other factors (such as ability, goal congruence and deliberation) that are important for determining the number of good ideas generated. Thus, it is not sufficient to assume that quality will always track quantity (Briggs et al., 1997).

We intend to assess the quantity of responses by counting the number of total ideas and the number of unique ideas generated by each group. This assessment will be accomplished by coding all of the responses into idea units. The idea units from the participants in the nominal conditions will be pooled. The total number of idea units will be counted for each group and will subsequently be compared using a two-tailed t-test. In addition, the number of unique (i.e., nonredundant) ideas will be counted for each group and will also be compared using a two-tailed t-test. In order to establish reliability, a second coder will independently code 10% of the responses. Intercoder reliability between the two coders will be assessed using both percent agreement and intraclass correlation coefficient (ICC). We hypothesize that the EBS groups will produce statistically more total and unique ideas than the nominal group participants.

Following the example of Barki and Pinsonneault (2001), the quality of ideas will be determined by the originality, feasibility and effectiveness as determined by 2 experts. The experts will independently rate the ideas on these qualities using a Likert Scale of 1-7 with 1 being very low and 7 being very high (Barki & Pinsonneault, 2001). Interrater reliability will be established by both percent agreement and Cohen's kappa, which is a statistical measure of inter-rater reliability. The ratings will be compared between the two groups using a two-tailed t-test. Previous research has found that large EBS groups (i.e., 12+ members) produced higher quality of ideas than nominal groups (Dennis & Valacich, 1994; Valacich, Dennis & Connolly, 1994). Thus, we hypothesize that our EBS groups will also have ideas that are rated higher in originality, feasibility and effectiveness as compared to the nominal group participants. However, other research has shown that there is no difference in the quality of ideas between smaller EBS and nominal groups (e.g., Barki & Pinsonneault). Thus, if our hypothesis is not correct, it might be due to the fact that our EBS groups were not large enough or that there is no difference in brainstorming formats for wickedly difficult problems found in industrial settings.

In addition, we will also compare quality of response by day. One novel element of our experiment will be assessing brainstorming performance over a period of time. It is often the case in a real-world industrial setting that groups of individuals brainstorm ideas over the course of several days or weeks. Since our study will take place over a period of four days, we will be able to assess whether the quality of the responses changed over the course of time. We will compare the quality of each group's responses over time using a mixed 2 (nominal vs. EBS) x 4 (day 1, day 2, day 3, day 4) Analysis of Variance (ANOVA).

We will also assess the participants' responses to questions on the satisfaction questionnaire. We will compare the responses of the two groups using a t-test. Previous research that has found participants in the EBS group tend to be generally more satisfied, motivated and interested in the brainstorming task than those participants in the nominal groups (Cooper, Gallupe, Pollard & Cadsby, 1998; Dennis & Valacich, 1993; DeRosa, Smith & Hantula, 2007; Gallupe, Bastianutti & Cooper, 1991; Valacich, Dennis & Connolly, 1994). Thus, we propose that our EBS participants will also be more satisfied, motivated and interested in the brainstorming task than those participants in our nominal group.

Additional analyses include assessing the number of common/redundant ideas, assessing word count and assessing sentence count. The number of common or redundant ideas is particularly interesting in our study. If many Sandians have the same ideas relating to the Hunter Question, the management at Sandia might be interested to know what these ideas are and how they might be incorporated into the Sandia business strategy. In addition, we will assess the sentence and word count of the responses for each group and compare them using a two-tailed t-test. These two measures will be assessed for convergence with the total number of idea units. Since participants in the EBS condition will be able to read and respond to other's ideas, we expect them to spend

more time on the brainstorming task than those in the nominal condition. Given that word and sentence count might be indicative of time spent on the brainstorming task (such that a higher count indicates more time spent on the task), we expect those in the EBS group to have higher word and sentence counts than those in the nominal conditions. However, if it turns out that the participants in the EBS condition do not have higher word and/or sentence counts, it might be the case that they did not spend longer on the brainstorming task as suggested.

Furthermore, we will correlate the word and sentence counts with the number of total and unique ideas for each group. Since our brainstorming question will be very complex and wickedly difficult (requiring lengthy and numerous ideas), we expect that word and sentence count will correlate positively with the number of total and unique ideas. Thus, those who compose many lines of text will have contributed the most ideas. If, however, there is a negative correlation between word and sentence count and number of ideas, then those who produce the *least* amount of words/sentences will have the most ideas, contrary to our hypothesis. Finally, if there is no correlation, then there will be no relationship between word/sentence count and number of ideas. In other words, there will be no way to tell the number of ideas a person contributed simply based on the word and sentence counts.

References

Barki, H. & Pinsonneault, A. (2001). Small group brainstorming and idea quality: Is electronic brainstorming the most effective approach? *Small Group Research, 32(2),* 158-205.

Bond, C. F. & Titus, L. J. (1983). Social facilitation: A meta-analysis of 241 studies. *Psychological Bulletin, 94(2),* 265-292.

Bouchard, T. J. & Hare, M. (1970). Size, performance, and potential in brainstorming groups. *Journal of Applied Psychology, 54,* 51-55.

Briggs, R. O., Reinig, B. A., Shepherd, M. M., Yen, J. & Nunameker, J. F. Jr. (1997). Quality as a function of quantity in electronic brainstorming. *In Proceedings of the Thirtieth Hawaii International Conference on Science Systems, 2,* 94-103.

Connolly, T., Routhieaux, R. L. & Schneider, S. K. (1993). On the effectiveness of group brainstorming: Test of one underlying cognitive mechanism. *Small Group Research, 24(4),* 490-503.

Cooper, W. H., Gallupe, R. B., Pollard, S. & Cadsby, J. (1998). Some liberating effects of anonymous electronic brainstorming. *Small Group Research, 29(2),* 147-178.

Davidson, G. S., Dornburg, C. C., Stevens, S. M., & Forsythe, J. C. (2007). Yellow Sticky, PHP software for an electronic brainstorming experiment. Sandia Report SAND2007- 5702, Sandia National Laboratories, Albuquerque, N.M.

Dennis, A. R. & Valacich, J. S. (1994). Group, sub-group, and nominal group idea generation: New rules for a new media? *Journal of Management, 20(4),* 723-736.

Dennis, A. R. & Valacich, J. S. (1993). Computer brainstorms: More heads are better than one. *Journal of Applied Psychology, 78(4),* 531-537.

DeRosa, D. M., Smith, C. L. & Hantula, D. A. (2007). The medium matters: Mining the long-promised merit of group interaction in creative idea generation tasks in a meta-analysis of the electronic group brainstorming literature. *Computers in Human Behavior, 23,* 1549-1581.

Diehl, M. & Stroebe, W. (1991). Productivity loss in idea-generating groups: Tracking down the blocking effect. *Journal of Personality and Social Psychology, 6(3),* 392-403.,

Dugosh, K. L., Paulus, P. B., Roland, E. J. & Yang, H-C. (2000). Cognitive stimulation in brainstorming. *Journal of Personality and Social Psychology, 79(5),* 722-735.

Furnham, A. (2000). The brainstorming myth. *Business Strategy Review, 11(4),* 21-28.

Gallupe, R. B., Bastianutti, L. M. & Cooper, W. H. (1991). Unblocking brainstorms. *Journal of Applied Psychology, 76(1),* 137-142.

Gallupe, R. B., Cooper, W. H., Grise, M-L & Bastianutti, L. M. (1994). Blocking electronic brainstorms. *Journal of Applied Psychology, 79(1),* 77-86.

Guerin, B. (1986). Mere presence effects in humans: A review. *Journal of Experimental Social Psychology, 22,* 38-77.

Karau, S. J. & Williams, K. (1993). Social loafing: A meta-analytic review and theoretical integration. *Journal of Personality and Social Psychology, 65(4),* 681-706.

Kerr, N. L. & Tindale, R. S. (2004). Group performance and decision making. *Annual Review of Psychology, 55,* 623-655.

Kravitz, D. A. & Martin, B. (1986). Ringelmann rediscovered: The original article. *Journal of Personality and Social Psychology, 50(5),* 936-941.

Latané, B., Williams, K. & Harkins, S. (1979). Many hands make light the work: The causes and consequences of social loafing. *Journal of Personality and Social Psychology, 37(6),* 822-832.

Madsen, D. B. & Finger, J. R. (1978). Comparison of a written feedback procedure, group brainstorming and individual brainstorming. *Journal of Applied Psychology, 63,* 120-123.

Nijstad, B. A., Stroebe, W. & Lodewijkx, H. F. M. (2003). Production blocking and idea generation: Does blocking interfere with cognitive processes? *Journal of Experimental Social Psychology, 39,* 531-548.

Osborn, A. F. (1957). *Applied Imagination.* (Rev. Ed.) New York: Scribner.

Paulus, P. B. & Yang, H-C. (2000). Idea generation in groups: A basis for creativity in organizations. *Organizational Behavior and Human Decision Processes, 82(1),* 76-87.

Pinsonneault, A., Barki, H., Gallupe, R. B. & Hoppen, N. (1999). Electronic brainstorming: The illusion of productivity. *Information Systems Research, 10(2),* 110-133.

Roy, M. C., Gauvin, S. & Limayem, M. (1996). Electronic group brainstorming: The role of feedback on productivity. *Small Group Research, 27(2),* 215-247.

Schruijer, S. G. L. & Mostert, I. (1997). Creativity and sex composition: An experimental illustration. *European Journal of Work and Organizational Psychology, 6(2),* 175-182.

Valacich, J. S., Dennis, A. R. & Connolly, T. (1994). Idea generation in computer-based groups: A new ending to an old story. *Organizational Behavior and Human Decision Processes, 57,* 448-467.

Zajonc, R. B. (1965). Social facilitation. *Science, 149,* 269-274.

Distribution:

1	MS-0830	Courtney C. Dornburg, 12335
1	MS-0830	Susan M. Stevens, 12335
1	MS-1188	James C. Forysthe, 6341
2	MS 9018	Central Technical Files, 8944 (1 electronic and 1 hardcopy)
2	MS 0899	Technical Library, 9536 (1 electronic and 1 hardcopy)
1	MS-1316	George S. Davidson, 1400