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Inspiring Creative Solutions: An Experimental Investigation of Three Ideation Methods in Generating Creative Product

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Inspiring Creative Solutions:

An Experimental Investigation of Three Ideation Methods in Generating Creative Product

by

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As members of the Final Examination Committee, we certify that we have read the dissertation prepared by Thomas P. Hanlon, entitled "Inspiring Creative Solutions: An Experimental Investigation of Three Ideation Methods in Generating Creative Product," and recommend that it be accepted as fulfilling the dissertation requirement for the Degree of Doctor of Philosophy.

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Ruth Ter Bush | Date

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Final approval and acceptance of this dissertation is contingent upon the candidate's submission of the final copy of the dissertation to the School. I hereby certify that I have read this dissertation prepared under my direction and recommend that it be accepted as fulfilling the dissertation requirements.

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STATEMENT BY THE AUTHOR

SIGNED: ___________________________

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TABLE OF CONTENTS

Title **Page**

List of Figures

List of Tables

Abstract

This study examines strategic, collaborative decision making with the goal of producing more creative solutions. Our experimental approach compares the results of three methods of ideation: *manual free brainstorming*, manual *carousel brainstorming*, and *electronic carousel brainstorming* (as implemented by a group support system). Our finding is that manual and electronic carousel brainstorming yield more creative solutions than free brainstorming. However, there is little difference between the former methods. Both the manual and electronic forms of carousel brainstorming are equally effective at yielding creative solutions.

Strategic, collaborative decision making, when well implemented, results in full consideration of the operational environment and selection of a solution. Yet the process is cumbersome. It is time-consuming. When it fails, it can produce solutions that are suboptimal. For these reasons, a vigilant decision making process is often abridged or neglected entirely.

One of the primary causes of that failure is due to *cognitive inertia*, a tendency to focus on a single solution to the neglect of others (Lamm & Trommsdorff, 1973, p. 364). The reasons for cognitive inertia are explained by the *cognitive network model of creativity* (Santanen, Briggs & de Vreede, 2000, p. 2). Cognitive inertia is due to a tendency of the mind to resonate around a local cognitive space. Better decision making could be achieved if stimuli were introduced that forced the mind to more remote cognitive spaces. This is accomplished by use of carousel brainstorming. The outcome is more creative solutions.

Chapter 1 Introduction

1.1 Decision Making in Overview

Decision making is a constant of human existence. Our lives are filled with choices. Most of these are trivial: what to wear, what route to take to work, where to have lunch, etc. Others, however, are more substantial: whether to fund a new civic center, whether to open a corporate office at an overseas locale, whether to undertake a new product offering.

In making these decisions we appeal to methods that are primarily *perceptive* or *methodical.* Under a perceptive method, the decision maker evaluates the situation by mentally creating an analogy to a previous incident. The analogized situation was acquired either by training or experience. Thus, a decision maker deciding what to eat for lunch may consider what they enjoyed in the past (Chi, Bassock, Reimann & Glaser, 1989)

Long-term, strategic decisions, however, require a greater degree of deliberation. For this, a more sophisticated, methodical style of decision making is required. The latter is a general problem solving method that employs systematic procedures to secure results. Methodical or "vigilant" decision making begins with an analysis of the problem, and proceeds to the generation of problem solutions (Janis & Mann, 1977, pp. 171-179). These solutions are then analyzed against a set of selection criteria. Finally, the solutions are compared, and the best choice is selected.

Problem features requiring the latter type of decision making are varied. Some involve the problem itself: its complexity, duration, and extent of effects. Others pertain to characteristics of the decision maker: familiarity with the subject, level of expertise, and commitment to results. Still others relate to the level at which the planning takes place (higher as opposed to lower). Finally, there is the duration of the effects: being long-term rather than short-term.

Whatever the complexity of the problem, the need for a structured method is not always accepted by the decision maker. The perceptive technique might still be chosen even when the situation warrants more elaborate analysis. Chi, Bassock, Reimann and Glaser (1989) found that analogy is a method frequently employed by less successful learners. More successful learners, they report, utilize systematic problem solving methods, such as outlined above. The latter resorted to analogy only when they reached a stalemate (Chi et al., pp. 145-182).

1.2 The Need for Collaboration

Yet even the most vigilant planning is rarely done in isolation. Strategic problem solving often requires the skills of more than one individual. The technological complexity of the work environment has heightened the level of proficiency required of planners. The knowledge and skills to achieve an end are more often than not beyond the ken of any one individual. Increasingly integrated and complex systems require the combined knowledge of experts from diverse fields. It requires the collaborative effort of assorted individuals working in unison.

Decision makers are frequently asked to make choices that cross diverse fields. But rarely does a single individual have the knowledge to make competent decisions in seclusion. Consultation with experts, ranging from information technology, to financial, to legal, and to civil affairs, is important in facing the many-sided problems of today's operational environment. Collaboration is not an option; it is a necessary part of the decision making process.

1.3 Problems of Collaboration

Collaboration is not a facile practice. While most collaborative sessions generate solutions, few do so optimally. As minds concentrate on a problem, the group coalesces into a singular mindset. They tend to concentrate on a small segment of the problem domain. Gradually, a set of solutions are developed, but they are ideas that lack individuality and distinctiveness. Often times, they are only minor variations on a solitary theme. What results is a solution set that features a small homogeneous collection rather than a more widely spaced array of choices (Lamm & Trommsdorff, 1973, p. 364).

This stultifying effect has been described as *cognitive inertia.* It occurs when a collaborative session stagnates towards a single set of thoughts while ignoring other alternatives (Lamm & Trommsdorff, 1973, p. 364). Reichert (2008, March 12) describes it as a *throwaway mentality*. He explains that it is "the common pitfall of presenting one good COA [course of action] among several `throwaway' COAs" (Reichert, p. 15).

The disadvantage of cognitive inertia is that it erroneously limits the solutions set. It focuses on a few choices, and overlooks the full range of alternatives available. The result is a restricted range of choices leading to a solution that is less than could be achieved if the complete range of options were considered.

1.4 Object of this Study

The purpose of this study is to advance theories and techniques used to generate creative solutions as a product of group ideation. Solutions are sets of actions, conditions or values that solve a problem. A solution set can range from a definitive single answer to an indefinite array of answers (Lamm & Trommsdorff, 1973, p. 362). At the most restrictive level, it can refer, for instance, to the values of variables that solve a mathematical equation. At a lesser restrictive level, it can refer to a variety of algorithms that solve a problem in computer programming.

Creativity is a cognitive process involving the association of ideas. It may relate existing ideas, or it might involve the conception of new ideas. Hender, Dean, Rodgers & Nunamaker (2001) offer two ascending schemes by which ideas might be described as creative. The first of these is *originality*. Creative ideas are new to the person or group. The wider the context of the group, the more original the idea can be said to be. A more novel approach they suggest is that of *paradigm relatedness*. The latter refers to the extent to which an idea is *germinal* or *transformational* (Hender et al., p. 6). Hence, in devising a solution to crossing a snow bound street, an idea within the conventional paradigm would be to clear the street of snow. An idea which transcended the paradigm would be to forgo crossing the street entirely, and instead communicate with a party on the other side via telephone or Internet. The latter would be a paradigm transcending solution, and signifies a higher degree of creativity than does originality.

Not all ideas are interesting in most decision making contexts. We are looking for ideas that represent solutions to problems. In this respect, Mednick (1962) distinguishes *original thinking* from *creative thinking*. The latter are characterized by the requirement of usefulness (p. 221). The former are not. Thus, false solutions may be considered original, but only a true solution may be considered creative. Originality, Mednick concludes, is the inverse of its "probability in a given population" (p. 221). Creativity, on the other hand, implies effectiveness.

Still another definition which combines many of the elements above was developed by Wagner (1996). Wagner proposed three attributes that defined a creative solution. To be a creative solution, an idea had to be *original*, *purposeful*, and *implementable*. The first of these terms meant that the idea must be novel. Yet an idea that is only novel may be a mere flight of fancy. Similar to Mednick, Wagner saw creativity as exhibiting more than mere novelty. A creative solution must also be purposeful and implementable. It must be workable, and it must solve the problem at hand (Wagner, p. 108).

This study will focus on solutions that involve neither conceptual nor theoretical problems, but those that involve practical problems. Our domain constraint is practicality. Generally, such a solution set will involve human actions. In its written form, it is a statement that is a formula for human behavior. It anticipates a sequence of events that will lead to a desired outcome.

The instigators for those actions may derive from factors external to the individual, such as natural forces in the environment. Or they may derive from factors internal to the individual, such as motivations, attitudes, and desires.

Creative solutions are not the result of a single, definitive method. Rather, they are the ideas that satisfy a group of constraints contained in the problem statement. The former is a set of procedures that accomplish a job, problem, or assignment. Not only are the problems those for which a variety of solutions are possible, but they are also those for which there is no objective criteria for determining whether the solution is correct or incorrect (Lamm & Trommsdorff, 1973, p. 362).

Summarizing the above, we seek to derive creative solutions. A ‘creative solution’ in the context of this study is something that: i) is a formula for human behavior, ii) anticipates a sequence of events that will lead to a desired outcome, iii) is innovative and iv) is effective in achieving the outcome.

One of the tools we shall employ in this regard is a group support system (GSS). A GSS is networked computer system that facilitates collaboration between group members. Participants can enter ideas simultaneously into the system with complete anonymity, if so desired. Other members of the group can view the ideas of their fellow participants on their own monitors (Shepard, Briggs, Reinig, Yen & Nunamaker, 1996, p. 156).

We hope that by use of a GSS we can eliminate some of the problems that plague traditional ideation. Chief among these is cognitive inertia. This phenomenon of cognitive inertia is universal. It stems not so much from pressures to conform, as it does from factors of human cognition. The failure to make an optimal choice stems from a tendency to prematurely settle upon a narrow set of alternatives. The latter is caused by a lack of creativity. Hence, by enhancing creativity we can improve the process as a whole.

1.5 The Importance of Collaboration

Is collaboration always needed? For many decisions, the answer is no. Our lives are filled with choices. Few of those choices require detailed consideration. Fewer still require consultation. Most of the decisions that we make are effectively solved perceptively on the basis of individual experience and expertise.

Is creativity always needed? Again, the answer is no. Many of the problems that we face can be solved by application of formulas and recipes (mathematical equations, statutory law, and bureaucratic rules, etc.) that prescribe a single course. Alternatives are lacking.

Yet there are some decisions where collaboration is a necessity. The complexities of problems encountered in many fields of the modern world exceed the expertise of any one individual. Lene and West (2007, December 5) complain that when considering multifaceted problems planners "Fail to think outside the box." Collaboration provides the background necessary to traverse the bounds of common thinking. It breaches the box.

Just as important to the process is creativity. In a second complaint made by Lene and West (2007, December 5), they note that planners "Fail to think of `other' options" (p. 22). The ability to create a range of alternatives is the product of creative imagination. Creativity inspires those options.

1.6 Military as Domain

The domain in which we shall examine and test the development of creative solutions is the military. It is a useful domain in which to study decision making. The military is a real-world environment that is comprised by salient, non-trivial problems that require solution. Planning processes are complex, and have sufficient degrees of freedom to lend to varied alternatives. Yet the problems are extensive enough so that even members of limited expertise might contribute to those solutions.

The United States military services reflect many of the same problems faced by other organizations in the world today. Military maneuvers are multifaceted. Weapon systems range from land, to sea, and to airborne venues. Components of military operations include personnel, logistics, civil affairs, legal, finance, and cultural affairs. The activities of the military services are world-wide. From the Americas, to Europe, to the Middle East, and to the Far East, the United States armed forces are engaged in day-to-day struggles. They comprise not only synchronous and symmetrical conflicts, but asynchronous and asymmetrical confrontations.

Improvements in decision making in the military have wider applicability. They have significant practical impact, as well as considerable theoretical interest. The applicability can be further generalized to include other domains. These might include business, government, and civic planning processes.

1.7 The Military Decision Making Process

The U.S. Army recommends a systematic technique for planning military operations that is known as the Military Decision Making Process (MDMP). The procedure consists of seven steps (see Figure 1-1). During the first two steps, the problem is received and analyzed. In Step 3, solutions are developed (Appendix III).[i] In the next three steps solutions are analyzed, compared, and the best solution is selected. Finally, the results are committed to writing in the form of an Operations Order (OPORD).

MDMP is conducted not by a single individual, but by a group of seasoned officers that comprise the Army staff. Under MDMP, Army decision making is a collective effort. It is the united product of specialists from varied fields. The Army staff's job is advisory. They are there to help a commander to analyze the situation, and to make a reasoned judgment thereof.[ii]

Figure 1-1 The Military Decision Making Process

Step 1 – Receipt of Mission
Step 2 – Mission Analysis
Step 3 – Course of Action Development
Step 4 – Course of Action Analysis
Step 5 – Course of Action Comparison
Step 6 – Course of Action Approval
Step 7 – Orders Production

Source: Field Manual 5-0 (2005). *Army Planning and Orders Production*. Washington, D.C.: Dept. of the Army, 3-11.

More than a mere collective, the Army Staff is a team. Whereas the former merely describes an assembly of people with a shared experience, the latter defines a group of individuals with a shared goal (DeSimone, Hornsby, Dowling, Hall, 2003, p. 321). The leader responsible for maintaining the integrity of the Army staff is the Chief of Staff (or Executive Officer). At his disposal are nine primary staff sections each of which provide input. At a minimum, all nine primary staff sections (plus subordinate commanders) are doctrinally assigned to work together to create an OPORD. The omission of any one of these sections sacrifices the special information and skills held by people of that specialty.

Thus, one of the key features of MDMP is *collaborative planning*. The Army defines this as: "the real-time interaction among commanders and staffs at two or more echelons developing plans for a single operation" (FM 5-0, 2005, p. 1-23). It specifically states that "collaborative planning allows sharing ideas and concepts for COA [course of action] development" (FM 5-0, 2005, p. 1-23). Accordingly, diversity, in the form of all staff sections cooperating in the production of the OPORD, is at the forefront of the MDMP.

As important as it is, military commanders are often reluctant to use the collaborative planning methods embodied in MDMP. McCroary (2007) reports one of the deficiencies of Battle Command Training is that "Commanders and staff do not routinely practice and incorporate the MDMP into their actions" (p. 4).

We have been involved teaching decision making to Army commanders and staff for the past thirteen years, as a trainer in the 3rd Brigade, 75th Division, Fort Sheridan, Illinois. The use of MDMP is Army doctrine. Consequently, most mid level commanders claim to have employed it. If awkwardly caught to site evidence of its use, a commander typically replies: "I did MDMP in my head." Presumably, what is meant by this is that the commander has mentally constructed several courses of action (COA), developed a set of evaluation criteria, carefully weighed each of the criteria, graded each COA in terms of criteria, and then tabulated the results—all without scratching a single note.

The scenario is possible but improbable. More plausibly, the commander who reports having done "MDMP in his head" has resorted to a different mode of reasoning. A good decision begins with a clearly defined objective. It considers the resources available to attain that objective. Information then links those resources to the objective in terms of alternatives.

A commander who does "MDMP in his head" has invariably neglected to consult other staff members. In so doing, that commander has made inadequate use of available resources—namely, the intellectual capital of experts. Further, the commander has made inadequate use of information. Information is more than data. The latter are mere facts and figures. Information is data that has been processed to provide meaningful context to the perceiver. When information is then interpreted, it becomes knowledge. And the best interpretation happens in the mind of the expert perceiver.

Unlike the expert, the amateur does not derive the same level of knowledge from a given set of facts as does the expert. A crucial detail might fail to stimulate the mind of a neophyte. The novice is apt to overlook fine points. He glosses over what he does not understand, and fails to discern meaning and import.

As in many fields of endeavor today, no individual soldier possesses all the skills and knowledge necessary to properly construe the information relevant to a military operation. Inadequate consultation, therefore, represents a failure on the part of the decision maker with respect to the use of resources and information. The decision that results is likely to be less than optimal.

Collaboration benefits decision making by ensuring diversity in the background of its planners. Expediencies might succeed in the short term, but the use of more disciplined methods produces more successful solutions in the long term. A planner who uses a full collaborative environment in their decision making will be more successful in the long term, even though he might succeed with less rigorous planning in the short term.

If leaders can be convinced that collaborative decision making leads to better solutions, then they will tend to employ it more often. And they will do so in the more rigorous fashion for which it was designed—as a collaborative process in the hands of the staff. Hence, eliminating one of the problems of collaboration—namely, cognitive inertia--will result in a wider, fuller use of MDMP, and an improved decision making in the organization overall.

1.8 Dependent Variable

The phenomenon of interest in this study is solution creativity. Lack of distinctiveness is symptomatic of lack of creativity being generated during the ideation process. Hence, creativity of solutions is a useful indicator of the success of the ideation. More creative options would permit greater choices, and better solution selection. Creative solutions, therefore, was our dependent variable.

We defined a ‘creative solution’ in the context of this study as something that: i) is a formula for human behavior, ii) anticipates a sequence of events that will lead to a desired outcome, iii) is innovative and iv) is effective in solving the problem. The first two parts of this definition describes ‘solution’ in terms of a course of action (COA). The next two parts define the ‘creative’ quality of the solution.

A creative solution is one that is more than merely being novel. It is also effective. Without effectiveness, innovation lacks grounding. It is a mere flight of fancy that has little chance for practical success. Yet just as effective is important, so too is innovation. Without innovation, effectiveness lacks insight. It results in s a work-a-day solution, filled with inefficiencies. Such a solution is apt to leave one wondering whether there "might be a better way". A truly creative solution comprises both elements.

While the U.S. Army takes consideration of COA solutions in respect to effectiveness and innovation, it employs other terminology. Instead of measuring solutions in terms of effectiveness and innovation, it prescribes five features (called the "FADS" test). There are attributes that are descriptive of a high quality solution. A proper solution must be *feasible, acceptable*, *suitable, complete* and *distinguishable* (FM 5-0, 2005, 3-30).

The five criteria of the FADS test correspond roughly to our measures of effectiveness and innovation. An effective solution must be actionable (feasible); it must be efficient in that benefits must exceed costs (acceptable); it must be defensible and conducive to approval of other members (suitable); and it must thoroughly solve the problem at hand (complete). An innovative solution is also one that is unique. It is easily recognized as being distinct from other solutions (distinguishable).

As has been noted, the domain of this study is the military. In order to gain an understanding of our measures of effectiveness and innovation, we will use the FADS test as a translation of our components of effectiveness and innovation into the military vernacular. In this way, our military evaluators will better understand our meaning, and be more capable of judging the results.

It is notable that four of the components of FADS relate to effectiveness, and only one component relates to innovation. Though we have not previously mentioned the weighting of creativity components, we will accept the judgment of military strategists, and use their weighting of four measures of effectiveness to one measure of innovation as the appropriate admixture within the military domain. Consequently, in determining the creativity of a COA solution, we shall employ a simple average of the five FADS components as our measure of creativity.

It should be noted that the FADS test is not used by the military as evaluation criteria for COA solutions. That determination is left to later stages of the decision making process, and is specific to the problem at hand. The FADS test, rather, is an initial screening device to be used during ideation sessions. For that reason, the military does not weigh FADS components (as actual evaluation criteria would be so weighted). The test merely assays ideas to determine where to focus efforts.

The FADS test relates reasonably well to our definition of 'creative solution', described above. The five attributes: feasible, acceptable, distinguishable, suitable, and complete, will together define our operative definition of creativity within the military domain.

1.9 Army Research Laboratory Studies

Investigation into improving MDMP was initiated by the Army Research Laboratory (ARL). Their work began in the 1980s. The ARL employed a GSS as a tool to facilitate Step 2: Mission Analysis (MA) of MDMP (Harder & Higley, 2003, p. 3).

Two tools of the GSS were most utilized by the ARL: categorizer and group outliner. The former was used to store staff and commander inputs. The latter was used to organize the input, and to store the details of the end product. The ARL found that while the group outliner was useful in organizing and assembling high level information, the system as a whole created a plethora of information which was difficult to categorize and employ (Harder & Higley, 2003, p. 8).

Although the results of the ARL studies were partially favorable, it was directed primarily at time-saving during the MA. The goal of the present study is directed elsewhere [see Section 1.4 (above)]. (Appendix XIV contains a chronology of studies done by the ARL in the use of GSS to support MDMP).

1.10 Organization

We presented in this chapter an overview, and a discussion of the object of the study. Chapter 2 will explore the current literature on ideation research, and derive the hypotheses. Chapter 3 will elaborate the experimental methodology. Chapter 4 will analyze the results of the data collection. Chapter 5 will present a discussion of the results obtained. Appendixes describe MDMP, carousel brainstorming (an ideation method), Hurricane Jane Operations Order, specification requirements, information sheet, facilitator/proctor scripts, creativity gradient, demographic questionnaire, a synopsis of ARL studies, Tukey Multiple Comparison results, and an analysis and comparison of FADS components.

1.11 Summary

This study will examine methods of enhancing the creativity of ideas spawned during collaborative solution generation, as part of a decision making process. Our goal is to develop a collaborative procedure that will eliminate cognitive inertia and result in more creative products. By so doing, we expect to derive solutions that are more creative, and improve a key feature of one of the steps (i.e., COA Development) of MDMP.

1.12 Expected Contribution

We expect to show by this study that an alternate collaborative process produces more creative solutions than traditional techniques. We will incorporate a novel manner of inspiring solutions by using specification requirements (Commander's Guidance in Army vernacular). It is hoped that an incremental consideration of specifications will increase sophistication of the problem frame in such a way as not to overstrain cognitive load. As a consequence of these innovations, superior staff involvement and staff recommendations will result. The outcome will be more creative COA alternatives generated.

Chapter 2 Literature Review

2.1 Overview and Current Methods

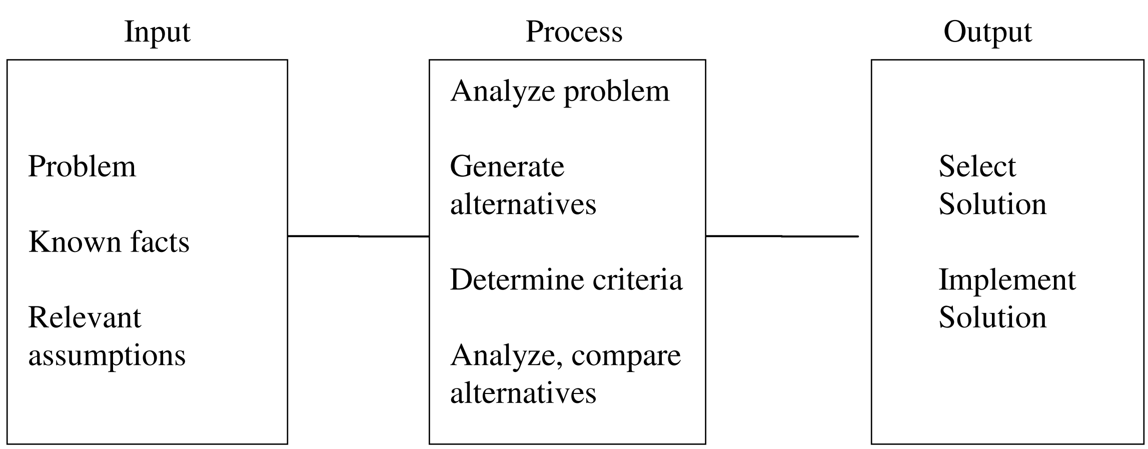
This chapter will explore the current literature on decision making and creativity. We shall then introduce the collaboration model to be employed.

The origin of decision making is timeless. Techniques are as old and as common as the human condition. Anyone who has considered alternatives before accepting a solution has to some degree practiced decision making.

Vigilant decision making is a systematic methodology for making choices. It is a model that is based on analyzing a problem, devising alternate solutions to solve the problem, analyzing and comparing those solutions against a set of criteria, and then selecting the most favored.

Thus, there are three parts to the model. They may be described by Input-Process-Output (see Figure 2-1).

Figure 2-1 Model of Analytic Decision Making



(Source: Adapted from Field Manual 5-0, Army Planning and Orders Production, Headquarters, Department of the Army, p. 3-29)

Inputs to the process are: the problem statement, known facts surrounding the issue, and any relevant assumptions made in lieu of available facts. These inputs undergo various processes. Among these are: problem analysis, generation of solutions, determination of selection criteria, and analysis and comparison of solutions. Output is the solution selected as a result of those comparisons.

Key to the model of vigilant decision making is the generation of alternative solutions. Under the current parlance, the process is described as 'ideation'. Ideation may (but not always) be practiced in a group context. The latter practice involves collaboration.

Creativity engenders the production of those solutions. As we have said, it is a cognitive process that involves the association of ideas. Creativity may connect existing ideas, or it might lead to the formulation of new ideas. In the domain of problem solving, creativity spawns alternatives.

2.2 Theories of Creativity

There have been numerous approaches to creativity. One approach sees it as process that can be practiced and learned. Another sees it as a personality trait that is inborn and unalterable. Still another view sees creativity as a characteristic of an artifact produced by a creative individual.

Under the process view, creativity is considered a practice that can be employed to evoke imaginative solutions. Much of the process literature is prescriptive rather than analytic (e.g., see Andriopoulos & Lowe, 2000, pp. 734-742). It recommends measures to improve creativity rather than to explore its nature. Practitioners of creativity as process recommend stages that a tyro is advised to undergo in order to enhance his or her creative powers (Rhodes, 1961, p. 307).

The problem with process theories is their object. If one is to improve creativity, what is the object of those improvements? Obviously, it is the person. So, if one considers creativity with respect to practices, it is ultimately the creativity of the individual that one seeks to improve. Thus, all "process" arguments devolve back upon people.

Another approach sees creativity as a character trait of a person. Such studies focus on the temperaments of creative individuals (see Csikszentmihalyi, 1996). Various qualities are seized upon. Creative people are seen to possess keen mental acuity. They are flexible in their thinking. And they have a capacity to redefine common beliefs (Rhodes, 1961, pp. 307-308).

However, a conundrum soon arises. Invariably, the creativity of a person is gauged by some artifact that such an individual creates. We can know a person to be creative only because that person produces creative things (Rhodes, 1961, p. 309).

Hence, studies of creativity in the end devolve to studies of creative products. For it is only in determining the creativity of an object that one can gauge the creativity of its creator. In the present study, therefore, we shall investigate creativity primarily as product. The product we are examining is that of creative solutions.

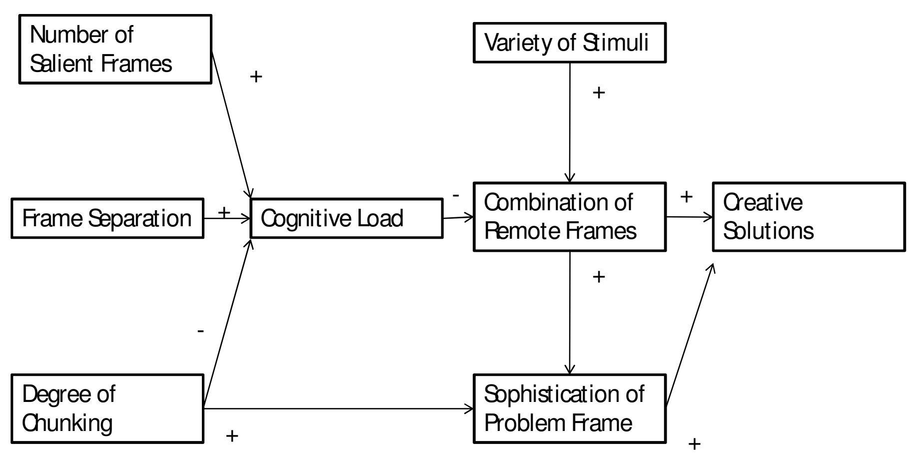
A useful model that describes creativity as product was developed by Santanen, Briggs & de Vreede (2000). According to the *cognitive network model of creativity* (CNM), creativity is viewed in terms of creative solutions. Those solutions are produced by mental habits that are influenced both by the environment, as well as by certain aspects of human cognition (Santanen, Briggs & de Vreede, p. 2).

Underlying CNM is a theory of mind. This is probably no better explained than by the *working memory model* developed by Baddeley (1992). The latter conceives of mind as divided into long- and short-term storage areas. Short-term memory is necessary for the handling of ideas that take place when people engage in such multifaceted cognitive tasks such as speaking, education, and reckoning (Baddeley, p. 556). Each of these requires both the storage and processing of inputs from the environment. Working memory allows the mind to temporarily store ideas while it engages in their manipulation.

Working memory is divided into three components. The first of these is the *central executive*. This component acts as the controller. It directs attention and engages in analysis. The *visuospatial sketch pad* assimilates visual imagery. And the *phonological loop* deciphers and maintains the meanings of the phonemes of speech. Each of the latter provides inputs to, and receives outputs from the central executive (Baddeley, 1992, p. 556).

In CNM, individual memories are clustered into closely connected groups called *frames* (see Figure 2-2). The pattern of association of frames may vary. With respect to a given memory, temporal sequence may be the overriding relationship. Thus, one might remember an experience from childhood. Each facet of the experience is connected by its relationship to the period in which it occurred. Details of childhood friends, childhood home, and childhood activities are all associated with one another temporally. In another frame, the associative principle may be training. Thus, one has learned how to accomplish a given task—perhaps word processing. A varied pattern of tasks, including steps to typing a document, parameters guiding its setup, and standards in evaluating success, might all be associated with that task—even though the person learned each subtask at a different time (Santanen et al., 2000, p. 2).

Figure 2-2 Cognitive Network Model of Creativity



(Source: Santanen, Eric, Briggs, Robert O., Vreede, Gert-Jan de (2000), The Cognitive Network Model of Creativity: a New Causal Model of Creativity and a New Brainstorming Technique, *IEEE*, p. 2)

Associations between frames take place by two separate processes. The first of these is an *automatic spreading activation*. It occurs without the conscious intention of the individual. Ideas of one thing simply lead to ideas that are closely related (Santanen et al., 2000, p. 2).

Yet cognitive resources are limited. There is an upper bound on the number of ideas that can occupy short term memory at a given time. Research since the 1950s has demonstrated that limit to be about seven. After that, confusion sets in (Miller, 1956; Zhang & Simon, 1985; Bellezzza & Young, 1986).[iii]

Although the number of frames is limited, the complexity of those frames is not. The amount of information contained in frames may vary. In this, there is a distinction between *bits* and *chunks* of information, and between *absolute judgment* and *immediate memory*. Whereas *amount of information* constrains the former, *number of items* constrains the latter (Miller, 1956, pp. 92-97). One way of increasing cognitive load is to increase the size of chunks.

Chunking as a psychological process was first identified by Miller (1956). He defined it:

> I have fallen into the custom of distinguishing between *bits* of information and *chunks* of information…Since the memory span is a fixed number of chunks, we can increase the number of bits of information that it contains simply by building larger and larger chunks, each chunk containing more information than before (pp. 92-93).

To elaborate, consider the list of Figure 2-3. The list comprises nine words. It is at the limit (seven plus or minus two) of what Miller has argued is the maximum cognitive load. Most people would have a difficult time remembering this list. Yet, we might rearrange the words to: "The quick brown fox jumps over the lazy dog". The list has gone from being nine separate ideas to being a single idea, arranged as a sentence. The method is one example of what Miller describes as chunking.[iv]

Figure 2-3 Example of Chunking

Dog

Brown

Lazy

Fox

The

Jumps

Quick

Over

The

Thus, the *cognitive load* experienced by an individual depends on three factors: i) the *number of salient frames* occupying short-term memory, ii) the amount of *frame separation*, and iii) the *degree of chunking* of information contained within those frames (see Figure 2.2). Yet, whatever the load, an important key to *creative solutions* is the *combination of remote frames* (Santanen et al., 2000, p. 2).

CNM explains why the problem of cognitive inertia (see above) develops. Once a given set of ideas is established, related frames are more easily recalled. When people are left to associate ideas freely, their minds tend to move first to those frames that have closest relationship with given frames. The process occurs unconsciously and freely, without mental effort. Free association, therefore, tends to produce ideas of the same pattern (Santanen et al., 2000, p. 2).

CNM proposes that introduction of a *variety of stimuli* causes associations to develop among more remote frames. Those associations lead to more *creative solutions*

(Santanen et al., 2000, pp. 2-3). [Another method the theory proposes is to increasing the *degree of chunking*, leading to a greater *sophistication of problem frame*. The latter method has been tried with some success by Hilliges, Terrenghi, Boring, Kim, Richter & Butz (2007) (pp.137-145)].

Stimuli are classified into two types. Some are a part of the process itself. These are described as *internal stimuli.* They include such matters as the problem statement, and any ideas engendered during problem solving. Another set of stimuli are those that derive from outside of the problem. These are described as *external stimuli*. They include interjections, analogies, and foreign concepts (Hender, Dean, Rodgers & Nunamaker, 2001, pp. 3-4).

CNM points to internal stimuli as leading to cognitive inertia. When ideas are stimulated by a single set of prods, they tend to activate other ideas of the same genre. One idea leads to a similar idea, and that idea in turn leads to another of the same variety. Stagnation ensues.

Creative ideas, on the other hand, are more likely inspired by external stimuli. The introduction of outside stimuli jolts members out of one set of associations and into another. External stimuli thereby alleviate the condition that leads to cognitive inertia (Santanen et al., 2000, p. 2).

Ideas are related by either *free association* or they are *forced*. In the former case, ideas are introduced by members without intervention. In the latter, ideas are planted on subjects by an outside agent. Since free flowing ideas tend to lead to familiar patterns, forced intervention provide another means for inspiring a fertile source of creative ideas

(Hender et al., 2001, pp. 2-3).

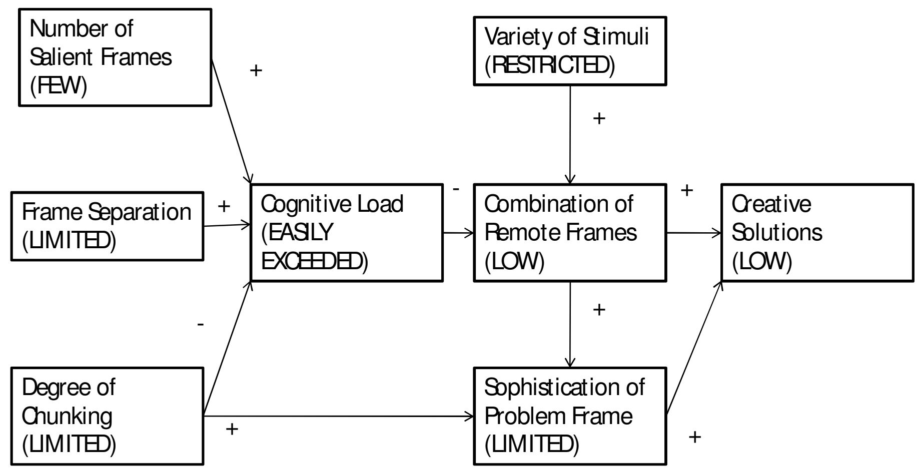
Thus, under CNM, in order to enhance creativity, we will employ forced external stimuli as a means to inspire the association among remote frames. By such means, we hope to alleviate the condition of cognitive inertia, and to inspire creative solutions.

2.3 Methods of Ideation

Under our model of analytic decision making, ideation is a key process to the generation of alternate solutions. The earliest method of ideation was developed by A. F. Osborn (1953). In a technique, which he called *brainstorming*, Osborn had members of a group submit ideas freely, without criticism, as lead by a facilitator. The stress was upon quantity not quality. Brainstorming attempted to build on the collective creativity of the group. Ideas submitted by one were visible to all for consideration. The hope was that ideas of each member would stir the imagination of other members, leading to a whole that was greater than the sum of the parts (Osborn, pp.1-397).

In the decades since, brainstorming has become the definitive model of ideation in America. It is synonymous with what we think of when we consider idea generation. Yet the method is not without criticism. Several disadvantages have been proposed to account for its lack of success. Among these are: 1) productivity bottleneck—the facilitator of a brainstorming session can write down only one idea at a time (Diehl & Stroebe, 1991), 2) evaluative apprehension—some group members fail to offer ideas for fear of criticism, 3) social loafing—group members refrain from submitting ideas out of indolence (Diehl & Stroebe, 1987), and 4) cognitive inertia—the tendency to focus on a single idea set to the exclusion of others (Lamm & Trommsdorff, 1973, also Santanen, Briggs & deVreede, 2000). The latter is a problem evident in the military (see Chapter 1).

Figure 2-4 Free Brainstorming as Analyzed under CNM



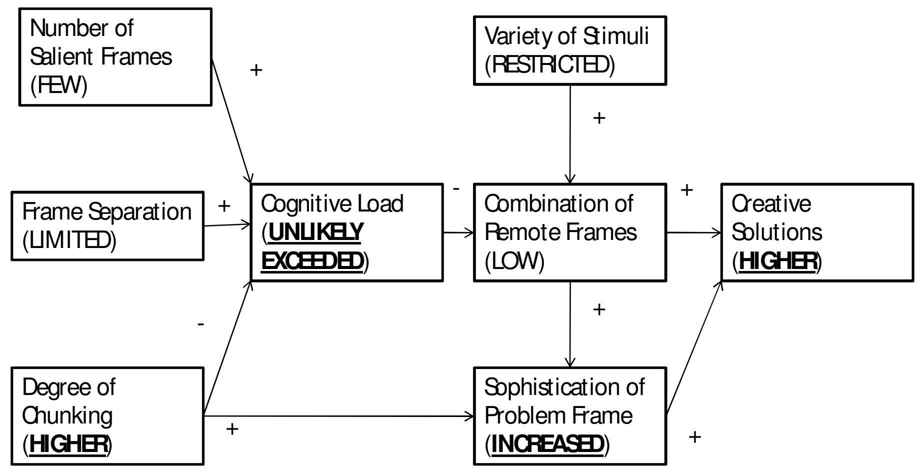
(Adapted from: Santanen, Briggs & Vreede, 2000, p. 2)

In relationship to the CNM, free brainstorming suffers from a number of problems (See Figure 2-4). The stimulus is internal, and is limited to the problem statement. Frames stimulated by the problem statement are few, and their separation is limited. New ideas that might be generated during the session, do not necessarily build on each other, and tend to be independent. Elaboration of a given solution is discouraged—resulting in very little chunking. Cognitive load, therefore, can be easily exceeded. With the generation of only five ideas, the capacity of the participants to consider another idea is clouded by excessive cognitive burden. Variety of stimuli under free brainstorming is internal, and is accordingly, restricted. Sophistication of the problem frame is also limited. The effort is quantity of ideas rather than on quality—something that does not lend itself to considering the problem in detail. The result is a low level of creativity in the solutions generated.

Because of the problems associated with free brainstorming, alternate ideation methods have been devised. One of these is *brainwriting*. Brainwriting is a method of ideation that was developed by Bernd Rohrback in the 1960s. It is a silent, written procedure. Techniques vary, but it generally involves a facilitator presenting a problem, and then having participants write solutions to the problem. By one technique, a problem statement is written at the top of a sheet and passed to a participant. The participant formulates one (or sometimes more) solutions. Afterwards, the participant passes the sheet to another member. Each participant is free to use the ideas of other members as a stimulus to their own solutions. The end product is a problem sheet that contains a variety of solution alternatives (Van Gundy, 1984, pp. 67-74, also Holt, 1966, pp. 77-82).

More recently, brainwriting has been transformed into an electronic form, called electronic brainstorming (EBS). It is characterized by using a computer network to share ideas among members, rather than using sheets of paper.

Figure 2-5 Brainwriting as Analyzed under CNM



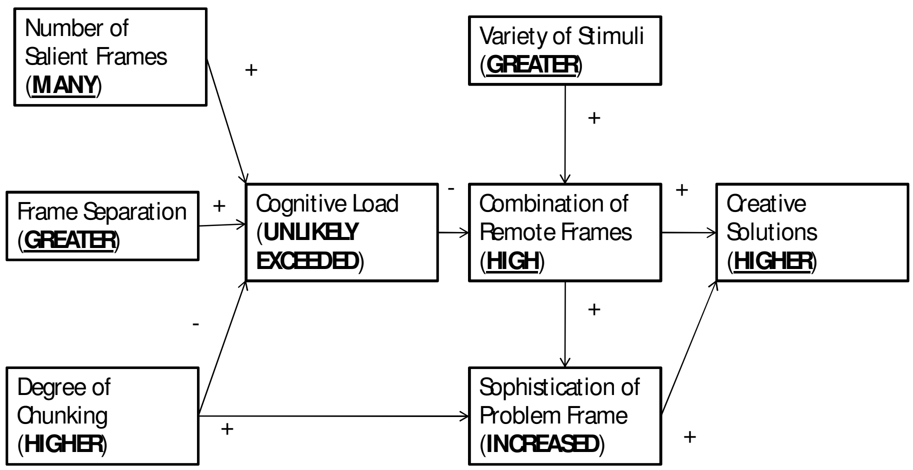
(Adapted from: Santanen, Briggs & Vreede, 2000, p. 2)

In relationship to CNM, brainwriting has a few advantages over free brainstorming. The stimulus again is internal—limited to the problem statement. Frames stimulated by that stimulus are few, and their separation is limited (being only those frames stimulated by the problem statement). However, elaboration of a given solution is encouraged. This results in greater levels of chunking, as new ideas are added as an elaboration of a given solution. Cognitive load, therefore, is less easily exceeded. Variety of stimuli is again internal, and is accordingly, restricted. Since new ideas are added to those existing, they are chunked with ideas prior, leading to increased sophistication of the problem frame. The process of elaboration upon ideas leads to more complex, and higher quality COAs. The result is a higher level of creativity in the solutions generated (see Figure 2-5).

A third ideation technique that has won more recent favor is *directed brainstorming*. Under this technique, a facilitator begins by devising a set of prompts that are intended to guide a group through an ideation session. At the first stage of the process, the facilitator presents the problem statement, and has the participants devise solutions. These are projected on a chalkboard—manual or electronic. Next, the facilitator addresses one of the prompts to the group, and attempts to refine the solutions generated. The process continues by successive stages. At each, the facilitator challenges the group to devise a solution in response to a different prompt. The facilitator might, for instance, ask participants to devise a solution that is least costly. Later, the facilitator might ask them to devise a solution that achieves results in the least amount of time. By this means, the facilitator gleans a wide array of solutions as garnered by his pre-arranged prompts (Santanen, 2005, p. 6).

Santanen, Briggs & de Vreede (2000) studied creativity comparing free brainstorming to directed brainstorming. The latter method proceeded serially, prompting the group with prods designed to *reset* the group's consideration of the problem. They found that the directed brainstorming group produced a greater number of *raw comments* and more *unique solutions* than did the control group. It did not, however, improve creativity (pp. 1-10).

Figure 2-6 Directed Brainstorming as Analyzed under CNM



(Adapted from: Santanen, Briggs & Vreede, 2000, p. 2)

In relationship to CNM, directed brainstorming has additional advantages over traditional brainstorming. The stimulus again is not merely internal, but external. That is, it includes not only the problem statement, but additional prompts devised by the facilitator. Frames stimulated by those prompts are many, and their separation is greater (being more remotely distanced in the mind depending on the remoteness of the prompts themselves). Elaboration of a given solution is encouraged. This results in even greater levels of chunking, as new ideas are added as an elaboration to a given solution. Cognitive load is much less easily exceeded. Since new ideas are added to those existing, they bear less cognitive burden. Variety of stimuli is external, and is very open.

Sophistication of the problem frame is increased. The elaboration of existing ideas generates more complex, and higher quality COAs. Remote frames are combined into complex solutions. The result is an even greater level of creativity in the solutions generated (see Figure 2-6).

2.4 Development of Carousel Brainstorming

Free brainstorming has been widely accepted as the primary method of ideation during solution development in many organizations. Yet it is the very thing that leads to cognitive inertia. Because ideas are freewheeling, members fall into patterns of associations that are limited in their perspective. Receiving only internal stimuli, they fail to consider the wider possibilities presented by matters under consideration.

What is needed is a way of forcing members to break out of a single pattern of associations and to form associations between more remote frames. One method of doing this is through an ideation technique that uses forced external stimuli.

Traditional brainstorming is lead by a facilitator. The facilitator guides the group through the ideation process, soliciting ideas, and recording those ideas where all members of the group can view them. Ideas are generally not elaborated, but written in summary format. Criticism is initially disallowed. The object is to capture as many ideas as possible. Evaluation is also postponed. When once a sufficient number of ideas are captured, analysis and criticism is allowed to proceed. The facilitator terminates the session at his discretion (Aiken, Vanjani & Paolillo, 1996, p. 92).

It is well documented that a good facilitator can lead a group to superior results. Shepherd, Briggs, Reinig, Yen & Nunamaker (1995-1996) found that a “star quality” facilitator working with a group reliably produced 50 percent more ideas than other groups (pp. 163-164). This qualification would apply to both free brainstorming and directed brainstorming, both of which rely upon facilitators.

Yet a skilled facilitator is not always available. This is particularly true of military organizations, where personnel turnover typically exceeds 30% per annum. A person serving in a given role is unlikely to remain there for long. Further, a facilitator who achieves “star quality” in any organization is often promoted away (Briggs, Vreede, & Nunamaker, 2003).

In response to the needs detailed above, we propose an alternate form of ideation that by use of external associations might force remote associations. Moreover, it does not require a facilitator. We name this ideation technique *carousel brainstorming* (CB).

Under CB, a seed set is first devised. Each of these seeds concerns a differ aspect of the problem. A single seed is written on separate sheets, and handed to each participant. Participants are directed to write ideas anonymously on the seed sheet, addressing the issue solely from that facet of the problem. Sheets are then exchanged with other group members for comment. These comments are aimed at enhancing the original solution. When all participants have had a chance to comment on each other’s solutions, the session ends.

CB can be implemented manually or electronically. It can be conducted by manual distribution of seed sheets or by electronic distribution via certain group support systems (GSS) (see Appendix IV).

CB combines some of the features of both brainwriting and directed brainstorming. Like brainwriting, CB is a silent, written procedure. But rather than employ only internal stimuli (i.e., the problem statement), CB employs external stimuli (i.e., specification requirements). CB focuses on viewing the problem from the perspective of examining different features thereof. Like directed brainstorming, CB involves prompts (or seeds) that lead the participants to consider the problem from various aspects. But it does so individually; not as posed by a facilitator.

Also contrary to directed brainstorming, rather than utilizing variously inspired prompts, CB uses specification requirements as seeds to ideation. CB anticipates that better results could be obtained by using individual specifications of the problem under consideration. Each of these requirements forms a locus around which ideas are formulated.

Specification requirements mark important parameters of the problem solution. They are ideally framed in a manner that provides the decision maker with a definitive way of distinguishing between options.

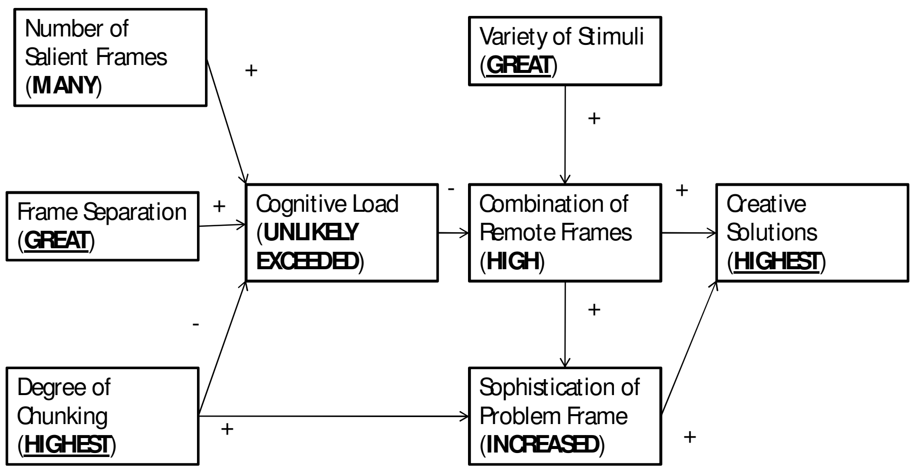
Well-stated specifications contain four elements. First, they clearly describe the characteristic being assessed. They identify it in a precise manner that erases ambiguity. Second, specifications provide a metric for establishing differences. If the feature is quantifiable, then units would be provided. If the feature is qualitative, then a definitive method for establishing qualitative differences would be detailed. Third, specifications provide a minimum value as a criterion against which the outcome could be measured. Finally, specifications provide an expression that determines how changes in the feature will affect evaluation. Will more or less of the feature bring about a better result? Is there an optimum level beyond or below which would be undesirable? (FM 5-0, 2005, 2-10).

Not all requirements are of equal importance. Some count more than others. Consequently, a well-stated set of specifications provides a system of weights that identifies which requirement counts more than others, and by how much (FM 5-0, 2005, 2-11).

The specification requirements of the problem would be most appropriately decided during the analysis of the problem at hand. An analogy is here made to the task of a systems analyst solving a design problem. It is incumbent upon the analyst to actively seek a complete understanding of what the end product is to look like from the client's perspective before proceeding to fashion program designs. The more detailed the specifications of that output, the more likely the software project is to succeed.

In the same way, it is incumbent on the decision maker to gain an understanding of the problem before proceeding to develop solutions directed to that problem. The chief goal of problem analysis is to develop a set of specification requirements. The latter are more relevant, and inspire more serious consideration. This leads to one of the constraints on CB. Since CB is driven by specification requirements, it is necessary that each participant be familiar enough with the domain to be conversant in devising solutions using applicable specifications. Although ideally, the number of specifications would match the number of participants to the session, this might not always be the case. In those instances where specifications exceed the number of participants, only the most salient specifications would be chosen as seeds to the CB session. In cases where the number of participants exceeds the number of specifications, the most salient specifications would be repeated on multiple seed sheets. Similar COA solutions that might result could be consolidated at the conclusion of the session.

Figure 2-7 Carousel Brainstorming as Analyzed under CNM



(Adapted from: Santanen, Briggs & Vreede, 2000, p. 2)

In relationship to CNM, carousel brainstorming has additional advantages over brainwriting or directed brainstorming. The stimulus again is not merely internal, but external. It includes not only the problem statement, but external stimuli. These are specification requirements that are designed to directly stimulate sophistication of the problem statement. Frames stimulated by that stimulus are many, and their separation is great (being more remotely distanced in the mind). The use of specification requirements as prompts results in even greater levels of chunking, since the prompts are designed directly to increase elaboration of a given solution. Cognitive load, therefore, is much less easily exceeded. The effort is to elaborate on good solutions, and to correct those that might be poorly formulated. Variety of stimuli is external, and is set in the context of the specifications. Sophistication of the problem frame is greatly increased, as each new specification stimulates participants to add to the complexity of solutions. Remote frames are combined forming highly complex solutions. The result is an even greater level of creativity in the solutions generated (see Figure 2-7).

2.5 First Hypothesis

This study will examine the use of CB under a GSS as a means to enhancing creativity in developing solutions during decision making. We will focus on the ideation step of the process.

The first question to be examined is a comparison of the creativity of solutions produced by the newly devised ideation method, CB, to manual free brainstorming (MFB). This comparison is worthwhile because MFB remains one of the most widely utilized methods of ideation. It is the method most often conjured by the term “brainstorming”. In business, government, and the military, MFB retains great currency.

CB was introduced as an improvement over other forms of ideation, namely, brainwriting and directed brainstorming. One of the reasons for developing CB was that it offered a way of enhancing traditional ideation in a way that does not require the use of a facilitator.

We will begin by comparing MFB with a manual version of CB. This will provide a baseline for appraising each method at its most fundamental level. The first research question, therefore, is: does manual carousel brainstorming (MCB) lead to more creative solutions than MFB? Formulated in detail:

> Hypothesis 1: Ideation techniques that employ person-to-person interactions using methods of external stimuli and forced associations, based on specification requirements, (i.e., MCB), will produce ideas that are more creative than techniques that employ person-to person interactions using methods of internal stimuli and free associations (i.e., manual free brainstorming).

2.6 Second Hypothesis

As mentioned, CB can be implemented manually or electronically (by means of a GSS). Current literature supports the use of GSS as a tool that improves ideation. A study by Bordia (1997) concluded that Computer Mediated Collaboration (CMC) discussions "take longer, produce more ideas, and have greater equality of participation" (Bordia, 1997, January, pp. 99-102). McLeod (1992) found that GSS "increased decision quality, time to reach decisions, equality of participation, and degree of task focus" (McLeod, 1992, pp. 257-280).

Under CB, as implemented by a GSS, each participant is again assigned an initial specification requirement to consider in devising a COA solution. After submitting their solution to a central pool, the participant then selects one of solutions offered by one of their fellows, and seeks to enhance that solution. The process continues until all participants have commented upon each of the solutions offered by the other participants.

The advantage of the GSS is that it offers additional structure: comprised of the computer hardware, the computer software, and the user interface. The combined effect is to transform the nature of the interaction. When participants sit down in front of computer screen, there is a change in ambiance. The interaction is no longer predominantly person-to-person, but is now a machine mediated person-to-person communication. Rather than being a social atmosphere, it is a contemplative, problem-attuned environment.

Under the manual method, a CB session creates a communal setting. As such, participants feel a need to converse. Even when the when the rule of silence is made clear, there is invariably a friendly chit chat that goes on. The prattle competes with the cognitive load presented by the problem at hand.

A GSS has potential to remove those distractions, and to better focus attention on the task. It prevents cognitive overload and increases the effect of chunking by limiting social interactions.

Whatever is said during manual sessions, the comments compete with the cognition of the problem and its specifications. When left unchecked, the chatter nullifies the benefits of carousel brainstorming entirely.

However, this is much less pervasive during a GSS session. There is less social interaction, and accordingly, less cognitive competition. In relation to the CNM, a GSS insures that cognitive load is less likely exceeded, and potentially increases the degree of chunking.

Hence, the second research question is: does electronic carousel brainstorming (ECB) lead to more creative solutions than does MCB? Formulated in detail:

Hypothesis 2: Ideation techniques that employ machine mediated person-to-person communication using external stimuli and forced associations, based on specification requirements (i.e., carousel brainstorming under GSS), will produce ideas that are more creative than techniques that employ person-to-person interactions using external stimuli and forced associations, based on specification requirements, (i.e., MCB, without the use of a GSS).

2.7 Summary

When complex problems are taken under consideration, better decisions might be rendered not by a single expert, but by groups of people working together. The point is not to gain a quick consensus, but to allow each person to proffer their individual opinions to the general body. The group thereby formulates a repertoire of different approaches to the problem before a given approach holds sway.

CB improves COA development in several ways. First, it insures a greater level of involvement. By forcing people to offer ideas for consideration, they are required to participate in the process. Second, it offers greater freedom of expression. Third, it averts the drawback of productivity bottleneck. Finally, CB allows a fuller range of ideas to be generated, without being lead to follow a single train of thought. In this, it alleviates the problem of cognitive inertia. CB accomplishes the latter by removing the internal stimuli that lead to stultification of ideas. Rather than the group concentrating on a single stimulus, each member concentrates on a separate facet of the problem, a stimulus provided externally from the proctor. These stimuli are nevertheless of greatest relevance to the problem at hand, since they each derive from the specification requirements.

Using a GSS in support of CB, more advantages might be gained. Because GSS limits social interactions, it prevents cognitive overload and increases the effect of chunking. This, combined with ease of use and access, results in an even further range of solutions unconstrained by stultifying influences.

We tested these hypothesis by comparing three test groups: a control group (using MFB), a test group (using MCB), and a second test group (using ECB). Outcomes developed by the three groups were evaluated in relation to creativity of the solutions generated.

Chapter 3 Validation of the Model

In the previous chapter, we presented a development of the model that we have adopted to explain the phenomena of interest. That model, the *cognitive network model of creativity* (CNM), was used to explain why cognitive inertia arises in groups, and why cognitive inertia inhibits the development of creative solutions.

We also developed a form of ideation, *carousel brainstorming* (CB) that employs some of the constructs that proceed from CNM. First, CB uses forced external stimuli. This leads to associations among remote frames in the mind of participants. Second, since those stimuli are derived from specification requirements, they represent different facets of the problem. Their consideration, each in turn, will lead an increasing sophistication of the problem frame in the mind of each participant. Together these features of CB will inspire creative solutions.

In this chapter we present the experimental method that we will employ to validate our method of CB as an extension to CNM. We begin with a description of the task, the participants, and the variables. We then explain the experimental procedures, the techniques for data collection, and the methods by which the data will be analyzed.

3.1 Task

The hypothetical task that we proposed was that of providing hurricane disaster relief. It was presented in the format of a standard Army Operations Order (see Appendix V). The participants were to play the role of the staff members of an Army Reserve battalion, stationed in the Midwest. The unit was ordered to provide hurricane relief under the direction of the Federal Emergency Management Agency (FEMA) for operations, centered in Gulf Port, Mississippi.

The major task of the participants was planning the transport of personnel, vehicles, supplies, and equipment to Camp Shelby, Mississippi (in the vicinity of Gulf Port). Under the scenario, the unit was ordered to arrive at Camp Shelby within one week.

3.2 Task Fit

This task was chosen because it is a mission typical of Army National Guard (ARNG) and Reserve units today. Hurricane relief has become an annual ritual for the Army. Planning to provide resources to that task is a realistic problem for an Army staff. Further, it is appropriately complex so that it requires collaborative planning. Only by the input of each staff member can a solution be found that optimally fulfills mission requirements.

3.3 Participants

3.3.1 Size

The experiment consisted of three classes of participants: two treatment groups and a control group. The first treatment group used *manual carousel brainstorming* (MCB), without the use of a *group support system* (GSS). The second treatment group utilized *electronic carousel brainstorming* (ECB), under a GSS. The control group used *manual free brainstorming* (MFB), without the use of a GSS. For each test, we ran four sessions and we required five participants for each session. A size of five was chosen, as it replicated the size of a typical Army MDMP session.

3.3.2 Composition

Participants to the experiment were members of the Army Reserve Officer Training Corps (ROTC). ROTC is a segment of the Army Reserves that is designed to recruit new members to the officer ranks. Membership to ROTC is very similar to membership in the Army Reserves. ROTC cadets usually attend classes once per week. Cadets also attend summer training camps. This is similar to the regimen of Army Reservists, who attend regular monthly meetings and fifteen days of annual training, often held during the summer. Membership to each group is voluntary.

ROTC cadets receive exposure to MDMP during their senior year of the military science curriculum. Prior to our experiment, all cadets received training in the MDMP process. The class that we presented and the practical exercise were a cap to that training. Given these consideration, conclusions regarding ROTC cadets should thereby be applicable to Army Reservists, and more loosely to military organizations (and militarily-structured organizations) as a whole.

3.3.3 Demographics

The majority of the participants (76%) were undergraduate students in their fourth year of studies. Average age was 22. Seventy eight percent were male, and 22 percent were female—a figure that approximated the gender ratios in the Army. Most (96%) had average to above average knowledge of computers. Ninety two percent rated their knowledge of military tactics as average to above average. Their knowledge of decision making, the majority rated as average to above average (88%). Collaboration techniques, on the other hand, they rated as only average (52%). Most (78%) rated their knowledge of group support systems as less than average.

3.3.4 Testing for Control of Dependent Variables

We tested the demographic results from the MCB and the MFB/ECB experiments for evidence of systematic bias. The samples were compared to determine whether the participants represented the same population or different populations with respect to the thirteen questions covered by the questionnaire.

What we wanted was a comparison of the proportion of responses to each answer, whether choices ‘a’, ‘b’, ‘c’, ‘d’, or ‘e’, for each group (MCB and MFB/ECB). The comparison is a *Test of Homogeneity*, and involves Chi Square.

Accordingly, in order to test for bias in the dependent variables, we conducted a Chi Square Test for Homogeneity. This was done using each question from the demographic survey to determine if the participants (MCB and MFB/ECB) represented samples from the same population, or if they represented samples from different populations. [We omitted from our homogeneity analysis questions on age (question #1) and years in service (question #3), since they did not fit the format of the other questions. The average age was: 22.45 and 22.21; average years in service was: 1.94 and 1.95, respectively.]

Table 3-1 Demographic Comparison of MCB and MFB/ECB Participants

Chi Square—Homogeneity Test

	$\Sigma(f_{mcb} - f_e)^2/f_e$	$\Sigma(f_{mfb/ecb} - f_e)^2/f_e$
...6. Education (circle the highest level completed):		
a. High School	0.0	0.0
b. Associate's Degree	1.1	0.5
c. Bachelor's Degree	1.1	0.5
d. Master's Degree	0.0	0.1
e. Doctorate Degree/Post Doc	0.0	0.0
7. In which education program are you currently enrolled?		
a. Undergraduate program (circle level)		
1. Freshman	0.0	0.9
2. Sophomore	0.0	1.0
3. Junior	1.7	0.7
4. Senior	0.2	0.1
b. Graduate program	0.0	0.3
c. Neither	1.6	0.7
8. Employment Status:		
a. Neither working, nor seeking	0.5	0.2
b. Unemployed, seeking work	0.0	0.0
c. Employed, Part time	1.5	0.6
d. Employed, Full time	0.0	0.9
9. How do you rate your computer skills?		
a. I am unfamiliar with computer	0.0	0.0
b. Poor	0.0	0.1
c. Average	0.1	0.0
d. Above Average	0.1	0.1
e. Expert	0.0	0.3
... Etc.		
Σ	29.4	18.1
X^2_{test} =	**47.5**	

H_0 : The participant answers are the same

H_A : The participant answers are not the same

d.f. = (rows - 1) (columns - 1)

d.f. = (48 – 1) (2 – 1) = 47

$\alpha = 0.05$

Reject H_0 if $X^2_{test} > 66.8$

Since the computed value of Chi Square, 47.5, does not exceed the Table value, 66.8, do not reject the null hypothesis

Conclusion: The two sets of demographic questionnaire answers (MCB and MFB/ECB) are the same.

The formula for the Chi Square test for homogeneity is:

$$X^2_{test} = \Sigma\,(f_{mcb} - f_e)^2 / f_e + \Sigma\,(f_{mfb/ecb} - f_e)^2 / f_e$$

In other words, the Chi Square Test is equal to the summation of the total of MCB responses for each answer minus the expected value, the whole being squared, divided by the expected value. Added to that sum is the summation of the total of MFB/ECB responses for each answer minus the expected value, the whole being squared, divided by the expected value. Expected value is the total of positive responses to that question divided by the total number of participants for both tests, times the number of participants for that particular test (see Table 3-1).

The null hypothesis under consideration is that the participant answers to the demographic survey of the MCB test, and the participant answers to the demographic survey of the MFB/ECB tests are the same. The alternate hypothesis is that they are not the same. The computed value of Chi Square that resulted from a comparison of the two sets of data was 47.5. This is compared to the value obtained from a standard Chi Square Distribution. In order to get the standard value we need the degrees of freedom, which is equal to: (rows -1) (columns – 1) = (48 – 1) (2 – 1) = 47. Based on d. f. = 47, and α = 0.05, we can obtain a standard value of Chi Square as 66.8.

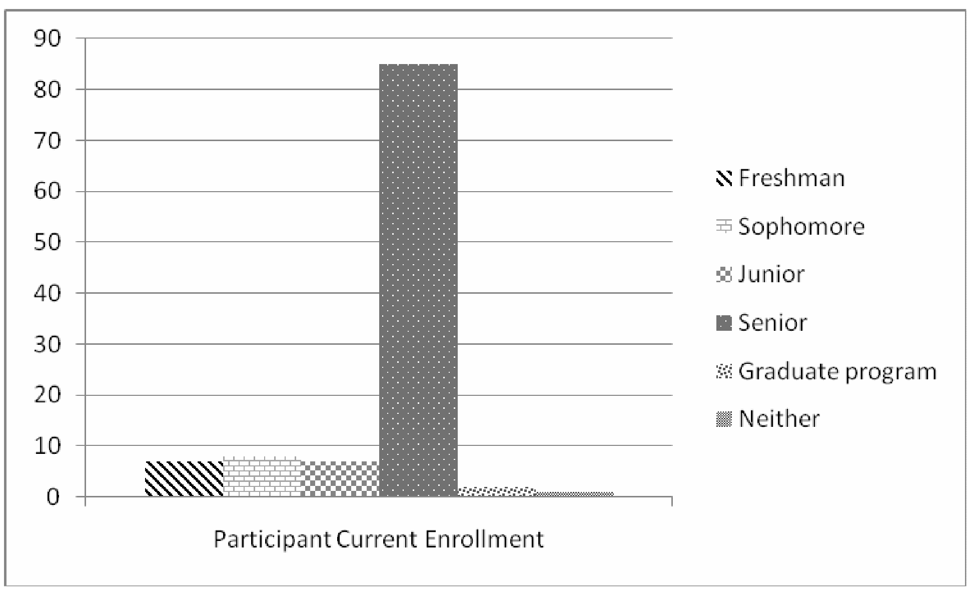
Since the computed value of Chi Square, 47.5, does not exceed the standard value of Chi Square, 66.8, we fail to reject the null hypothesis. We can conclude that the answers provided by each group of participants (MCB and MFB/ECB) to the demographic questionnaire do not significantly differ. Their responses are the same.

Therefore, the demographics of the two groups of participants did not vary in respect to the variables considered. (This is provided that participants understood the questions, and that they answered the questions honestly.) Given the above, we can assert that we controlled the dependent variables under consideration.

3.3.5 Results of Demographic Questionnaire

Data was collected from 113 ROTC cadets located at eight universities in the Midwest. All data collection was done on site at each of the participating ROTC battalions. The experiment was comprised of 21 groups in total, developing 112 COA solutions.

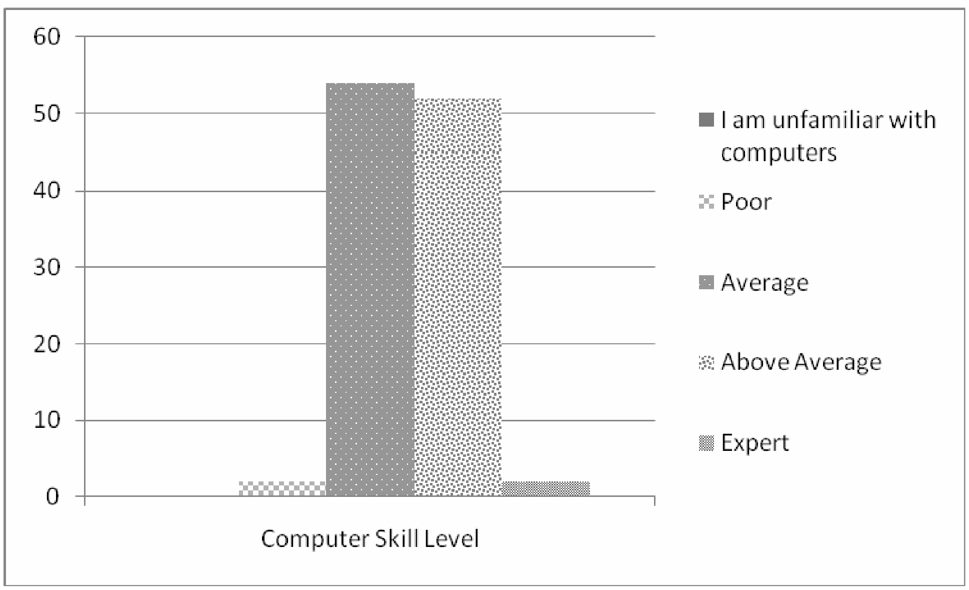
Figure 3-1 Current Enrollment of Participants



Seventy six percent of the participants were seniors (see Figure 3-1). The point is noteworthy. ROTC students proceed through the program as a group. Each semester, cadets of a given year group attend the same military science courses together. Much of the training that they attend during the summer months is received as a group. They also participate in assorted extra-curricular exercises together. Consequently, the participants to the study were people who knew each other well. They had studied together, worked together, and played together. Many had at one time or another roomed together. They were familiar with each others' plans, aspirations, ideas, and attitudes. They were people whose identities were difficult to hide from one another.

This fact had an impact on the experiment in that the cadets' familiarity with each other facilitated free brainstorming sessions. There was probably more evaluative apprehension experienced by participants than would be had by group of strangers. Cadets were inclined to talk. They were used to discussing issues with one another.

Figure 3-2 Computer Skills of Participants



That same familiarity, however, acted as a detractor during the MCB and ECB sessions. The inclination to talk (which is forbidden during MCB and ECB) had to be carefully monitored and controlled. And it made anonymity nearly impossible. Cadets were able to guess who had said what merely by the content of the responses. In spite of our best efforts, there was little that we could do to disguise authorship.

Although computer skills were not important to all tests, most participants (96%) had average to above average knowledge of computers. This probably accounted for participants' quick grasp of GSS procedures, and lack of assistance in general that they required during the ECB sessions (see Figure 3-2).

Ninety two percent rated their knowledge of military tactics as average to above average (see Figure 3-3). This can be attributed to the fact that the majority of the participants were undergraduate seniors. They were in their fourth year of study of military science, and were comfortable in their knowledge of the subject.

Figure 3-3 Knowledge of Military Tactics of Participants

Participants' knowledge of decision making, the majority rated as average to above average (88%). Most quickly grasped the method of MDMP, and were able to apply it successfully to problem solving (see Figure 3-4). Never was a question raised that would indicate that a participant did not understand MDMP, or was confused about the procedure.

Figure 3-4 Knowledge of Decision Making of Participants

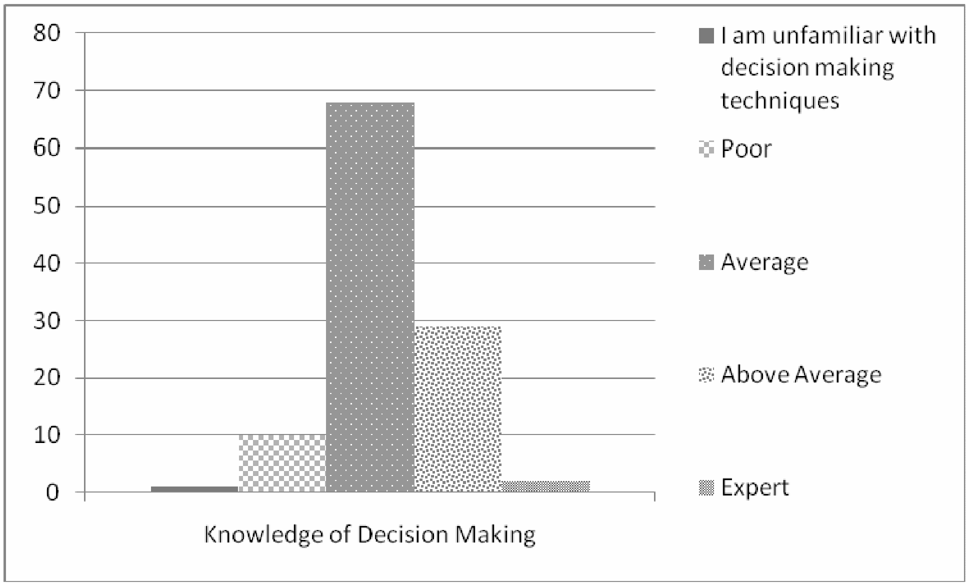
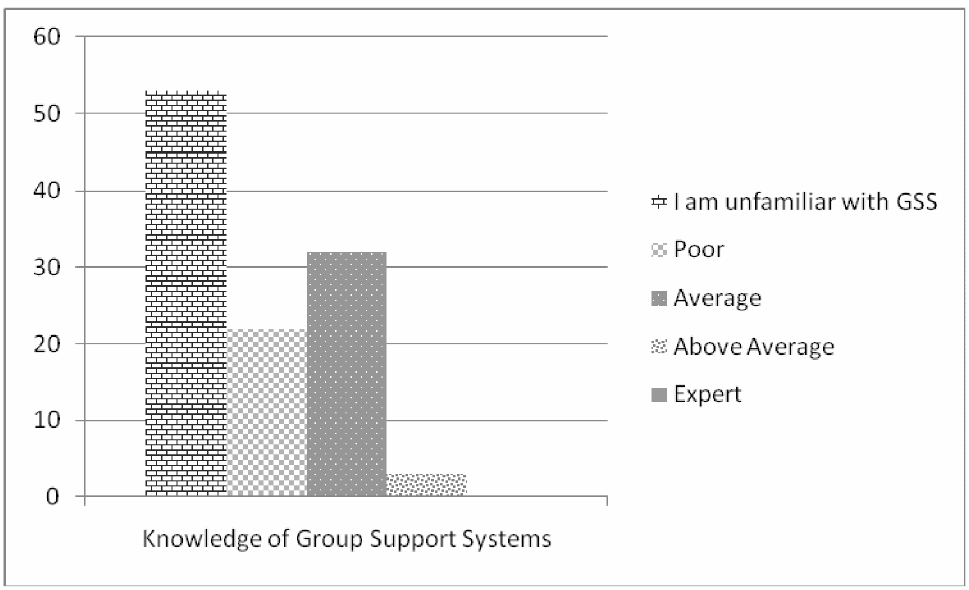


Figure 3-5 Knowledge of Group Support Systems



Most (78%) rated their knowledge of group support systems as less than average (see Figure 3-5). This can be explained by the fact that ROTC students are not required to major in a specific field. Cadets majored in a variety of disciplines. Their knowledge of GSS depended on their field of study.

The lack of knowledge of GSS may have slightly impacted the results. All cadets quickly grasped the instructions on the use of ThinkTank, and were immediately able to use it with skill. However, lack of knowledge of the overall system may have caused apprehensions. The latter perhaps lead to lower creativity scores under ECB.

3.3.6 Participant Flow

The total number of participants to the experiment was 113. These were divided among 21 groups. Two periods of data collection were conducted. The first set of data was collected during the spring of 2009, and the second set was collected during the fall of 2009. The spring data collections consisted of: (a) MFB: 5 groups, 20 participants, 35 COA solutions; MCB: 4 groups, 20 participants, 20 COAs; ECB: 4 groups, 20 participants, 20 COAs. The fall data collections consisted of: MCB-revised: 8 groups, 37 participants, 37 COAs; ECB-revised: 4 groups, 16 participants, 20 COAs. The totals tallied to: 25 groups, 113 participants, 132 COAs. [Note: the Spring 2009 MCB data (4 groups and 20 COAs) was not used due to a revision of the MCB procedure].

3.3.7 Recruitment

Recruitment to the study was solicited by electronic mail messages to the commanders of ROTC battalions at universities in the Midwest. Eight commanders agreed to participate, from ROTC battalions at: University of Illinois-Chicago, Marquette University, Northwest Indiana University, Western Illinois State University, Eastern Illinois University, University of Wisconsin-Madison, Southern Illinois University-Edwardsville, and Purdue University. All commanders agreeing to the study were accepted. None were declined.

Cadet participants from those universities were selected by the commander of the battalion. Most came from the senior class of undergraduate students (MDMP is part of the senior class curriculum). Prior to the session, cadets were given an information sheet, and they were offered the chance to individually decline participation. Although no pressure was put on cadets to participate, no one ever declined.

3.3.8 Environment

The experiment was conducted at the site of each ROTC unit. ROTC commanders in the Midwest were solicited to allow us to conduct a class on the MDMP, on a date of their choosing.

Each session was held in a standard classroom, with audio visual equipment available. The lecture consisted of a brief explanation of the purpose and steps of MDMP, with the aid of PowerPoint ® slides.

During the Spring 2009, the practical exercise was conducted at three locations at the site. The control group remained in the same classroom as the lecture. The designated facilitator (a cadet participant) was provided an easel, with butcher pad, on which to record the results of MFB session. The facilitator was also provided with a script (Appendix VIII) containing directions for MFB, that he/she was directed to read to the group.

The first (manual) treatment group was conducted in a separate room. The group was provided five sheets, each containing a specification requirement. These sheets served as the initial seeds, handed to each participant. The proctor (the researcher) read a script (Appendix IX) containing the directions for MCB to begin the session.

The second (electronic) treatment group was lead to a second separate room, where a computer was made available to each participant. Each computer had Internet access to the GSS software. The GSS was pre-loaded with five "seeds" to the problem. The proctor (the researcher) read a script (Appendix X) containing the directions for ECB to begin the session.

Arrangement of participants was generally in a rough circle for MCB and ECB. We attempted as far as possible to replicate the same environment across each of the experimental sessions.

3.4 Materials

Control and treatment groups were segregated to separate locations. The control group conducted MFB in a classroom with butcher pad and easel. The treatment groups conducted CB, the first manually, and the second electronically under a GSS. [Note: during the fall 2009, this arrangement was modified. Only one test was conducted at each site (MCB or ECB), and all groups were located in a single room under the supervision of the proctor.]

The GSS that we chose for this study was commercial available software: ThinkTank®. ThinkTank is a leading GSS software designed to provide a facility where members of a work group can communicate, share documents, and work together on a project. Access to ThinkTank is by web browser.

Two types of users are offered by ThinkTank: the participant and the session leader. The former consist of the individuals that make up the primary members in the ideation process. For our purposes this was the cadets, acting as the Army staff. The latter was the researcher who acted as the administrator. The session leader had authority to create sessions and to admit participants to the process.

Results of the various processes created by ThinkTank were moved to Microsoft Word ®. The latter was used to perform further refinements of the data obtained.

3.5 Independent Variables

To stimulate the development of creative solutions, an external impetus is required. This impetus serves to transfer thought to a new region of the brain. Once transferred, the new set of nodes forms a separate region around which ideas are formulated.

In this study we used a list of specification requirements as the external stimuli. These specifications take the shape of a long list of features. These features are incapable of being maximized simultaneously. The maximization of one variable (time to complete) naturally interferes with the maximization of another variable (number of features). A balance must be struck between competing requirements.

It is no more possible to develop as list of general specifications as it is possible to develop a list of specific generalities. Specifications are peculiar to each problem and circumstance. Under MDMP, these specifications constitute the *commander's guidance,* and would be devised by the commander during Mission Analysis.

Since our time was limited, we provided participants with a list of specification requirements (see Appendix VI). In order to ensure fairness, both the control and treatment groups had the same list of specifications available. However, unlike the control group, each member of the treatment groups was given one specification on which to initially focus.

3.6 Experimental Design

CNM postulates that creative ideas are based on a combination of remote frames. That combination is affected by stimuli and by cognitive load. The latter is shifted by increasing the degree of chunking, leading to more sophisticated problem statements. It is also be affected by the type of stimuli brought to bear upon the cognition of the problem solver. Increase the variety and method of introducing stimuli (by forced external means) and one can achieve a combination of remote frames, leading to creative solutions

Thus, we conducted three tests using two ideation techniques: free brainstorming and carousel brainstorming. We tested carousel brainstorming under two separate implementations: manual and electronic (using a GSS). Our object in testing MFB is due to the fact that it is the most popular version currently implemented by many organizations, and therefore forms a baseline against which to test the other procedures. Since electronic free brainstorming is not widely implemented, nor is it an enhancement envisioned under CNM, it was not tested (see Table 3-2).

Table 3-2 Experimental Design

Ideation Technique	Manual	Electronic
Free Brainstorming	tested	not tested
Carousel Brainstorming	tested	tested

The introduction of a variety of stimuli was a key focus of the research. What we were seeking was a general rubric for adding diversity to the stimuli introduced. As mentioned, we introduced prompts based on specification requirements. The prompts were *external*, *forced*, stimuli that strove to produce increased sophistication of the problem frame through chunking.

3.7 Methodology

3.7.1 Pilot Study

Before proceeding with the experiment, a pilot study was conducted at the Naval Station Great Lakes, Great Lakes, Illinois, using Southern Illinois University-Carbondale student/sailors as participants. The purpose of the pilot study was to test the experimental design and to determine its practicability. We duplicated each of the parameters of the experiment as closely as possible. The same environment (classroom and computer lab), materials (butcher pad and ThinkTank ® software), and procedures (MFB and carousel brainstorming scripts), were employed as with the actual experiment. The one difference was in the composition of the participants (sailors versus ROTC cadets).

During the course of the pilot study we identified minor problems with materials, procedures, and data collection, and resolved them. First, we gained an appreciation for the amount of time necessary to conduct the set-up of our experiment. Preparation of the computers and gaining access to the Internet were critical to the use of the web-based ThinkTank ® software.

Second, we gained insight into some of the difficulties of successfully conducting

MCB sessions. There was a propensity to transgress from the rules of the procedure were noted. Participants tended to pass the sheets to whoever was available. Further, participants had a strong inclination to discuss the OPORD with fellow participants. MCB sessions thereby tended to deteriorate into MFB session.

To deal with the first problem we learned to plan to arrive at the site several hours early in order to deal with contingencies. We also learned to bring extra equipment: cables, network cards, extra laptops, etc, to manage whatever deficiencies we encountered.

The second problem we dealt with by insuring that the proctor stayed with the class during the entire session. The proctor quickly corrected violations of procedures, and forbade any discussion of the OPORD during the MCB and ECB sessions.

Statistical power was also determined during our pilot study. Since we want to guard most against a Type I Error (claiming the samples represent different populations when they represent the same population), we chose an alpha level of 0.05.

The Power of the test is equal to 1 minus the probability of committing a Type II Error (claiming that samples represent the same population when they represent different populations). At an alpha level of 0.05, and for a normal distribution, this will be 0.851.

Since all participants contribute equally to the product of the ideation sessions, the number of people in each group is not significant. It need only be large enough that we can call it a group. As a minimum, this requires three participants. Other qualifications: i) we wanted a roughly equivalent size group for each test; ii) the group size should roughly equal the standard size of military ideation groups. Given these considerations, we agreed previously that groups be composed of 3-5 people each. That requirement was met in all 25 sessions conducted.

A sample, under this study, is an evaluated COA solution: a "creative solution". As the standard deviation differs for each test, the number of samples to gain statistical significance also varies. For Manual Carousel Brainstorming (MCB), the power of the statistic was: Probability of Type I Error = .05; Probability of Type II Error = .851; Sample size: $1 - \beta = s.d. / \sqrt{n}$; $1-.851 = .5859 / \sqrt{n}$; $n = 16$. For Electronic Carousel Brainstorming (ECB), the power of the statistic was: Probability of Type I Error = .05; Probability of Type II Error = .851; Sample size: $1 - \beta = s.d. / \sqrt{n}$; $1-.851 = .6405 / \sqrt{n}$; $n = 19$.

So the required sample sizes to gain statistical significance are: 16 creative solutions for MCB and 19 creative solutions for ECB. The sample sizes that we used: 32 and 35 respectively, exceeded these numbers. They were therefore sufficient to gain statistical power.

3.7.2 Procedures

Three classes of participants were used in our testing. The first was a control group. They conducted an ideation session using MFB. The second was a treatment group using MCB. The third was a treatment group employing ECB as implemented by ThinkTank ®.

The reason for the segregation was to duplicate, via the control group, current popular methods for COA development—that is, free brainstorming without GSS. It is the combination of CB as implemented under a GSS that we were ultimately comparing to common usage. The control group stayed in one room, and used traditional manual methods. The treatment groups moved to a separate rooms and employed CB both manually, and under a GSS.

3.8 Treatments

3.8.1 Lecture

The class consisted of a lecture in combination with a practical exercise (PE) / experiment, and lasted a total of 50-75 minutes. The PE/experiment focused on COA development, using the Hurricane Jane OPORD (see Appendix V).

Selection to the control and treatment groups was done randomly. Every second participant was selected to MCB group, and every third cadet was selected to ECB group. Facilitators were chosen for the MFB group by drawing straws. The facilitators were briefly instructed in their duties, and the ideation sessions were allowed to proceed.

Prior to the start of the class, Informed Consent Notification Forms were distributed (see Appendix VII). Non-interested parties were permitted to depart the area for the duration of the class. Since identification of cadets was kept confidential, and the experiment imposed no physical dangers, there were no departures that might introduce a systematic bias. In every session, all class members participated. A short demographic survey was also administered at this time (see Appendix XIII).

3.8.2 Manual Free Brainstorming Session

MFB sessions were lead by a cadet facilitator.[v] The facilitator guided the group through the ideation process, soliciting ideas, and writing those ideas down in a place where all members of the group could view them. The facilitator was instructed to lead the control group in creating as many COA solutions as they could devise (see Appendix VIII). We had available an easel, with a butcher pad, for the facilitator to record the control group's deliberations. The facilitator was permitted to terminate the session at his discretion when a sufficient number of ideas were generated.

3.8.3 Manual Carousel Brainstorming Session

The first treatment group was lead by the researcher. After reading the script of directions (see Appendix IX), the researcher randomly handed each of the participants a sheet upon which a specification requirement was listed. The participant anonymously wrote a COA solution to the problem, one that maximized that specification, on the same sheet. After the participant completed a COA solution, they deposited their sheet to a central tray. (The procedure was then paused until all participants had so deposited their sheets). Each participant then selected a paper (apart from their own) from the tray, reviewed the ideas of the other member, and wrote their comments. This process was repeated until all participants had an opportunity to comment on the COA solutions of each of the other members.

3.8.4 Electronic Carousel Brainstorming Session

The second treatment group was also lead by the researcher. A set of computers in a separate room was used to perform the experiment. Prior to use, members of the treatment group were trained in the technology of collaboration and the use of the software (see Appendixes X and XI).

During the session, each group member devised a COA solution to a single specification requirement (randomly selected) using ThinkTank®. Participants were not identified. After "submitting" the COA solution, it entered a common pool, provided by the software. (The procedure was then paused until all members had devised a COA solution for their specification requirement). Members then selected one of the other COA solutions, and wrote suggestions to enhance it. The process was repeated until all members had a chance to comment on each of the COA solutions submitted.

3.8.5 Conclusion of the Class

At the end of the ideation sessions, the researcher reunited the groups, and discussed the results of the ideation. The focus of the discussion was on MDMP, and its advantages over individual decision making. Neither the experiment nor its conclusions were mentioned.

After the discussion, the researcher thanked the class, and returned them to their regular ROTC instructor. Before leaving, the researcher collected the written materials from the control and manual treatment groups. The data from the electronic treatment group was already recorded in ThinkTank for retrieval at a later time.

3.9 Dependent Variable and Data Collection

Data collected were the COA solutions developed as a result of each ideation session. Ideation sessions were recorded by the GSS in separate databases. All submissions were logged and were easily retrievable from the database. Data from the control group was the written COAs, recorded on the butcher pad provided. Data from the manual treatment groups were the five "seed" sheets, upon which the separate problem solutions were recorded. Both manual sets of data were collected at the conclusion of the classes.

3.10 Data Analysis

The central task of data analysis was that of determining the level of creativity exhibited by each of ideation sessions. This was best answered in reference to the definition of creativity present in Chapter 1. We utilized a Likert scale to rate each of the solutions. The scale ranged from one to four. The gradient rated the solution with respect to each of the five components of creativity: distinguishable, feasible, acceptable, suitable, and complete. The scores for the five components were averaged to produce a "creativity" score.

The evaluation of the creativity of the solutions was based on the gradient (see Appendix XII), as judged by a panel of twelve Army officers. Evaluations were conducted on four separate occasions: August 2009, October 2009, November 2009, and May 2010. Every COA solution was evaluated at least once by an Army officer. Some COA solutions were rated multiple times (due to random selection from among the pool of COA solutions gathered). In cases where a COA solution was evaluated more than once, a single evaluation was randomly chosen as the creativity score for that solution. This was done to ensure a balanced assignment of creativity scores.

All officers were members of the Army Reserve unit: 3/75th Division (Training Support). One of the primary missions of the 3/75th Division is to train Army Reserve units in MDMP. Every officer in the U.S. Army is trained in the use of MDMP. Such training begins with pre-officer training schools (such as ROTC), and extends to Officer

Basic and Officer Advanced courses.

Officers of the 3/75th Division made particularly good judges due to their repeated exposure to teaching MDMP, observing MDMP sessions, and evaluating the results of MDMP sessions. The 3/75th Division specializes in teaching MDMP, and continually conducts MDMP classes for Army Reserve units (frequently extending over several days). Additionally, the 3/75th Division directs assorted Command Post Exercises, Field Training Exercises and Mission Readiness Exercises for Army Reserve units. MDMP is one of the primary topics of evaluation during these exercises. Every officer of the panel chosen had upwards of six years of service in the Army, and at least one year of service as a member of the 3/75th Division (TS). Accordingly, every panel member was an expert in the structure and use of MDMP.

3.11 Summary of the Method

Collaborative decision making is an important task to any modern organization. But it is a task that is not without problems. This study addressed those cases in which decision making goes awry. The phenomena of interest were creative solutions. Our intervention sought to enhance the decision making process by increasing creativity of solution options developed therein.

We did this by the use of CB as implemented by a GSS to support solution development. Specification requirements were used as seeds to the ideation sessions. A GSS, we hoped, would help to shape the environment in such a way that decision making resulted in more innovative and effective solution options.

The best evaluation of decision making using CB under GSS would be conducted by an actual unit, in the field, with real world problem-solving. For reasons of security, safety, and operational concerns, that was impossible. We contented ourselves with participants working in a classroom setting, using a simulated problem.

Chapter 4 Results

In the previous chapter, we presented the experimental method used to validate the CNM. We began with a description of the task, the participants, and the variables. We then explained the experimental procedures, the techniques for data collection, and the methods by which the data would be analyzed.

In this chapter, we present the results and an analysis thereof. A brief summary and defense will be offered.

4.1 Statistics and Data Analysis

4.1.1 Evaluation of the data

Evaluations of the data were conducted by a panel of twelve Army Reserve officers. Each officer evaluated one set of COA solutions from each of the MFB, MCB, and ECB groups. The group of data that a panel member evaluated was selected randomly (by toss of die) from each of the three ideation styles. It was then copied to an evaluation sheet that was created separately for each panel member. The sequence of the groups (MFB, MCB, and ECB) was randomly determined (again by toss of die) so that the order of the data evaluated varied. The above process, we hoped, would present the least biased comparisons.

4.1.2 Results of Evaluations

The creativity scores are derived from an arithmetic average of the rating of the five FADS components. This is based on a Likert scale of 1 (least) to 4 (most) creativity.

The resulting means (without verifying statistical significance) indicate that: MCB (mean = 2.5892) > ECB (mean = 2.255) > MFB (mean = 1.6571), with respect to overall creativity ranking. Dispersion of the data was tighter for MCB and ECB, with standard deviations (s. d.) of .6514 and .7103 respectively. Scores for MFB were more widely dispersed, having a standard deviation of .8752.

Each evaluated COA (i.e., creative solution), constituted a sample. There were 37 creative solutions for MCB submitted by eight ideation groups at Eastern Illinois University (EIU) [two groups], University of Wisconsin-Madison (UWM) [three groups], and Southern Illinois University-Edwardsville (SIUE) [three groups]. There were 40 creative solutions for ECB submitted by eight ideation groups at: UIC [one group], Marquette [one group], NWIU [two groups], and Purdue University [four groups]. Finally, there were 35 creative solutions for MFB submitted by five ideation groups at: University of Illinois-Chicago (UIC) [one group], Marquette University [two groups], Northwest Indiana University (NWIU) [one group], and Western Illinois University (WIU) [one group]. This gave us a total of 112 creative solutions generated by 21 groups.

Under MFB, the number of solutions generated by a group was fluid. Groups were free to develop as many (or as few) COA solutions as the facilitator directed. The range was substantial. Some MFB groups developed as few as four solutions. Others developed as many as ten.

Under MCB and ECB, however, the procedure dictated the number of solutions to be developed—one per seed. As groups were generally composed of five cadets, each of whom initiated a seed, the number of COA solutions reliably totaled five. As we measured the quality and not the quantity of the solutions generated, this difference in number was not deemed significant.

A Newman-Keuls Multiple Comparison was conducted of the results of the three test groups: MFB (1), MCB (2) and ECB (3), (see Table 4-1). It involved a sequential comparison of means from largest to smallest. The comparison began with the largest mean and compares it to the smallest. In this case, the largest means was gained by MCB, and the smallest means was gained by MFB. A difference of 0.932 was calculated between the means of MCB, "Mean(2)", and MFB, "Mean(1)", using the three (P) subsets of means so ranked. Since the Critical q (3.364) at a .05 significance level, is less than the observed Q (7.473), the difference between the means warranted a rejection of the null hypothesis (that the sample means represent the same population). Hence, the observed differences between MCB and MFB scores were not likely due to error, and were significant.

Table 4-1: Newman-Kuels Multiple Comparison

Newman-Keuls Multiple Comp.	Difference	P	Q	Critical q (.05)
Mean(2)-Mean(1) =	0.932	3	7.473	3.364 *
Mean(2)-Mean(3) =	0.3342	2	2.77	2.805
Mean(3)-Mean(1) =	0.5979	2	4.883	2.805 *

Approximate P: < .001

*Indicates significant difference

Note: Mean (1) represents MFB; Mean (2) represents MCB; and Mean (3) represents ECB

The Newman-Keuls procedure next performed a comparison of the second highest ranked means: MCB and ECB. A difference of 0.3342 was calculated between the means of MCB "Mean(2)", and ECB, "Mean(3)", using two (P) subsets of means so ranked. Since the Critical q (2.805) at a .05 significance level, was not less than the observed Q (2.77), this difference between the means did not warrant a rejection of the null hypothesis. Hence, the observed differences between MCB and ECB scores were within a margin of error, and were not significant.

Finally, the procedure performed a comparison of the third ranked means: ECB and MFB. A difference of 0.5979 was calculated between the means of ECB "Mean(3)", and MFB, "Mean(1)", using two (P) subsets of means so ranked. Since the Critical q (2.805) at a .05 significance level, was less than the observed Q (4.883), this again warranted a rejection of the null hypothesis. Hence, the observed differences between ECB and MFB scores were also not likely due to error, and were significant.

The small Approximate P-value ($P < .001$), confirmed that there was a significant difference between the groups, and it provided the figure at which this would no longer be the case. As a check on the results from the Newman-Kuels Multiple Comparison, we conducted a Tukey Multiple Comparison using the same data. It confirmed that observed differences between ECB and MFB scores were not likely due to error, and were significant (see Appendix XV).

The results of the ANOVA and multiple comparisons warranted are re-evaluation of our results. Since the differences between MCB (mean of 2.59) and ECB (mean of 2.26) were statistically insignificant [and were well within the margin of error (+/- .56)] the conclusion that MCB > ECB was unwarranted. The two groups in fact represented the same population. The difference between MCB and MFB, was, however significant.

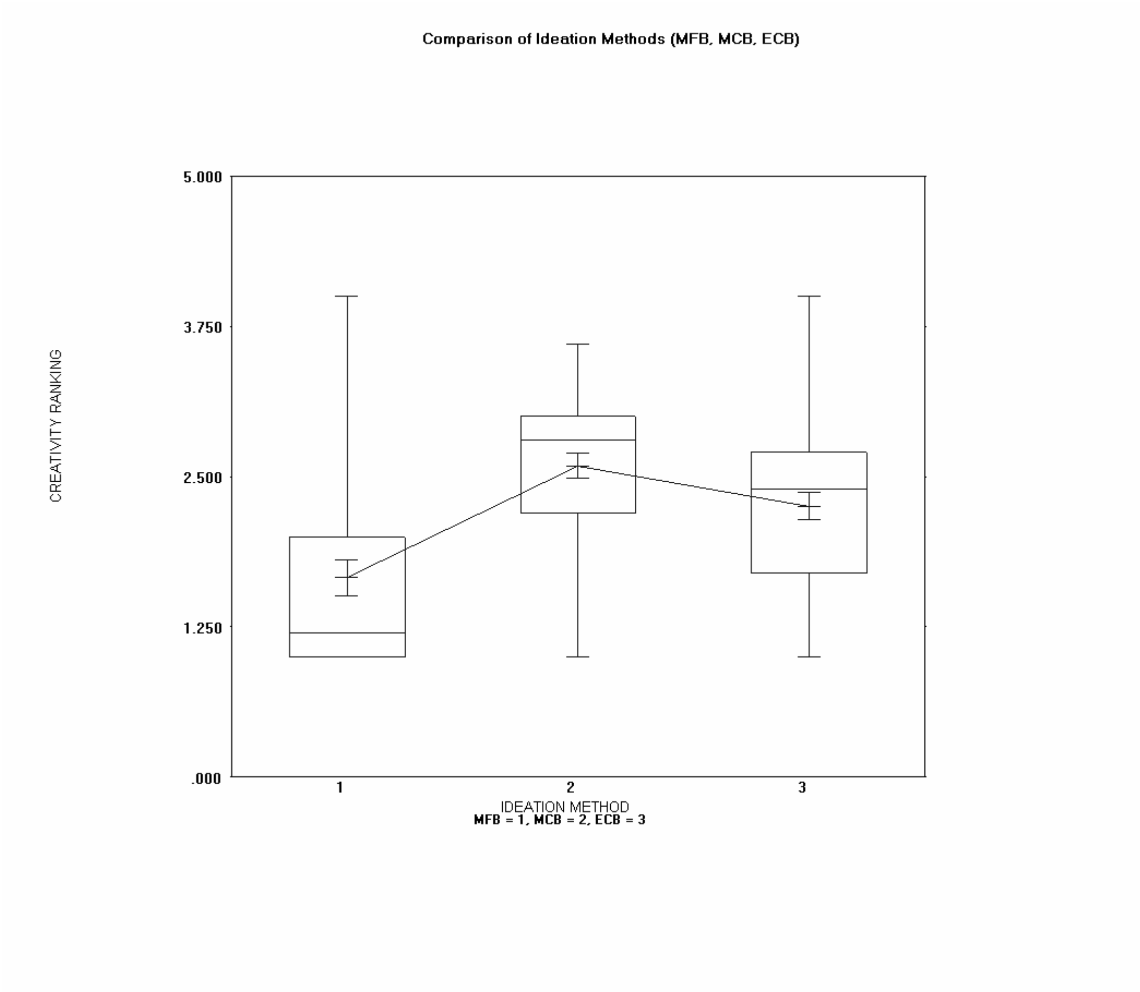
Based on the above, we can confirm by a comparison of the means, combined with the tests for significance, that MCB > MFB is valid. Similarly, the difference between ECB and MFB is also significant. We can therefore conclude, based again on a comparison of the means, combined with the tests for significance, that ECB > MFB.

The box chart (see Figure 4-1) displays the distribution of the data of the three methods (MFB, MCB, and ECB) with respect to the means (connected). It indicates that both the MCB and the ECB data was skewed low (with means less than the medians), while the MFB data was skewed high (with mean greater than the median).

A Pearson coefficient of skewness (Sk) analysis confirmed the box chart. (Sk Ranges from -3 to +3, with Sk = 0 meaning a perfectly symmetrical distribution.) For MFB**:** Sk = 3 (X – Md) / s; Sk = 3(1.65714 – 1.20) / 0.86265; Sk = 1.58978; indicating a medium positive skew. For MCB: Sk = 3(2.58919 – 2.80) / 0.64254; Sk = -0.9843; indicating a somewhat negative skew. And for ECB: Sk = 3(2.255 – 2.40) / 0.70141; Sk = -0.620; indicating slightly negative skew. (An explanation of the skewing will be offered in *Section 5.5.6*, (below).

Next we considered rankings with respect to the components of creativity: as combining effectiveness and innovation (see Table 4-2 and Figure 4-2). Again, MCB scored well with respect to both effectiveness and innovation. MFB, on the other hand, scored fairly well with respect to innovation, but it scored low with respect to effectiveness. ECB scored a middle rating with respect to both effectiveness and innovation. And chiefly because of the low effectiveness score, MFB had a significantly lower creativity ranking than the other two methods. (For a comparison of the Army's FADS components, see Appendix XVII).

Figure 4-1: Box Chart of MFB, MCB, and ECB Results



Note: Vertical lines (above) represent the ranges of the data. Boxes represent the middle 50% of the scores. The middle dash inside each block represents the mean scores (connected). The upper and lower dashes represent the error interval. Horizontal line dissecting a box represents the median.

Carousel Brainstorming most improved effectiveness, but also improved innovation (though not significant). Innovation was improved by the use of external stimuli (specification requirements). Carousel Brainstorming provided an external stimulus that jolted participants out of their cognitive inertia, and inspired insight into new solutions. However, it inspired those solutions only <u>once</u>, when and individual developed a COA in response to the specification listed on their initial seed sheet.

Differences in effectiveness ranking were likely due to the repeated enhancement of COA solutions by subsequent review of seeds sheets. This occurred when the first participant devised a COA, and it occurred each time it was reviewed by a fellow participant. The mechanism of chunking added to previous frame and increased sophistication of overall problem frame. Each of these reviews had an impact on effectiveness, by the participant adding to that COA. Whereas innovation was improved once, effectiveness was improved five times. Accordingly, the greater impact on the product was in effectiveness rather than innovation. And because the commander's insights (the whole of the specification requirements) were made clear, effectiveness was still further improved. Cadets were forced to a fuller consideration of issues, which further improved effectiveness.

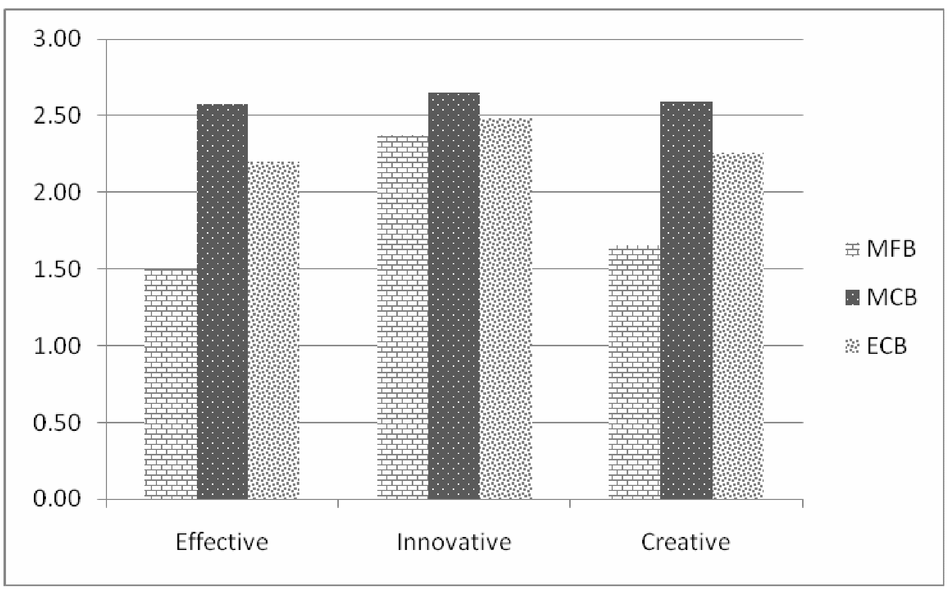
Table 4-2: Effectiveness, Innovation, and Creativity Rankings

	Effectiveness (x4)	Innovation (x1)	Creativity
Manual Free Brainstorming	1.49*	2.37	1.66*
Manual Carousel Brainstorming	2.57*	2.65	2.59
Electronic Carousel Brainstorming	2.20*	2.48	2.26

Note: * Indicates statistically significant difference. Analysis of statistical significance reveals the following differences: Effectiveness: Three statistically significant differences emerge: MCB differs from MFB, ECB differs from MFB, and MCB differs from ECB. Innovation: No significant differences. Creativity: MCB differs from MFB and ECB differs from MFB. But MCB differs not from ECB (see Appendix XVI). Effectiveness is weighted (x4) with respect to Innovation (x1), to accord with the Army's FADS test [see Section 1.8 (above)].

The raw data bears out the difference. Under MFB, participants produced a wide range of suggestions. Yet the suggestions were terse. MFB participants failed to elaborate on their ideas. And many of the ideas submitted were far-fetched (such as traveling down the Mississippi River by barge). They seem to have been offered merely to startle and amuse, rather than to represent a realistic possibility. On the other hand, MCB and ECB sessions had a more serious atmosphere. Cadets were determined to find the best solution to the problem, and not merely to entertain their classmates.

Figure 4-2: Creativity Rankings with Respect to Effectiveness and Innovation



The COA solutions produced under MCB and ECB provided much greater elaboration. Absent were the facetious solutions. All ideas offered represented realistic possibilities. The lack of effectiveness is a considerable drawback in domains, such as the present, where practicality is key. Both MCB and ECB produced solutions that were higher in effectiveness, and were consequently more useful.

4.2 Hypothesis 1 Analysis

Hypotheses 1 was that ideation techniques that that employ person-to-person interactions using methods of external stimuli and forced associations, based on specification requirements, (i.e., MCB), would produce ideas that are more creative than techniques that that employ person-to-person interactions using methods of internal stimuli and free associations (i.e., manual traditional ideation). This was substantiated by the data. There was a statistically significant improvement in the creativity of COAs produced by MCB as opposed to MFB (see Table 4-1). However, this was weighted towards effectiveness. Innovation was not significantly improved. Hence, **hypothesis 1 is only partially confirmed.**

4.3 Hypothesis 2 Analysis

Hypothesis 2 was that ideation techniques that employ machine mediated person-to-person communication using external stimuli and forced associations, based on specification requirements (i.e., carousel brainstorming under GSS), will produce ideas that are more creative than techniques that employ person-to-person interactions using external stimuli and forced associations, based on specification requirements, (i.e., MCB, without the use of a GSS). This was not substantiated by the data. There was no significant improvement in the creativity of COAs produced by ECB as opposed to MCB. **Hypothesis 2 is rejected.** The reason for this outcome is discussed in Chapter 5.

4.4 Summary of results

The results partially verified hypothesis 1, but failed to verify hypothesis 2. It showed that the effect of more creative solutions was obtained by the procedure itself, and not by the medium used to execute that procedure.

The results failed to strongly endorse the use of GSS for the specific objectives of the study. It succeeded in partially validating the CNM. Both MCB and ECB utilized external stimuli to enhance the creativity of MDMP. It was a procedure that should have enhanced innovation. But innovation was not significantly improved. However, both procedures did demonstrate that chunking, and the subsequent sophistication of the cognitive frame, can have a positive effect on the creativity. This effect was evinced in the significantly enhanced effectiveness of the COA solutions produced.

Chapter 5 Discussion

In the previous chapter, we presented the results of our data collections and gave an analysis thereof. The results demonstrated a statistically significant improvement in effectiveness of COA solutions under MCB and ECB as opposed to MFB.

In this chapter we will discuss the results, and offer some interpretations of the data. A general conclusion will be offered, as well as recommendations for future studies.

5.1 Differences between MFB and MCB

In each of the sessions, MFB, MCB, and ECB, participants were presented with the same stimuli. This consisted of the problem statement and the specification requirements (see Appendixes V and VI). However, in MFB the stimuli were presented as a group, prior to the ideation session. Under carousel brainstorming (MCB and ECB), the Operations Order (OPORD) was presented prior, but the specification requirements were withheld, and presented later, individually on seed sheets. In the former case, the impact on the effectiveness of solutions was less than that of the latter.

The reason had to do with cognitive load. The consideration of all specifications together (five), along with the problem statement, reached the limits of the cognitive capacity of most participants. Accordingly, they failed to lend to more effective solutions. Miller (1956) demonstrated that when cognitive capacity is exceeded, the response is not simply to drop some points from consideration, but rather to enter into a state of confusion (pp. 83-84). The participant is disoriented and is unable to come to terms with the additional stimuli. The result was that under MFB, when the specification requirements were presented together with the problem statement, they failed to inspire more effective solutions.

Under carousel brainstorming, on the other hand, the specifications were presented individually. The participant was directed to consider that single stimulus in relation to the problem statement. Under those conditions, cognitive overload was unlikely. The participant considered that particular specification in relationship to the OPORD, and developed a COA solution. They then submitted the solution to the central pool, and selected another seed sheet. This sheet contained a new specification, along with the COA solution offered by one of their fellows. Participants were directed not to develop another COA solution, but to enhance the COA of their fellow participant. Having already derived their own solution, the new stimulus was likely to be added to what they had already considered. As a result, it was chunked with their existing solution. With each round of review, they continued to increase their understanding of the problem frame, chunking new points of consideration with the old, until they arrived at a higher level of sophistication—resulting in more effective solutions.

5.2 Differences between MCB and ECB

The results in effectiveness of COA solutions of MCB and ECB each represented an improvement over MFB. Between the two, MCB lead to similar results as ECB. Both of the latter made use of forced external stimuli.

The CNM lead us to postulate that forced external stimuli would enhance the creativity of solutions. The method of ideation that we employed, carousel brainstorming, was designed to draw maximum effect from those external stimuli and the chunking of the ideas so that they did not overload cognitive abilities. Whereas the operation of chunking was successful, the effect of the external stimuli was not. It did not lead to significantly more innovative ideas. The outcome was a partial validation of hypothesis 1.

Hypothesis 2, however, drew upon present theory demonstrating that the use of GSS can be a further enhancement to the ideation procedure. The prevention of cognitive overload and increase the effect of chunking by limiting social interactions lead us to believe that the use of GSS would further those results. They did not.

The reasons for that failure were not due to the CNM, but to other considerations. The lack of effect is in part a testimony to the efforts that we made to eliminate relevant differences between the procedures. Great exertion was made to make sure that the manual and electronic procedures matched in every way. During the conduct of the sessions, we were quick to intervene whenever participants broke the rule of silence. Whatever differences remained between MCB and ECB did not influence the outcome. The conclusion indicated that similar procedures produce similar results.

However, given a choice between the two, there are still reasons for preferring ECB. One of the drawbacks of MCB was that it lacked robustness. The slightest nuance detracted from the results. We gained facility in MCB only after a considerable number of pilot tests. MCB required continuous monitoring so that participants adhered to the procedure of depositing papers to the central tray (something they were disinclined to do). It required spacing people apart so that they could not view one another's papers. And it required diligent enforcement of the rule of silence so that the MCB sessions did not deteriorate into open discussions.

ECB, on the other hand, provided these features more resiliently. We observed this in the actions of the participants throughout our study. Unlike MCB, ECB participants were not as inclined to depart from the procedure. After submitting their initial COA solution, natural curiosity prompted them to click on other COAs to view what their fellows had written. Even if participants sat near one another, they could easily turn their screens so as to secure privacy. Continued monitoring was unnecessary. Finally, silence was more easily obtained under ECB than under MCB. People working at a computer monitor are inclined to silence. People working in a small group are inclined to talk. Thus, whereas natural inclinations detracted from the effects of MCB, it supported ECB.

Our observations demonstrated that more effective solutions could be gained with greater consistency by using ECB as opposed to MCB. The latter required close supervision in order to produce more effective results. ECB, on the other hand, produced superior results over MFB, with minimal supervision.

5.3 General Observations

Previous studies in the use of GSS as an aid to ideation have focused primarily on the quantity of solutions derived (see Lamm & Trommsdorff, 1973). In this study, we concentrated on quality as the independent variable. We found while that GSS (e.g., ECB), does not improve solution quality when a well-structured process is already employed (as compared to manual carousel brainstorming), it does improve quality when it is lacking (as compared to manual free brainstorming).

The reason for the above may be that a GSS forces the participants into a structure process. While manual structured processes might be sufficient if they are employed religiously, such a thing is rare. Our observations confirmed that manual structured processes are often cut short. A GSS ensures reliable adherence to procedures in what might otherwise be a sporadic venture. In the latter case, a GSS provides a superior tool for gaining more effective solutions.

5.4 Implications for MDMP

As was mentioned, studies in the use of GSS to support MDMP were conducted by the ARL during the 1980s. They focused on Step 2: Mission Analysis, and had partial success in the organization and assembly of high level information (Harder and Higley, 2003, p. 8).

We, on the other hand, investigated the use of GSS as an implementation of CB to enhance the creativity of solutions generated. The latter is conducted during Step 3 of MDMP: COA Development.

The results of our study demonstrated that the effectiveness of the solutions gained during COA Development would be improved if ECB were adopted for widespread use. Current Army doctrine concentrates on manual ideation techniques. This study demonstrated not only that ECB produces more effective COA solutions, but that it does so more robustly than manual techniques. ECB garners more effective solutions from a group of participants in a manner that is not prone to failure.

ECB produces COA solutions that are more feasible than does MFB. Thus, it creates solutions that can better be accomplished given the resources of people, money, time and material. ECB produces solutions that are acceptable, so that benefits justify the costs. ECB produces solutions that are suitable, so that each solution agrees with the guidance received from the commander. And they produce solutions that are complete--it accomplishes the mission set forth. It entails all necessary operations to achieve the result, and nothing more. This affords the commander effective COAs as options to fulfilling the mission.

With a superior tool in hand, commanders would be more inclined to utilize MDMP than they are currently. Use of ECB could significantly enhance the effectiveness of COAs available to the commander to meet the mission requirements. Its advantages would soon become apparent. Rather than relying on intuition, commanders would be more inclined to use the analytic decision making methodology that MDMP affords. ECB will thus enhance MDMP to produce a tool of much greater facility to the commander of any military unit. It will in turn produce more effectual planning.

5.5 Threats to Validity

Our hypothesis centered on external stimuli as being the causal agent in producing creative solutions. We believe that the results verified our hypothesis. However, there are other candidates for the effect. Each of these is discussed below.

5.5.1 Change in Procedures

Data collections were done during two periods: spring 2009 and fall 2009. The reason for the separation was due to a fault in the procedures that was discovered after the conclusion of the spring 2009 data collections. During spring 2009, the MCB procedure directed participants to pass their seed sheets to the right, adding comments, until the sheets returned to their originators. This posed a problem, for it differed from the procedure of ECB. The ECB procedure employed a central pool to which participants deposited their COA solutions, and then selected other solutions for comment.

In order to achieve a congruency between the procedures, we changed MCB so that participants deposited and selected sheets from a central tray. The reported results involved the fall 2009 data for MCB, using these revised procedures. The spring 2009 data for MCB were considered as part of the pilot study.

The separation of the data collections may have caused effects due to instrumentation. The researcher was more familiar with conducting the class and experiment in fall 2009 than he was during spring 2009.

We do not, however, believe that these effects were significant. The revised procedures were equally new to the fall data collections as the previous procedures had been new to the spring data collections. Nor was there maturation among the participants, since new groups of cadets from separate universities were chosen for the fall sessions. The revisions involved only the MCB and ECB. There were no changes required of the MFB (nor was it repeated).

5.5.2 Violations of Anonymity

Another candidate for the effect was anonymity. The CB sessions preserved anonymity to a high degree. Deliberate attention was paid to seating cadets apart, and to enforcing strict observance of procedures.

In the end, however, anonymity could not be preserved with the subject groups. Writing style, writing instrument, heaviness of stroke, strikeout method, and error correction all revealed the author of a given input. An undercurrent of banter carried on by participants during the sessions that indicated that there was a general awareness of who had written what. This happened even under ECB, where anonymity was best preserved.

The lack of anonymity was due in part to the makeup of the groups. The participants were undergraduate seniors who had worked together for the past four years. They knew each other well. The mere content of what had been written provided clues as to who had authored what.

A striking example of this occurred at the conclusion of one of fall MCB sessions. Three groups of cadets were conducting separate MCB sessions in the same classroom, as supervised by the researcher. One group finished before the others, and was made to wait for the other two groups to conclude. During that time, a cadet idly retrieved a seed sheet from the tray, and casually identified the author of each of the comments on the sheet. Each of the other cadets admitted to his guesses.

During one of the fall ECB sessions, a light banter was carried on by two cadets of the same group, who kidded each other about their comments. Yet they were seated a full ten feet apart!

In spite of our best efforts, it seems unlikely that anonymity was well-preserved during any of our sessions. We project that it was not a salient cause of the results obtained.

5.5.3 Short changing the procedure

The natural impulse of cadets was to short change the MCB procedure. Rather than following the rules, cadets were inclined to exchange papers, via a person-to-person handoff to whomever was available. This created a departure of the MCB from the ECB procedure where such exchanges were made impossible by the nature of the computerized context.

During the fall data collections, the researcher was careful to ensure that such exchanges did not occur. Participants were made to follow procedures exactly. We conducted the revised MCB procedure for eight groups of cadets, and observed all sessions in their entirety. Of the 144 exchanges that we witnessed, there was only one exchange (a single exchange at UWM) that did not adhere to the rule of depositing and removing sheets from the central tray--representing an error rate of 0.7%. We feel safe to claim that the fall data accurately reflected the revised procedures. There was very little short changing of the rules.

5.5.4 Silence

One of the most important lessons that we learned from our pilot study was the inclination of cadets to violate the rule of silence. Left to their own cognizance, participants were inclined to discuss the OPORD and its solutions freely with one another. In nearly every session, it was necessary for the researcher to remind participants of the rule of silence. Most strongly were participants inclined to violate this rule during MCB sessions, which had them facing each other in a rough circle. Inadvertently, the arrangement created a social situation, in which participants felt compelled to speak. (This was not nearly as evident in the ECB procedure which had participants facing a computer screen.)

Without continued supervision, participants were disposed to discuss matters with each other. The outcome was that without supervision, MCB deteriorated into MFB, with the attendant problem of cognitive inertia.

The same problem did not emerge nearly as often with respect to ECB. The reason we suspect is due the different environment that the use of a computer creates. In front of a computer, participants are inclined to remain silent. The activity of computer work is not social. It is more akin to reading or studying. Talking is a distraction. There is a natural inhibition that promotes silence.

Neither was the problem of maintaining silence an issue with MFB. MFB is a social process. It is lead by a facilitator, who encourages participants to discuss the problem and solutions thereof. Discussion is not proscribed, but encouraged. The inclination to socialize is not a problem under MFB as it is under MCB and ECB. Rather, than being a detractor, it is an enhancer.

5.5.5 Seeds

The core of the CNM is the seed sheets. They provide the external stimuli that is absent from MFB sessions. The major difference between MCB/ECB and MFB is the seeds sheets.

The results demonstrate how fragile is creativity. It depends as much on how the stimuli is presented, as much as what is presented. All three groups were given the list of specification requirements. But only when the specifications were presented singly, in a private context, did they affect the results. Face-to-face discussions erased the impact of the external stimuli, and brought the problem of cognitive inertia to the fore.

During the fall 2009 data collections we were careful to observe the entire procedure. We were present during the whole of the sessions, and were able to closely monitor cadets' adherence to the rules, especially with respect to the rule of silence. While we could not prevent participants form uttering occasional comments, we absolutely forbade them to discuss the OPORD or COA solutions. The fall sessions, we believe, faithfully represents the MCB procedure.

5.5.6 Data Skew

The box chart of Figure 4-1 (above) indicated that the data was skewed. It showed that the COA solutions developed under MFB were skewed high. Just the opposite was true of the MCB and ECB data. Both were skewed low.

The skewing on the part of the MFB can be explained by the differences of facilitator chosen to lead the group. Facilitators were chosen randomly. It is well-documented that a free brainstorming session depends in part on the skills of the facilitator. While most facilitators did an average job of leading the group to COA solutions, one facilitator did particularly well. In that session, luck of the draw gave the role of facilitator to the highest ranking cadet. The individual in question was a “star quality” facilitator. He produced seven COA solutions (in proportion to a total of 35 COA solutions total for all MFB sessions) with a mean creativity ranking of 2.7429 (as compared to the mean creativity ranking for all MFB session of 1.65714). These solutions were highly regarded for their innovation by the panel of evaluators. Because of this single, high-scoring session, MFB scores were skewed high.

The skewing on the part of the MCB is much more complicated. Of the eight ideation sessions conducted, three MCB groups had means above the overall median (2.8), and five groups had means that were below the overall median for MCB results. The latter accounted for 22 COA solutions of the 37 total COA solutions. So the lower scores by these latter groups had a proportionately greater bearing upon the whole, and resulted in a skew towards the low end for the MCB sessions.

The reason for this skewing we postulate as differences again in the talents of the students involved. During our observations of the sessions, we saw that certain students spent more time on solutions than did others. And the quality of their input was superior to that of other members. Like MFB, MCB is influenced by star quality performers. Whereas in the case of MFB, the star quality concerned management and leadership abilities, in the case of MCB, the star quality concerned planning and writing abilities. However, because the star quality performances in the case of MCB were small in proportion to the whole (whereas in the case of MFB they had been large), a greater effect was made by the lower quality performances.

With regard to ECB, there was a different problem. This study was conducted at diverse sites around the Midwest. We were dependent, at least in part, on the resources made available to us at each site. One of the things which varied most was Internet access. In cases where access was fast and reliable, participants had fewer distractions in their work. In cases where access slowed, or stopped, work was interrupted until the problems could be fixed. During these interruptions, it was physically impossible for participants to enter their input into the GSS. Contributions of those participants were thus limited. We propose that because of the hiatus in the input of some ECB participants, ECB scores were skewed low.

5.5.7 Conclusion regarding data collections

In addition to the use of seeds, one of the most important factors in obtaining the effect was the rule of silence. Where discussions ensued, it threatened to change the nature of MCB/ECB to MFB.

It should be noted that MFB groups were also provided a written sheet of all five specification requirements. It was not the information presented, but the manner of the presentation that caused the effect. In the absence of face-to-face discussion, the seed sheets provided an external stimulus that produced more creative COA solutions. But face-to-face discussions dominated over written seed sheets.

5.5.8 Conclusion validity

Conclusion validity is the degree to which our conclusions about relationships between the data are reasonable. We were aided in this by the use of manual as well as electronic procedures in conducting the study. The use of the MCB sessions helped to validate the causal factors (i.e., the external stimuli) as the single most prominent causal factor that contributed to the results. By use of the manual technique, we were able to rule out other aspects of the GSS that might have contributed to creative solutions. In the end, it helped to identify the procedure, not the medium, as the cause of the effect.

5.5.9 Internal validity

Internal validity is the assurance rendered to cause-and-effect relationships. In the present study, it refers to the degree that CNM caused the effect measured.

While this study did not directly test the validity of the CNM, it did so indirectly in that the CNM was used as the theory supporting the formulation of CB. In this regard, internal validity was insured by having the researcher present during the duration of each of the MCB and ECB sessions. We demanded strict adherence to the rules, and monitored that adherence. Likewise, a cadet facilitator was present during the whole of the MFB sessions. (The researcher periodically checked on the conduct of the session—as a balance between insuring procedure adherence and introducing bias). A cause-and-effect relationship was established between the cause (external stimuli as embodied in the CB technique), and the effect (creative COA solutions).

A question might be asked here as to whether the results obtained are attributable solely to the ideation procedure, CB, or is it simply due to the fact that MDMP was here applied more rigorously than in the Army? In response, it should be pointed out that none of the experiments involved the complete MDMP. Rather, the experiment concentrated on one sub-step, Generate Options, of one step, COA Development, of the seven-step MDMP. In all cases: MFB, MCB, and ECB, the same procedure was applied. Each session covered only the Generate Options sub-step. During that sub-step, MCB/ECB reliably produced solutions of greater creativity than did MFB (the Army's recommended ideation technique).

Granted, the Army would certainly benefit if MDMP were applied more rigorously across its commands. And that benefit would likely be gained regardless of the ideation technique employed. The present study did not address that question. Rather, the present study demonstrated that in the absence of any other change in military procedures, if MCB/ECB is employed in lieu of MFB, during COA Development, solutions of greater effectiveness will result.

5.5.10 Construct validity

Construct validity refers to the degree to which our testing procedure accurately measured theoretical constructs. In our experiment, it is the degree to which we actually manipulated external stimuli and chunking to produce creative solutions.

External stimuli are those that are external to the problem statement. We introduce five such stimuli in the form of specification requirements. Although they pertained to the problem at hand, none were directly mentioned in the problem statement. In this they were "external."

Chunking is the degree to which separate ideas are conjoined to produce a single idea. It is advantageous to decision making in that it permits consideration of complex problems without the confusion that sets in after excessive ideas are crowded in the mind.

We manipulated chunking by presenting our specification requirements in two forms: as part of the problem statement (in a list attached at the end of the OPORD), and as a separate stimulus, as recorded individually on seed sheets. By presenting the same stimuli in two forms, we demonstrated the operation of chunking. Only under the latter method was the creativity of the solutions enhanced. The reason had to do with chunking (see Section 2.3, above).

Finally, with respect to the production of creative solutions, we defined creativity in terms of two factors: effectiveness and innovation. In the military vernacular, we translated effectiveness as comprised of the Army's measures of: feasible, acceptable, suitable and complete. Innovation we took as corresponding to the Army's measure of distinguishable. Arguments in behalf of this definition were presented in Chapter 1 (above). These concepts were made clear throughout the study. Their definitions were printed at the top of every evaluation packet.

The second aspect of this last construct is entailed by our mode of evaluation. In this study, we employed a panel of twelve Army Reserve Officers to assess the creativity of COA solutions offered in solution to a military OPORD.

Our panel consisted of highly qualified judges of the COA solutions under consideration. The officers that we selected were all members of the 3/75th Division (Training Support), one of whose primary mission is the teaching of MDMP. All had experience assessing outcomes under MDMP. Each panel member was familiar with the components of the measurement: feasible, acceptable, distinguishable, suitable, and complete.

We also took measures to inform panel members of the context of the problem. A copy of the OPORD that cadets had used to devise their COA solutions was provided to each panel member. A copy of the list of specification requirements that cadets had used to guide their COA development was also provided to each panel member during each evaluation session. And as a reminder, the definition of each term used in the measurement was included at the top of the evaluation packet.

Our measuring instrument was optimally designed to provide an appropriate degree of sensitivity. A Likert scale (of 1-4) was chosen to help evaluate the COA solutions with respect to each measurement. Each ranking for each factor was then averaged to produce the final rating for each COA. So, each COA solution was rated according to five different components of creativity. This helped to level deviations that might occur with respect to an individual measurement.

Finally, the researcher is himself an Officer and current member of the 3/75th Division. He has been an active member of that unit for the past thirteen years (previously designated the 1/85th Division). During that period, he has conducted numerous MDMP classes and exercises. The researcher's own ability to evaluate the evaluators helped to ensure construct validity.

5.5.11 External validity

External validity refers to the degree to which the results of the experiment can be applied to other groups. Our object throughout this study has been MDMP as utilized by the U.S. Army. Accordingly, we selected Army ROTC cadets as participants to the study. For reasons already discussed (see Chapter 3), we believe that Army ROTC cadets fairly match the population targeted (U.S. Army Reservists).

We solicited these cadets from eight major universities in the Midwest. All experiments were done on site, using the classroom, Internet access, and equipment being currently used by the cadets at their training locations.

Further, the majority of the cadets that participated in our study were in their fourth year of the study of military science. They are within a few months of graduation. While not currently soldiers, they are people who will shortly be Army officers. Consequently, we consider these results as applicable to Army Reservists, and to a lesser degree, to the Army as a whole.

Outside the Army, the results would be applicable to groups similar to the military in hierarchy, structure, and purpose. Police forces, security agencies, and certain government organizations would be included in the circle of applicability.

5.6 Limitations of this research

We examined creative solutions in the context of strategic, collaborative problem solving. We did not examine creativity in contexts where practicality was not a consideration.

One of the results that we obtained was that MFB produced solutions with a high degree of innovation. And the three methods did not produce statistically significantly different results with respect to innovation alone. However, since the effectiveness of MFB solutions was low, MFB results were of lesser value to the military (and by our measures were ranked lower in overall creativity).

The same might not be true of other contexts. Creative solutions in the arts, for example, might tolerate less effective solutions, and stress those that offered more innovation. In those contexts, MFB might serve as well as CB to arrive at creative solutions.

5.7 Future Research

Whereas carousel brainstorming was shown to enhance the effectiveness of solutions, it did not significantly enhance innovation. This may have been due to a fault in the procedure. By repeatedly enhancing COAs already presented, the treatment favored effectiveness over innovation. During the first round only of the process were participants instructed to devise a COA solution to the problem. Subsequent rounds were devoted only to improving upon the solutions presented. Participants were restricted from considering more innovative approaches, and were confined to improving upon the approaches already presented.

In order to gain a more even treatment of the two components of creativity, participants in future trials might be granted the option of either devising a separate COA solution in response to the specification requirement listed on the seed sheet, or else enhancing one or more of the COA solutions already listed there. This would permit equal effect to the inducement of the external stimulus as well as the operation of chunking. The results might bring about a significant improvement to effectiveness as well as to innovation.

Another step in future research would be to test the creativity ranking of ECB results as compared to other methods of electronic brainstorming. The most prominent of these techniques is directed brainstorming. As a follow-on study, the two electronic methods of carousel and directed brainstorming could be compared against free brainstorming.

Again, the researcher's interest is in the context of the military and military-like units. We suggest the ROTC students could again be used as the population for the experiment. Though we favored carousel brainstorming for its lack of the need for a facilitator, it would be useful and interesting to discover which of the methods proved superior in producing creative COA solutions.

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List of Appendices

Appendix I List of Acronyms

Active Component - AC

Area Support Battalion – ASB

Army Combat Uniform - ACU

Army Research Laboratory – ARL

Army National Guard – ARNG

Brigadier General - BG

Cognitive Network Model of Creativity - CNM

Carousel Brainstorming – CB

Commander - CDR

Commander's Critical Information Requirements – CCIR

Command Sergeant Major - CSM

Course of Action – COA

Department of the Army - DA

Electronic Carousel Brainstorming – ECB

Federal Emergency Management Agency – FEMA

Field Manual – FM

First Sergeant – 1SG

Group Support Systems – GSS

Headquarters and Headquarters Detachment - HHD

Identity – ID

Lieutenant Colonel - LTC

Manual Carousel Brainstorming – MCB

Manual Free Brainstorming – MFB

Military Decision Making Process - MDMP

Mission Analysis – MA

Mobilized - MOB

Not Later Than – NLT

Organizational Clothing and Individual Equipment - OCIE

Officer in Charge - OIC

Operations Order – OPORD

Personnel Action Center - PAC

Temporary Combat Service - TCS

Temporary Duty - TDY

To Be Determined – TBD

To Be Provided - TBP

Appendix II Military Decision Making Process (MDMP)

The Army's method for conducting comprehensive planning is the Military Decision Making Process (MDMP). It is the current technique for arriving at complex decisions. The Army defines MDMP as:

> a planning model that establishes procedures for analyzing a mission, developing, analyzing, and comparing courses of action against criteria of success and each other, selecting the optimum course of action, and producing a plan or order. The MDMP applies across the spectrum of conflict and range of military operations (FM 5-0, 2005, p. 3-1).

Army MDMP is a decision making process of seven steps:

A.I.1 Receipt of Mission

The receipt of mission is the start of the procedure. It can take several forms. First, a military unit can receive a written (or verbal) order from higher headquarters. In such circumstances, the commander's task is to interpret that order, and to formulate his own plans on how best to accomplish it. Second, the commander can receive a mission by perceiving that opportunity or peril forces him to deploy his unit. Such an instance would be when a unit comes under attack by an enemy. Another would be a target-of-opportunity that suddenly presents itself. Here the commander is not given a written order, but intuits a mission from circumstance.

Army doctrine recommends that upon receiving a mission the commander take three actions. First, he and his staff must do a brief analysis of the mission. Second, the commander should offer his insight to the staff concerning it. Finally, he should issue an order to subordinate units warning them of the impending mission.

A.I.2 Mission Analysis

Mission Analysis is the core of the MDMP process. Here, each staff section gathers information about the current situation and evaluates that information in light of the mission. The commander gives the staff his conception of *critical information requirements* (CCIR). These are those aspects of enemy and friendly forces that he sees as pivotal. CCIR of enemy forces include strength, location, and disposition. CCIR of friendly forces include the location of adjacent and supporting units, ammunition and fuel allocation, and location of supply points.

The S2 conducts an Intelligence Preparation of the Environment. This is a complete analysis of terrain, avenues of enemy approach, location of enemy units, and strength of enemy forces.

The S3 considers facts and assumptions, constraints, and specified, implied, and essential tasks. The S1 considers the mission in terms of personnel requirements. And the S4 regards it in terms of logistics.[vi]

A.I.3 Course of Action Development

In this step, the staff formulates several courses of action (COA) to solve the problem. Army doctrine recommends no fewer than two and no greater than five COA options be developed.

Guidelines during this step emphasize that COA options should be *distinguishable*, *feasible*, *acceptable*, *suitable*, and *complete*. The first of these indicates that COA options should be genuinely different, and not simply be variations upon a theme. Feasibility insures that a COA should be practical within the capabilities of current resources. Acceptable insures that benefits exceed costs. Suitability indicates that it accords with the commander's intent. Complete insures that all aspects of the operation have been considered (FM 5-0, 2005, pp. 3-29 through 3-30).

A.I.4 COA Analysis

During COA Analysis the staff considers the merits of each COA and determines the details as to how each are to be accomplished. Army doctrine recommends that the staff refrain from comparing COA options at this stage—that is to be left to the next step. The purpose of leaving the comparison for later is to insure a full consideration of each COA upon its own merits.

A.I.5 COA Comparison

Here, COA options are evaluated with respect to their promise for accomplishing the mission. COA options are considered against success criteria in the form of a decision matrix. Decision Support Software is widely available in the Army for executing this step.

A.I.6 COA Approval

Now the commander evaluates the work of his staff and adds his input. The staff briefs the commander on their recommendations, and the commander approves or disapproves.

A.I.7 Orders Production

Finally, the pieces of MDMP are assembled in the Operation Order (OPORD). The OPORD is a written set of instructions issued to unit members and subordinates. It consists of five parts: *Situation, Mission, Execution, Service and Support, Command and Signal*. The Situation paragraph details the general environment, describing both friendly and enemy forces. Mission, succinctly describes the task and purpose of the unit. Execution, explains how the mission is to be accomplished. The Service and Support paragraph contains directives for Combat Service Support. Command and Signal details the location of the commander and defines communications codes and parameters.

The Army recognizes that not all decision-making lends itself to MDMP. Most of the decisions that a commander makes can be decided upon the basis of intuition. Elsewhere time is short so that commander has no time to consult his staff. He must make a decision on his own—again relying upon his intuition. For other decisions, time is limited, but the situation is not so desperate. Here, MDMP might be employed, albeit in a limited role. In doing this abbreviated MDMP, Army doctrine recommends that all of the steps be completed, albeit fewer courses of action be considered. Increased input by the commander is also recommended. Where time is more expansive, the full MDMP process can be employed.

Appendix III Course of Action Development

The course of action (COA) Development step in MDMP consists of six sub steps: 1) Analyze relative combat power. Here, the fighting capabilities of each party to the conflict must be discerned. There are several rules of thumb regarding the relative power necessary to conduct a successful operation. These shift depending on whether the operation is offensive or defensive in nature. 2) *Generate options*: Create several COA options towards accomplishing the mission. 3) Arrange units: Deciding what role subordinate units will play in the fighting. At a minimum, the main effort, shaping efforts, and reserve forces must be delineated. 4) Develop concept of operations: The concept of operations is a detailed plan of how to accomplish the mission. It describes the actions of each subordinate unit from start to finish. 5) Designate a headquarters: Designation of chain of command, and where each unit fits in the hierarchy must be established prior to the operation. 6) Draw up COA statement and sketches: As a general rule, all COA options must be described both verbally and diagrammatically (FM 5-0, 2005, pp. 3-29 through 3-37).

Appendix IV: Carousel Brainstorming

The basic method behind carousel brainstorming is the anonymous submission of ideas to a central repository. A problem is first presented by a proctor. Each member is given the opportunity individually to devise a solution to the problem. Other members are then afforded the opportunity to comment upon or to make additions to each of the submissions. Ideas are not evaluated until all members have had a chance to comment on each of the ideas submitted.

Carousel brainstorming can be carried out by any of several means. It can be conducted manually, via email, or by use of group support system software. It can proceed by using the same problem statement, or by different problem statements "seeded" with assorted approaches to the solution. Ideas can be submitted serially or in parallel.

A.III.1 Manual Procedure

Under a manual procedure, it can proceed by a circular arrangement of participants around a central proctor. The proctor presents the problem under consideration. Each of the participants silently writes their solution on a piece of paper. At the end of set period of time (i.e., two minutes), solutions are passed to the center. Each member then selects a sheet of another member, reviews the idea, and makes additional suggestions. The proctor then directs that the papers be passed again to the center. Once more, participants review the submission, and add comments. The process is repeated until all participants have had a chance to comment on each of the other sheets.

A.III.2 Email Procedure

If conducted via email, the process is again initiated by a proctor who sends out email messages to each of the participants detailing the problem, and requesting a suggested resolution. As the suggestions are returned, the proctor forwards the suggestions to another member for comment. Suggestions are continually forwarded by the proctor until all members have added their comments. The repository of suggestions is implemented by the email box of the proctor.

A.III.3 Group Support System (GSS)

If conducted via GSS software, the carousel brainstorming session is generally conducted in a computer lab that has been set up for ideation. Each of the members is given a computer terminal, networked together, and accessible to the GSS software. The proctor proposes the problem, and the members each write down a solution utilizing the GSS software. Each solution is submitted to a central repository where they can be viewed and edited by the other members. Members are directed to add comments to the submissions of the other members until each has had a turn to comment on each of the ideas submitted.

A.III.4 Parallel versus Serial Submission

Under a serial submission scheme, all participants consider the same aspect of the problem simultaneously. Ideas are then passed from person to person for comment. After one aspect of the problem has been considered, a different seed is introduced, and participants are directed to consider a solution with regard to that aspect.

Under a parallel submission scheme, each member is asked to consider the problem with respect to a different seed. Solutions are then passed from member to member for comment, until everyone has had a chance to edit all of the solutions.

Appendix V Hurricane Jane Operations Order

Copy __ of __
HQ, 300th Sustainment BDE
Camp Perry, OH
110800 AUG 2009

300th Sustainment BDE OPERATIONS ORDER 09-005 (OPERATION JANE RELIEF)
REFERENCES: Current Standard Operating Procedures.

Time Zone Used Throughout the Order: Romeo (Local).

1. SITUATION.

a. Enemy Forces. Per current intelligence summary.

b. Friendly Forces: The 425th Area Support Battalion (ASB) will be under the operational control of the Federal Emergency Management Agency (FEMA), headquartered in Gulf Port, Mississippi. FEMA has responsibility for conduct of relief efforts in the states of Mississippi, Alabama, and Louisiana.

c. Attachments and Detachments: None.

2. MISSION.

425th ASB deploys 190800 AUG 2009 to Camp Shelby, MS for a period of 30 days in order to conduct relief operations in the aftermath of Hurricane Jane.

3. EXECUTION.

Commander's Intent: 425th ASB deploys to Camp Shelby, MS to conduct relief efforts as directed by FEMA. End state: Relief of disaster victims and safe return of 425th ASB to Camp Perry, OH.

a. Concept of the Operation.

1) 425th ASB departs for Camp Shelby, MS 190800 AUG 09.

2) All soldiers are to report to 425th ASB Headquarters NLT 180700 AUG 09.

3) Travel to Camp Shelby will be by military convoy.

b. Tasks to Units.

1) A/B/C/D Companies.

a. Ensure transportation assets available NLT 181800 AUG 09.

b. Provide DA-31s or TDY orders for all soldiers on Leave or on Missions to the HHD CDR NLT 181200 AUG 09.

c. Tasks to Staff Sections.

1) S-1/PAC: Provide a by-name roster with SSN of all soldiers.

c. Provide copies of MOB/TCS Orders for all AC/Reserve soldiers mobilized/assigned outside of Camp Perry.

2) 1SG/S-4

a. Ensure vehicles are fueled, ready, and equipped for the convoy to Camp Shelby, MS.

d. Coordinating Instructions:

1) No Passes or Leaves are allowed for the period if they have not been submitted by 171000 AUG 09.

4. SERVICE SUPPORT

a. Supply.

1) Duty Uniform: ACU.

2) All soldiers must bring: Military ID card, ID tags, OCIE issue.

b. Services. TBP

5. COMMAND AND SIGNAL

a. Command.

1) HHD Commander and Convoy OIC: LTC Davis

2) HHD 1SG: 1SG Colby

b. Signal.

1) Questions concerning this order should be directed to LTC Davis at 653-222-6553 or CSM Colby at 653-222-6594.

ACKNOWLEDGE:

JASON SMITH
BG
Commanding

Classification: UNCLASSIFIED

Appendix VI Requirement Specifications (Commander's Guidance)

1. Transport to Camp Shelby, Mississippi should as expeditious as possible, and arrive no later than one week from today's date.

2. The unit should maximize the number of vehicles transported (up to the unit's assigned strength of 50 two and one half ton trucks, 15 HMWVV's, and 3 four-ton wreckers), with enough supplies necessary to sustain itself for as long as practical (no less than 30 days).

3. Transportation to the site should minimize costs.

4. Transportation to the site should minimize obstruction to civilian traffic on roadways.

5. Safety is a priority. The method chosen should minimize risks to soldiers and civilians.

Appendix VII Information Sheet for Participation in Research Study

Enhancing Creativity of the Military Decision Making Process

You are being asked to participate in a research study being conducted by Thomas P. Hanlon, a graduate student at De Paul University, as a requirement to obtain a Ph.D. This research is being supervised by his faculty advisor, Dr. Daniel Mittleman. We are asking you because we are trying to learn more about improving procedures for Army decision making. The study will take about one hour of your time. If you agree to be in this study, you will be asked to participate in a brainstorming session where you will develop courses of action (COA) for moving an Army Reserve unit to the Gulf Coast to aid in hurricane disaster relief. Additionally, you will be asked to complete a short demographic survey. The survey will include questions about your education, military background, and experience with decision making. You can choose not to participate. There will be no negative consequences if you decide not to participate or change your mind later. Alternately, you can chose to work in independent study on the Military Decision Making Process.

If you have questions about this study, please contact Thomas P. Hanlon, (847) 689-0055, hanlon@siu.edu; or Dr. Daniel Mittleman, (312) 362-6103, Mittleman@cdm.depaul.edu. If you have questions about your rights as a research subject, you may contact Susan Loess-Perez, De Paul University's Director of Research Protections at (312) 362-7593 or by email at sloesspe@depaul.edu.

You may keep this information for your records.

Appendix VIII Free Brainstorming Script

Good day! Our task today is to develop courses of action (COA) to providing hurricane relief operation to Gulf Port, Mississippi. The problem will be to plan for the deployment of approximately 450 members of the 325th Supply Battalion from Camp Perry, Ohio, to Camp Shelby, Mississippi, for a period of 30 days. Operations at Camp Shelby will be under the control and supervision of the Federal Emergency Management Agency (FEMA).

We are to play the role of the battalion staff. The major task will be planning the transport of personnel, vehicles, supplies, and equipment to Camp Shelby. Under the scenario, the unit is ordered to arrive at Camp Shelby within one week.

As the facilitator, I will guide you through the ideation process, soliciting ideas, and writing those ideas down on this butcher pad, where all of you can view them. We are to create as many COAs as we can devise for solving the problem. In accordance with Army doctrine, the COAs should have the characteristics of feasible, acceptable, distinguishable, suitable, and complete.

The rules for this brainstorming session are that ideas are not to be elaborated, but written in summary format. Evaluation and criticism are disallowed. The object is to capture as many ideas as possible. I, as facilitator will be terminate the session at my discretion when a sufficient number of ideas have been generated.

Let us begin. Can anyone suggest how to transport the 450 members of the 325th Supply Battalion from Camp Perry to Camp Shelby for a stay of 30 days?

Appendix IX Manual Carousel Brainstorming Script

Good day! Our task today is to develop courses of action (COA) to providing hurricane relief operation to Gulf Port, Mississippi. The problem will be to plan for the deployment of approximately 450 members of the 325th Supply Battalion from Camp Perry, Ohio, to Camp Shelby, Mississippi, for a period of 30 days. Operations at Camp Shelby will be under the control and supervision of the Federal Emergency Management Agency (FEMA).

We are to play the role of the battalion staff. The major task will be planning the transport of personnel, vehicles, supplies, and equipment to Camp Shelby. Under the scenario, the unit is ordered to arrive at Camp Shelby within one week.

As the facilitator, I will guide you through the ideation process. We are to create COAs for solving the problem. In accordance with Army doctrine, the COAs should have the characteristics of feasible, acceptable, distinguishable, suitable, and complete.

I am now handing out to each of you a sheet upon which a seed to the problem is posed. Each of you are to silently write your solution on that same sheet of paper. After you have completed your solution, you are to pass your sheet to this central tray. You will then be directed to select a sheet from the tray, and to review the ideas of the other members, making any enhancements that would improve that COA.

When considering the COAs submitted, you should ask yourself if there is a better way to accomplish the COA as written. If so, write a comment that supplements the COA. If you discern problems with that COA, then address the problems. After so doing, you will pass the papers again to the central tray. Once more, you will review the submission, and add comments. This process will be repeated until all of you have had a chance to comment on each of the other COA s.

Appendix X Electronic Brainstorming Script

Good day! Our task today is to develop courses of action (COA) to providing hurricane relief operation to Gulf Port, Mississippi. The problem will be to plan for the deployment of approximately 450 members of the 325th Supply Battalion from Camp Perry, Ohio, to Camp Shelby, Mississippi, for a period of 30 days. Operations at Camp Shelby will be under the control and supervision of the Federal Emergency Management Agency (FEMA).

We are to play the role of the battalion staff. The major task will be planning the transport of personnel, vehicles, supplies, and equipment to Camp Shelby. Under the scenario, the unit is ordered to arrive at Camp Shelby within one week.

As the facilitator, I will guide you through the ideation process. We are to create COAs for solving the problem. In accordance with Army doctrine, the COAs should have the characteristics of feasible, acceptable, distinguishable, suitable, and complete.

In performing our experiment, we will be using ThinkTank® software. During the session, you will write down your ideas using ThinkTank. You, the participants need not be identified. All ideas are to be submitted anonymously. Elaboration is encouraged. After submitting an idea, the idea will enter a common pool. You will then proceed to select and to comment upon each of the ideas submitted. When all of you have had a chance to comment on each of the ideas, the session will terminate. I proceed now to conduct a short training session on the use of ThinkTank.

Appendix XI GSS Training Session

The style of ideation that we are employing today is done by way of a Group Support System (GSS). The software that we are employing to conduct this session is called: ThinkTank®.

ThinkTank, makes use of multiple windows. In the left window, courses of action (COA) already submitted can be viewed with read-only privileges by participants. In the right window, new COAs may be composed. Pressing the submit button releases a comment to the common pool.

Once a COA is submitted, you may select and add to COAs already submitted. You may use your mouse to select those COAs into which you wish to add comments.

I have distributed to each of you a card naming a requirement specification from the OPORD regarding the Hurricane Jane relief operation. I want each of you now to select that requirement from the left window on your computer screen. Once selected, read the problem statement and write a COA for transporting the 450 members of the 325th Supply Battalion from Camp Perry, Ohio, to Camp Shelby, Mississippi, for a period of 30 days. Focus on the specification requirement written in your file. When you are finished composing your COA, press submit button to release it to the common pool. You may then proceed to add comments to the ideas already submitted. Use the Categorizer feature to scroll the icons and select next one from the top into which to add a comment. Continue until you have added comments to each of the COAs submitted by your colleagues.

When considering the COAs submitted, you should ask yourself if there is a better way to accomplish the COA as written. If so, write a comment that supplements the COA. If you discern problems with that COA, then address the problems.

While the session is proceeding, I will circle the class, and assist you with technical questions about the use of ThinkTank and the brainstorming procedure. I anticipate that this session will last no more than 15-20 minutes, at which time we will return to the classroom.

Appendix XII Gradient of Creativity

DIRECTIONS: Rate each course of action below, along an interval of one to four, in accordance with the Army's FADS test.

Feasible: "The unit must be able to accomplish the mission within the available time, space, and resources" (FM 5.0, p. 3-29).

Acceptable: "The tactical or operational advantage gained by executing the COA must justify the cost in resources (FM 5.0, p. 3-29).

Suitable: "A COA must accomplish the mission and comply with the commander's planning guidance" (FM 5.0, p. 3-29).

Distinguishable: "Each COA must differ significantly from the others…Significant differences include difference in the—Use of reserves, Task organization, Timing (day or night), Scheme of maneuver" (FM 5.0, p. 3-30).

Complete: "A COA must show how—The decisive operation accomplishes the mission, Shaping operations create and preserve conditions for success of the decisive operation, Sustaining operations enable shaping and decisive operations" (FM 5.0, p. 3-30).

Feasible

Infeasible	Feasible with Major Qualifications	Feasible with Minor Qualifications	Entirely Feasible
1	2	3	4

Acceptable

Unacceptable	Acceptable with Major Qualifications	Acceptable with Minor Qualifications	Entirely Acceptable
1	2	3	4

Suitable

Unsuitable	Suitable with Major Qualifications	Suitable with Minor Qualifications	Entirely Suitable
1	2	3	4

Distinguishable

Indistinguishable	Similar in Major Respects	Similar in Minor Respects	Entirely Distinguishable
1	2	3	4

Complete

Incomplete	Missing Major Details	Missing Minor Details	Entirely Complete
1	2	3	4

Appendix XIII Demographic Survey

DIRECTIONS: Please answer the following questions. Circle your selection, as appropriate. Do not include your name or any identifying marks on this survey.

1. Age? (Please write): ____

2. Sex? M / F.

3. Number of years of military service (if any): _____

4. If military, branch of service: ______________

5. Rank (service or ROTC): ________________

6. Education (circle the highest level completed):
   a. High School
   b. Associate's Degree
   c. Bachelor's Degree
   d. Master's Degree
   e. Doctorate Degree/Post Doctorate.

2. In which education program are you currently enrolled?
   a. Undergraduate program (circle level)
i. Freshman
ii. Sophomore
iii. Junior
iv. Senior
   b. Graduate program
   c. Neither

3. Employment Status:
   a. Neither working, nor seeking work
   b. Unemployed, seeking work
   c. Employed, Part time
   d. Employed, Full time.

4. How do you rate your computer skills?
   a. I am unfamiliar with computers
   b. Poor
   c. Average
   d. Above Average
   e. Expert.

5. How do you rate your knowledge of military tactics?
    a. I am unfamiliar with military tactics
    b. Poor
    c. Average
    d. Above Average
    e. Expert.

6. How do you rate your knowledge of decision making techniques?
    a. I am unfamiliar with decision making techniques
    b. Poor
    c. Average
    d. Above Average
    e. Expert.

7. How do you rate your knowledge of collaboration techniques?
    a. I am unfamiliar collaboration techniques
    b. Poor
    c. Average
    d. Above Average
    e. Expert.

8. How do you rate your knowledge of group support systems (GSS)?
    a. I am unfamiliar with GSS
    b. Poor
    c. Average
    d. Above Average
    e. Expert.

Appendix XIV Synopsis of ARL Studies in the use of GSS to Support MDMP

Prairie Warrior (1998). In the fall of 1998 the Army Research Laboratory (ARL) did a study of a group support systems (GSS): GroupSystems ®, to facilitate Military Decision Making Process (MDMP) planning during the exercise "Prairie Warrior." The latter was a simulation exercise designed to train military staff elements. Step 2: Mission Analysis was the focus of GSS implementation. Success was partial. They found that while the GSS aided in organizing data, it had the unwanted consequence of flooding planners with information (Higley & Harder, 2003).

Consequence Management (1999-2000). To deal with the Y2K issue plaguing the Department of Defense, the ARL incorporated GSS into the Consequence Management process. Its role was to assist in the coordination of reaction to Y2K problems, and to provide a log of actions. Various GSS facilities were utilized, to include *categorizer* and *outliner*. They found that the use of GSS facilitated the process of gathering and coordinating information from diverse offices and agencies (Harder, Barrick & Hocking, 2001).

Prairie Warrior (2001). The ARL again employed a GSS, GroupSystems ®, to support Prairie Warrior. Again, they focused on Step 2: Mission Analysis of the MDMP. Among the features of GroupSystems that they utilized were: *Categorizer*, *Groups Outliner*, and *Alternative Analysis*. Lessons learned included the need for flexibility and adaptability (Harder & Hocking, 2001).

Battle Command Battle Laboratory (2001). Between August and December 2001, the ARL utilized a GSS in support of two tactics classes at the Battle Command Battle Laboratory, Fort Leavenworth, Kansas. Again, the focus was on Step 2: Mission Analysis of MDMP. The results showed that a GSS could be easily adopted by an Army staff, and could replace other devices, such presentation software (Harder & Higley, 2002).

Command and General Staff Officers Course (2002). The ARL conducted a study at the Command and General Staff Officers Course, Fort Leavenworth, Kansas in the use of GSS to support Step 2: Mission Analysis of MDMP. Their focus was in using GSS as a time saver. They found that the GSS was easily learned and utilized by military officers, and proved a useful tool for an Army staff (Harder & Higley, 2002).

Objective Force (2003). The ARL proposed the use of a GSS in support of the Army's vision of the future, called Objective Force. They reviewed various types of *thinkLets* available under a GSS, and made suggestions for their use. One of the more prominent of these was the *Wagon Wheel* interview technique. It allowed for parallel interviewing of personnel, saving time and coordinating results (Harder & Higley, 2003).

Appendix XV Tukey Multiple Comparison of Ideation Groups

Tukey Multiple Comp.	Difference	Q	Critical q (.05)
Mean(2)-Mean(1) =	0.932	7.473	3.364 *
Mean(2)-Mean(3) =	0.3342	2.77	3.364
Mean(3)-Mean(1) =	0.5979	4.883	3.364 *

The Tukey test for statistical significance involves a sequential comparison of sample means from largest to smallest. It begins with the largest mean and compares it to the smallest. In this case, the largest means was gained by MCB, and the smallest means was gained by MFB. A difference of 0.932 was calculated between the means of MCB, “Mean(2)”, and MFB, “Mean(1)”. Since the Critical q (3.364) at a .05 significance level, is less than the observed Q (7.473), the difference between the means warranted a rejection of the null hypothesis (that the sample means represent the same population). Hence, the observed differences between MCB and MFB scores were not likely due to error, and were significant.

The Tukey procedure next performed a comparison of the second highest ranked means: MCB and ECB. A difference of 0.3342 was calculated between the means of MCB “Mean(2)”, and ECB, “Mean(3)”. Since the Critical q (3.364) at a .05 significance level, was <u>not</u> less than the observed Q (2.77), this difference between the means did not warrant a rejection of the null hypothesis. Hence, the observed differences between MCB and ECB scores were within a margin of error, and were not significant.

Finally, the procedure performed a comparison of the third ranked means: ECB and MFB. A difference of 0.5979 was calculated between the means of ECB “Mean(3)”, and MFB, “Mean(1)”. Since the Critical q (3.364) at a .05 significance level, was less than the observed Q (4.883), this again warranted a rejection of the null hypothesis. Hence, the observed differences between ECB and MFB scores were also not likely due to error, and were significant

Appendix XVI Statistical Analysis of FADS Components

Feasible:

Newman-Keuls Multiple Comp.	Difference	P	Q	Critical q (.05)
Mean(2)-Mean(1) =	1.1238	3	7.5	3.365 *
Mean(2)-Mean(3) =	0.2917	2	2.011	2.806
Mean(3)-Mean(1) =	0.8321	2	5.696	2.806 *

Acceptable:

Newman-Keuls Multiple Comp.	Difference	P	Q	Critical q (.05)
Mean(2)-Mean(1) =	1.1838	3	8.066	3.364 *
Mean(2)-Mean(3) =	0.6088	2	4.288	2.805 *
Mean(3)-Mean(1) =	0.575	2	3.992	2.805 *

Distinguishable/Innovative:

Newman-Keuls Multiple Comp.	Difference	P	Q	Critical q (.05)
Mean(2)-Mean(1) =	0.3344	3	2.034	3.364
Mean(2)-Mean(3) =	0.1736	(Do not test)		
Mean(3)-Mean(1) =	0.1607	(Do not test)		

Suitable:

Newman-Keuls Multiple Comp.	Difference	P	Q	Critical q (.05)
Mean(2)-Mean(1) =	1.2216	3	8.473	3.364 *
Mean(2)-Mean(3) =	0.4216	2	3.023	2.805 *
Mean(3)-Mean(1) =	0.8	2	5.653	2.805 *

Complete:

Newman-Keuls Multiple Comp.	Difference	P	Q	Critical q (.05)
Mean(2)-Mean(1) =	0.8417	3	6.055	3.364 *
Mean(2)-Mean(3) =	0.2203	2	1.638	2.805
Mean(3)-Mean(1) =	0.6214	2	4.554	2.805 *

Effective:

Newman-Keuls Multiple Comp.	Difference	P	Q	Critical q (.05)
Mean(2)-Mean(1) =	1.0922	3	15.029	3.317 *
Mean(2)-Mean(3) =	0.385	2	5.477	2.774 *
Mean(3)-Mean(1) =	0.7071	2	9.929	2.774 *

Appendix XVII Comparison of FADS Test Rankings

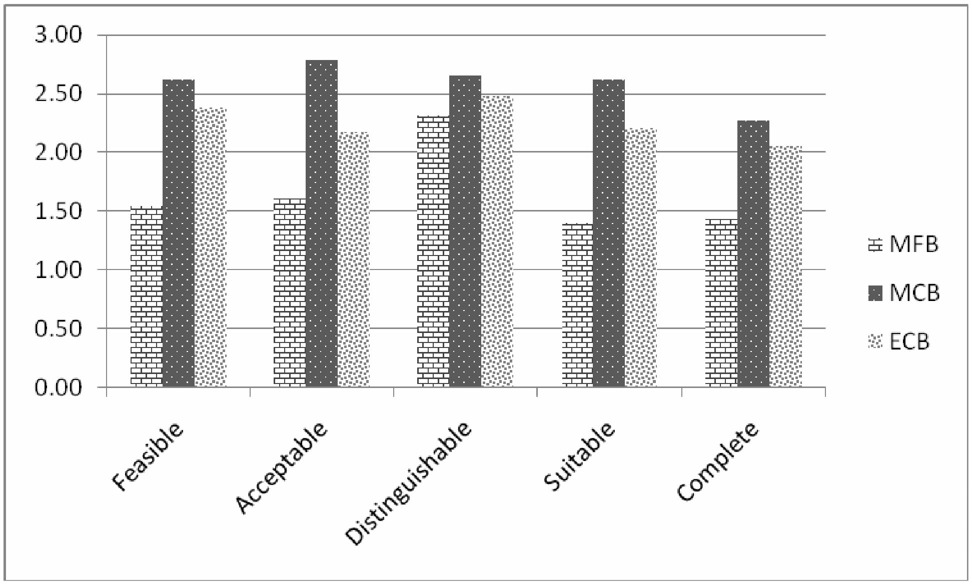
In accordance with the Army's "FADS test": feasible, acceptable, distinguishable, suitable, and complete, the highest score was obtained by MCB (See Table XVII-1 and Figure XVII-1). It scored well in all measures of effectiveness: feasible, acceptable, suitable, and complete. And it scored highly with respect to distinguishable. However, the latter was somewhat less than MFB. Yet, although MFB resulted in highly distinguishable solutions, lacking effectiveness, they were not actionable.

Table XVII-1 FADS Test Rankings[vii]

Ideation Technique	Feasible	Acceptable	Distinguishable	Suitable	Complete
Manual Free Brainstorming	1.54*	1.60*	2.31	1.40*	1.43*
Manual Carousel Brainstorming	2.62	2.78*	2.65	2.62*	2.27*
Electronic Carousel Brainstorming	2.38	2.18*	2.48	2.20*	2.05*

Note: * indicates statistically significant difference. However, analysis of statistical significance is convoluted: Feasible: Two statistically significant differences emerge: MCB differs from MFB and ECB differs from MFB. But MCB differs not from ECB. Acceptable: Three statistically significant differences: MCB differs from MFB, ECB differs from MFB, and MCB differs from ECB. Distinguishable: No significant differences. Suitable: Three statistically significant differences emerge: MCB differs from MFB, ECB differs from MFB, and MCB differs from ECB. Complete: Three statistically significant differences: MCB differs from MFB, ECB differs from MFB, and MCB differs from ECB (see Appendix XVI).

Figure XVII-1 Rankings with Respect to the FADS test



The FADS test components reflect the seeds that were used during the MCB and ECB procedures. One way of explaining individual differences in the creativity was due to the specification requirements that were used as seeds. Five specifications were used (see Appendix VI). There referred to arrival time, equipment requirements, monetary costs, obstruction to civilian traffic, and safety. Each of these had an impact on FADS components. Because equipment requirements were a key issue, it enhanced the feasibility of CB solutions. Because costs were a primary issue, acceptability was improved. Because the commander's insights (the whole of the specification requirements) were made clear, suitability was improved. And because cadets were forced to a fuller consideration of issues, completeness was improved. The one component that the seeds did not affect was 'distinguishable'. It ranked nearly the same among the three methods.

Significant differences between the MCB and ECB results were probably due more to a general low skewing of the ECB data. As mentioned, problems with connectivity plagued many of the ECB sessions. This likely accounted for the differences seen above with respect to acceptable, suitable, and complete [see *Section 5.4.6* (above)].

ENDNOTES

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i Note that MDMP takes place at higher echelons of the military. It concerns decision making at the level of battalion and above. It does NOT involve the actions of soldiers and officers in combat operations in the field. Decision making by lower level commanders are prescribed by what the Army calls "Troop Leading Procedures" (see Appendix II).

ii Current doctrine employs nine primary staff positions. Staff 1 (S1/G1) advises the commander with respect to personnel and administration. Staff position 2 (S2/G2) provides advice concerning military intelligence. Staff position 3 (S3/G3) deals with operations and training. Staff position 4 (S4/G4) is supply. Staff position 5 (S5/G5) is future operations. Staff position 6 (S6/G6) is communications. Staff position 7 (S7/G7) is information operations. Staff position 8 (S8/G8) is finance. Staff position 9 (S9/G9) is military-civil operations. Note that "G" indicates a staff dedicated to advising a general officer, whereas "S" indicates all others.

iii Briggs' (1997) *focus theory* has shown that just as cognitive resources are limited, so too are attentive resources. As the number of phenomena under consideration expands, the ability to carefully consider each while generating new ideas diminishes (Briggs, Reinig, and Shepherd, 1997, pp. 1-10). Human cognition is thus able to consider only a limited set of ideas, after which fatigue and mental ability wane.

iv This is similar to what occurs in carousel brainstorming (both manual and electronic). After the initial round of COA development, the group as a whole is left with five COAs and five specifications requirements. These might be five COAs**:** drive unit vehicles, go by rail, go by bus, go by air, and go by bicycle. Along with these might be five specification requirements: expeditious, maximize vehicles and equipment, minimize cost, minimize obstruction to civilian traffic, and travel safely.

If these were presented in a MFB session, the two lists would comprise ten separate ideas. Together they would exceed the cognitive load of most people.

However, in carousel brainstorming the participants view only one COA at a time. They never have more than six ideas to deal with. As the brainstorming session proceeds, each participant examines each COA in turn. They consider not only the original specification requirement under which the COA was devised, but the specifications that they themselves have previously considered. A sophistication of the problem frame increases in the mind of each participant as they consider the problem in light of the new specification. Their natural inclination is to enhance each COA to include the specifications that they have already contemplated.

Hence, "Drive unit vehicles" might be enhanced to include a daily plan for 350 mile segments. It might later be enhanced to include packing each vehicle with a maximum load of supplies. Later, use of the shortest route (via the Interstates) might be appended. A condition to use only the slow lane of highway traffic might then be added. Finally, a series of preventive maintenance checks might be required of each vehicle on a daily basis.

So the first COA might be enhanced to produce: "The unit will drive its vehicles, packed with maximum supply loads, from Camp Perry to Camp Shelby, in daily 350 mile segments, on available Interstate Highways, using the far right lane of traffic, while conducting daily preventive maintenance checks on each vehicle." This would be done for each of the five COAs developed during the carousel brainstorming session as it proceeds.

What results are five COAs that chunk each of the five specifications. The list of specifications no longer needs to be considered. What is left to be deliberated by the group is a list of five COAs—something that is within the cognitive load of most people.

v A cadet facilitator was chosen for the Free Brainstorming groups so as to minimize bias. Under free brainstorming, the facilitator plays an important role in leading the group through the ideation session. On the other hand, the researcher was chose as proctor for MCB and ECB, since in those cases the proctor served no other role than to ensure that participants correctly followed procedures.

vi There are 17 tasks that Army doctrine details as being necessary during MA: Task 1: Analyze the Higher Headquarters Order. Task 2: Perform Initial IPB. Task 3: Determine Specified, Implied, and Essential Tasks. Task 4: Review Available Assets. Task 5: Determine Constraints. Task 6: Identify Critical Facts and Assumptions. Task 7: Perform Risk Assessment. Task 8: Determine Initial Commander's Critical Information Requirements and Essential Elements of Friendly Information. Task 9: Determine the Initial Intelligence, Surveillance, and Reconnaissance Plan. Task 10: Update the Operational Time Line. Task 11: Write the Restate Mission. Task 12: Deliver a Mission Analysis Briefing. Task 13: Approve the Restated Mission. Task 14: Develop the Initial Commander's Intent. Task 15: Issue the Commander's Planning Guidance. Task 16: Issue a Warning Order. Task 17: Review Facts and Assumptions. (FM 5-0, 3-15 thru 3-29).

vii Creativity ranking may be computed by various means. One could average each of the five components of the creativity gradient (feasible, acceptable, distinguishable, suitable, and complete). Alternately, one could average just the components of effectiveness and innovation. The former method has been employed in this study.