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The impact of group support systems on idea incubation: Exploring creativity in information system development projects

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THE IMPACT OF GROUP SUPPORT SYSTEMS ON IDEA INCUBATION: Exploring Creativity in Information System Development Projects

by

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ABSTRACT

The Impact of Group Support Systems on Idea Incubation: Exploring Creativity in Information System Development Projects

by

Beata M. Lobert

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This interdisciplinary study bridged research from social psychology of creativity, small group behavior, and information systems (IS). The study explored creativity in group information system development projects. Several avenues were pursued.

A laboratory experiment was used to determine the effects of group support systems (GSS) on idea incubation. The following questions were posed:

- Are the IS project proposals generated in teams with the aid of a GSS more creative than IS project proposals generated without GSS help?
- Can GSS shorten the group creative process by eliminating the need for incubation to take place?

To perform the experiment a new, realistic task was developed for the IS domain. The group task required preparation of a proposal for a new IS

module at a university. Completion of the task involved both creativity and decision-making. The experimental task outcomes were rated for their creativity by expert judges. Rather than focusing on the quantity of the creative effort, the quality of the creative effort was evaluated with a creativity assessment questionnaire. The questionnaire was prepared based on the Creative Product Semantic Scale (CPSS) originally developed by Besemer and O'Quinn (1986).

To test the formulated hypotheses, data was obtained using two different evaluation methods: an overall creativity assessment and a detailed creativity assessment. The ANOVA results, from either evaluation method, enabled the experimenter to answer positively the first research question posed, however, there was not enough evidence found to answer positively the second question. GSS was shown to significantly improve the creativity of team IS proposal development. Further exploratory analysis revealed that the GSS groups were able to select ideas that were more novel and to develop them better than the non-GSS group.

Following a discussion of the results follows, a new, event-driven model of a group creative process is presented. Several GSS capabilities supporting the group creative process are outlined.

DEDICATION

In memory of my mother,

Helena Przybysz,

who fostered in me the love of learning,

and who encouraged my vivid imagination.

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Without the support of the Educational Computer Center staff at Baruch College - Frank Werber, Nikki Bermek and Emmanuel Toussant - this study would not have taken place. They were instrumental in the network software installation and troubleshooting. They supported all my laboratory sessions, making sure that the facilities were available, that the software ran as it was supposed to, and that all the emergencies were dealt with on a timely basis.

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My appreciation and thanks go to Israel Pressman, the Chairman of the Statistics and Computer Information Systems Department at Baruch College, for the use of all the facilities, for the office space, for the copying privileges (I did not abuse them!), and for the good words that he spoke on my behalf to my prospective employers.

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TABLE OF CONTENTS

TABLE OF FIGURES

PART I. THEORETICAL FOUNDATIONS

Chapter 1

Introduction

1.1 Introduction

The geo-political trends of the 1990's that brought about the birth of the free market economy in Eastern Europe and the emergence of the European Economic Community have expanded the global market. Rapid technological advances in computing and communications technologies are shrinking the globe and speeding up the rate of social and economic changes. With these developments come immense pressures as well as opportunities and challenges for organizations. To adapt to such an environment and function effectively and successfully, organizations and businesses must now find new ways to do business.

According to Ackoff and Vergara (1981), the "greater the need for new ways of doing things, the greater is the need for creativity." Creativity is one of the untapped human resources. Although not very well understood, it is considered one of the critical factors directly responsible for producing competitive advantages in the 1990's (DeBono, 1992). Creativity dividends include improved productivity, improved profitability and a bonus in the form

of higher job satisfaction (Coulson and Strickland, 1991). Quality and excellence cannot be improved merely by focusing on cost-cutting and efficiency. More emphasis needs to be put on creative solutions and on utilization of creative problem solving. Rational thinking that quality improvements bring to an organization must be balanced with chaos and passion that lead to innovation. (Quinn, 1985; Thier, 1991). Creativity, therefore, is becoming a serious enterprise in the 1990's. Corporate leaders are learning to develop and utilize it. Awards are given for it. Incentives encourage it (Anderson, 1992).

In the 1990's, the computer industry in particular has to be concerned with creativity. The concerns are three-fold:

- technology is evolving almost on a daily basis and we continually look for new ways to utilize resources.
- most simple systems have already been developed and implemented, and the challenging ones are still ahead (Couger, 1992).
- many information systems are old, not meeting the existing demands, and soon they will become obsolete (Turban, 1993).

While the information systems of the past decades focused on the improvement of efficiency and control, the systems of the 1990's must focus, among other things, on innovation. Re-engineering, restructuring of outdated information

systems to meet the challenges of the 1990's markets, has become an essential element in many companies' competitive strategy (Turban, 1993).

Computer professionals will benefit from focusing on and tapping into creativity in their daily activities. Creativity has the potential to enable them to:

- re-engineer obsolete systems and business processes.
- innovate by introducing successful new software, systems and services.
- improve old products by improving their quality, cost effectiveness, durability and robustness.
- utilize existing products in new ways.
- make new ideas appear.
- change the work environment so new ideas will flourish.

In general, creativity will enable the IS professionals to do more, quicker and with less, while increasing product quality and the company's competitiveness.

Although the creativity literature is rich in such fields as philosophy, psychology, architecture, education and art, computer information systems journals explore the concept rather infrequently. Yet, there is a definite need to develop a better understanding of creativity as it relates to the computer industry.

The following issues need to be explored:

- Can computer technology be of any help in fostering the creative, collaborative endeavor of system analysts and/or end-users to enable production of more valuable system products?
- Can computer technology be used to improve the creative process and if so, how?

The increased understanding of creativity and the creative process, as it applies to the computer industry, may step up the scientific and technological progress.

1.2 Dissertation Overview

The theoretical foundations for this study are presented in chapters two and three. Chapter two summarizes the previous literature in the fields of creativity, creativity in information systems, collaborative group work, group support systems, and information systems. The purpose of this overview is to provide the reader with the research themes that led to this investigation, to determine what research is lacking, and to develop theoretical justifications for the proposed research questions. Chapter three provides the objective of the study with a detailed statement of the hypotheses tested.

The details of the study are presented in chapters four, five and six. Chapter four discusses the research frameworks that were adapted and integrated to conduct the study from the fields of creativity and group support system research. Chapter five presents the methodology used in the study. It details the experimental design and experimental procedures utilized. The experimental setting, subjects, task, data preparation and pilot study are also presented. Chapter six demonstrates the research frameworks for the creativity assessment of task outcome adopted in this study. The details of the materials that were developed and used to perform the evaluation are presented.

The results of the study are summarized in chapters seven, eight and nine. Chapter seven includes the data on subject background and demonstrates that the experimental manipulation of subjects was successful. Chapter eight describes the statistical analysis performed, including the statistical techniques, the power of the test and the results of the hypotheses testing. Chapter nine contains results from the statistical analysis of the subjects' post-session feedback, summarizing and comparing their perceptions about clarity of instructions, motivation level, group dynamics, level of satisfaction, outcome usefulness, and technology effects.

The conclusions from the study are presented in chapters ten, eleven, twelve

and thirteen. Chapter ten discusses the results of the study and proposes a new model of the group creative process. It also outlines the GSS capabilities to benefit the process. Chapter eleven offers the key limitations of the conducted research. Chapter twelve outlines the directions for future research and chapter thirteen summarizes the study and its results.

All the materials developed and used in the study - the experimenter materials, the subject materials, the pilot study materials, the evaluator materials, the task outcomes and other relevant information - are included in the appendices.

Chapter 2

Review of the Literature

This interdisciplinary study of the impact of group support system technology on idea incubation will explore the concept of creativity and its relation to collaborative group work and information system design. This section presents a review of previous research in the pertinent areas.

2.1. Creativity

Creativity is an illusive concept that is difficult to define. There is no single, accepted definition. The definitions vary greatly in complexity and focus. Parnes et al. (1977, p. 14) define creativity as the: "association of thoughts, facts, ideas, etc. into a new and relevant configuration, one that has meaning beyond the sum of its parts -- that provides a synergistic effect." Morris (1992, pp. 3-4) defines creativity as: "the spark of originality, of inspiration, of illumination that mixes fresh colors, invents new products, arrives at ground-breaking solutions." Newell and Shaw (1972) provide the most comprehensive definition, which states that a creative solution must satisfy one of the following conditions:

- the product must have novelty or value.
- the thinking is unconventional, requiring modification or rejection, or

synthesis of previous ideas.

- the thinking requires motivation, persistence and high intensity over a period of time.
- the initial problem is vague or ill-defined, so problem formulation is part of the solution.

Creativity involves both the conscious and the subconscious parts of the brain. It draws on knowledge, logic, imagination, intuition and the ability to see connections between ideas (Smith, 1985). It involves going beyond the current boundaries.

"There is still no single, unifying theory of creativity which is embraced by all researchers and practitioners." (Tulenko and Kryder, 1990) Philosophers and psychologists from Plato to Freud (1970) and, more recently Schank and Childers (1988), Evans (1991) and DeBono (1992), have long struggled with the meaning of the word, producing an abundance of definitions and explanations in the literature. Kneller (1965) explores the concept in depth from the philosophy and psychology perspectives.

Organizational behaviorists also have been interested in the concept of creativity. Recently, Woodman et al. (1993) developed a theoretical framework for understanding creativity within organizations.

According to Rhodes (1981), creativity can be analyzed in a number of ways, involving four different parameters: person, process, product and environment. Much of the published literature can be analyzed in this manner.

2.1.1 The Creative Person: Most empirical research in the area of creativity focuses on the creative person (Nicholls, 1972) and assumes that anything a creative person produces will be creative. According to Maslow (1959) and Rogers (1970) creativity is present in everyone and, with proper training, everyone can be creative. Ackoff and Vergara (1981) classify all the explanations of creativity into two categories:

- origin-oriented, focusing on the source of the action, and
- process-oriented, focusing on the thought process.

Their summary of views on the nature of creativity is presented in Figure 1.

Most of the research in this area, however, concentrates on determining the character traits and skills that are present in individuals who produce highly creative results. Amabile (1983, p. 68) identified the necessary and sufficient components that guarantee creative production in any domain, in any individual. They are: domain-relevant skills, creativity-relevant skills and task motivation. The details of her componential model are outlined in Figure 2.

Origin-oriented approaches

Psychoanalysts

Creativity arises from conflicts within individuals. The creative process involves externalizing the internal product of imagination through interaction of primitive and more mature types of thinking (Freud, 1970).

Humanisitic psychologists

Creativity arises when there is no conflict within an individual. The creative process involves the release of natural creative potential through the removal of inhibitions from the individual and obstructions from his environment (Fromm, 1959).

Psychometricians

Each individual's natural creative potential is limited by his genetic endowment and can be measured by standard tests. The creative process involves the interaction of two contrasting types of thinking: 'divergent', which converts information into a variety of unconventional alternatives, and 'convergent' thinking, which aims at unique or conventional outcomes (Guilford, 1977).

Process-oriented approaches

The Associationists

An individual's creativity is a function of the person's ability to invoke and explore remote associations in selecting a response to a problem (Mednick, 1962).

Gestalt psychologists

Creative thinking proceeds neither by piecemeal logical operations nor by disconnected associations, but by more determinate restructuring of the whole situation (Wertheimer, 1959, pp. 234-259). Creativity lies in the ability to redirect a line of thought taken in solving a problem (Maier, 1970, pp. 195-196).

Information theorists

The human thinking process can be simulated as the process of information processing in a computer programs. Creative activity is a special class of problem-solving activity characterized by novelty, unconventionality, persistence, and difficulty in problem formulation (Newell et al., 1962).

Figure 1. Summary of Views on the Nature of Creativity (Source: Ackoff & Vergara, 1981)

Domain-Relevant Skills:	***Creativity-Relevant Skills:***	***Task Motivation:***
Includes: • Knowledge about the domain • Technical Skills • Special domain-relevant "talent"	*Includes:* • Appropriate cognitive style • Implicit or explicit knowledge of heuristic for generating novel ideas • Conducive work style	*Includes:* • Attitudes toward the task • Perception of own motivation for undertaking the task
Depends on: • Innate cognitive abilities • Innate perceptual and motor skills • Formal and informal education	*Depends on:* • Training • Experience in idea generation • Personality characteristics	*Depends on:* • Initial level of intrinsic motivation toward the task • Presence or absence of salient extrinsic constraints • Individual ability to cognitively minimize extrinsic constraints

Figure 2. The Components of Creative Performance (Source: Amabile, 1983, p.68)

Organizational behaviorists, Woodman and Schoenfeld (1989, 1990) propose an interactionist model of creative behavior. Their model combines several explanations of creative behavior using elements of personality theory (e.g., Woodman, 1981), cognitive style theory (e.g., Hayes, 1989), and social psychology theory (e.g., Amabile, 1983). They propose that the individual, the situation, and their interaction over time need to be examined in order to understand creativity fully. The individual's creativity is a function of antecedent conditions (e.g., past reinforcement history, biographical variables), personality factors (e.g., self-esteem), cognitive factors (e.g., divergent thinking), intrinsic motivation, relevant knowledge, contextual influences (e.g., physical environment, task and time constraint), and social influences (e.g., social rewards). Group creativity is not only a function of individual creative "inputs," but the interaction of the individuals involved (e.g., group composition), group characteristics (e.g., group norms, size, degree of cohesiveness, history, diversity), group process (e.g., approaches to problem solving, social interactions), and contextual influences (e.g., characteristics of the group task) also contribute to the group creative performance.

Miller (1988) distinguishes among four distinct styles of creativity, innovation and change. The styles are determined by the way people gather information, and by the way they use it. Individuals and groups are likely to display one or a combination of the following styles:

modifier builds and improves on what has already been learned and accomplished by using facts and finding new ways to take action.

explorer questions all the assumptions, even the most basic ones, using symbols and metaphors to change paradigms and to find solutions; emphasizes adventure; uses insight to perceive new connections between facts.

visionary realistically imagines the ideal end-state and lets the long-term goals guide the actions; emphasizes power and knowledge; uses insight to find new ways to take action.

experimenter uses a systematic process to combine different variables in new ways, testing the viability of each possibility; emphasizes action; uses facts to find new connections between facts.

Miller believes that the styles may have an effect on creativity. Although individuals with different styles may have an equal creativity level, a certain style may be more suited to a particular industry or a particular task.

2.1.2 The Creative Process and Incubation: Creativity occurs in a variety of ways, even in the same individuals. Most creativity experts agree (Kneller, 1965; Lawson, 1990; Morris, 1992) that there are four basic stages in the process of creativity, as originally identified by Wallas (1926). They are illustrated in Figure 3. Each phase is indefinite in length.

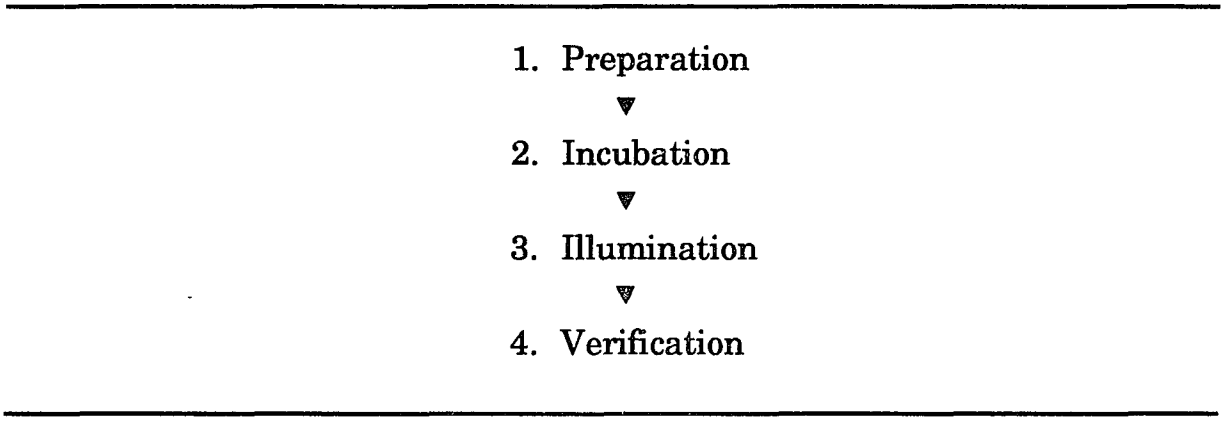


Figure 3. The Creative Process

Preparation involves the sum of everything that a person has learned. Additionally, it may involve a thorough investigation of the original idea. It manifests itself in reading, note-taking, questions, discussions, explorations. It includes learning specific techniques that are appropriate to the problem. In general, it provides the person with the necessary background for solving the problem.

Incubation is a period of subconscious activity, where the conscious mind concentrates on other activities. During this period, the mind reorganizes facts, prepares new sequences and combinations of accumulated facts, tries new paths, and seeks new ways around barriers. Also, in this phase the process of selective forgetting takes place.

Illumination is the moment of discovery or insight, when the "innovator grasps a solution to the problem" and the process of creation is brought to a climax. It is the product of incubation (Kneller, 1965).

Verification is an elaboration of the new idea or an evaluation phase when the new idea or the new approach to an existing problem is tested. It is the period during which the utility of the solution, as well as its correctness, are examined. Then the idea is edited or revised, if necessary. If no acceptable solution is found, the individual returns to one of the previous phases and iterates through the process, until a solution is found.

Of the four phases of the creative process, incubation seems to be the most controversial. There has not been much interest in studying it; however, its alleged benefits are reaped in numerous creativity techniques which prescribe periods of incubation during individual or group work (Kirkwood, 1984).

Researchers argue whether the incubation stage is necessary in the creative process and report inconsistent results. Ghiselin (1952) and Koestler (1964) report numerous accounts of the occurrence of incubation in highly creative individuals. There have been only few experimental investigations, however, of the phenomenon, since the incubative activity is difficult to simulate and control in experimental conditions. Figure 4 presents a summary of several experimental studies of incubation.

Investigator	**Task**	**Evidence of Incubation?**	**Could Results Be Confirmed?**
Fulgosi & Guilford, 1967	Consequences	yes	no
Dreistadt, 1969	Insight Puzzle	yes	no
Murray & Denny, 1969	Ball & Tube problem	yes	not attempted
Silveira, 1971	Insight Puzzle	yes	no
Dominowski & Jenrick, 1972	Hat Rack Problem	no	not attempted
Dominowski, 1972	Crossword Puzzle	no	not attempted
Olton &Johnson, 1976	Insight Puzzle	no	not attempted
Olton, 1979	Chess End-Game	no	not attempted
Patrick, 1986	Remote Associates Test	yes	not attempted
Browne &Cruse, 1988	Insight Puzzle	yes	not attempted

Figure 4. A Summary of Several Experimental Studies of Incubation (Source: modified from Olton, 1979)

Interestingly, some studies have not been able to find any evidence of the incubative process at all. Other studies have obtained positive effects, but their results could not have been replicated, even when attempts to follow every detail of the original study has been made. This of course does not prove the non-existence of incubation. Olton (1979) suggests one possible explanation for these results: the tasks have been too trivial, not motivating the subjects enough, and the time periods assigned to the task and incubation have been too short. In real life accounts of incubation, the task usually involves specific knowledge and skills which are highly developed in the individuals solving the problem. Also, individuals experiencing incubation tend to be highly motivated. Laboratory settings are poor approximations of such conditions.

In a more recent study, Patrick (1986) has been able to find an incubation effect, but only in individuals with high ability level in the domain. Subjects with a low ability level have not benefited from the incubation period. Browne and Cruse (1988) have determined that subjects given relaxation instruction and no intervening task during a problem-solving break were more successful than those who worked continuously on the problem or were given a demanding mental task as an intervening task.

The content of the incubation period is a critical factor in inducing incubation. Kirkwood (1984) "presents findings that certain forms of the incubation

sequence may improve group problem solving." Involving individuals during incubation in topics radically different from the main problem will produce significantly better solutions than the non-incubation approach.

Torrance (1979) suggests using an instructional model for enhancing incubation and increasing the chances for incubation to occur. The model requirements are as follows:

- States of consciousness other than the logical, wakeful state of consciousness must be activated at least for a brief period.
- Intellectual and emotional functions must all be brought into play.
- There must be a realistic encounter with a problem, intense absorption, involvement and commitment.
- Opposite, contradictory concepts, images or ideas must be confronted simultaneously.
- Visual, auditory and other sensory modes of thought must be brought into play.

Since incubation is a subconscious process, it is hard to demonstrate, complex to investigate scientifically, and difficult to explain. Dorsel (1979) explains incubation as a special case of a learning principle, known as reminiscence. Intensive practice during the preparation stage may result in a temporary depressing effect on performance. A rest period, therefore, will cause improved performance and a solution may suddenly emerge.

Schubert (1979) suggests that incubation is a silent, internal rehearsal of unusual responses by the subject, which may lead to an increase in creativity in a post-incubation period. After a period of incubation, usual responses are discarded in favor of more original ones. His research is supported in creativity literature by Osborn (1957), Meadow et al. (1959) and Renzulli (1973), who indicate that later responses to a problem tend to be rated more creative than earlier responses. Guilford (1979) has fully analyzed the functional relationship between idea production and time. He has found that "...the further along in time from the beginning of the task, the more likely the response found to be of high quality... The higher-quality responses that come then are more likely to involve transformations, which have become recognized as an important secret of originality." The period of incubation provides the necessary time for the transformations to take place.

Incubation has been linked to a state of relaxed effort, coupled with high levels of motivation and persistent desire to solve a problem (Guilford, 1979). It is still to be determined, however, under what conditions incubation normally occurs and what conditions favor its occurrence or prevent it (Guilford, 1979).

2.1.3 The Creative Product: Jackson and Messick (1965) propose that for a product to be considered creative it must necessarily satisfy the following conditions:

- the product must be unusual and appropriate in the context of norms.
- it should transcend the conventional constraints, producing new forms, rather than improving on the old ones.
- it should have the property of creative "condensation," where the apparent simplicity and complexity of the solution are unified.

According to Amabile (1983, p.33):

> "a product...will be judged as creative to the extent that:
> (a) it is . . . a novel and appropriate, useful, correct, or valuable response to the task at hand, and
> (b) the task is heuristic rather than algorithmic, i.e., the task does not have a clear and readily identifiable path to a solution."

There exists no objective, conclusive set of criteria for the identification of a creative product in any domain. There exist, however, proprietary tests used in specific domains, especially within the arts or sciences, geared specifically to identify the strengths and weaknesses, in terms of creativity, of products in those domains.

There has been a strong need for establishing a set of agreed-upon criteria - precise standards of judgement - that could allow the measurement of a product's creativity in any domain. Besemer and Treffinger, in their 1981 article, reviewed more than 90 publications on the topic and identified over 125 criteria proposed in literature. In the years since, Besemer and O'Quinn have developed and refined the theory and a model for studying the attributes of

creative products. The model, called the Creative Product Analysis Matrix (CPAM),

> "proposes three conceptual dimensions to be considered in analyzing a product's creativity:
> - novelty (newness of process, materials, techniques and design)
> - resolution (functionality, usefulness, workableness of the product) - the degree to which the product fulfills the needs of the problem situation, and
> - elaboration and synthesis (the stylistic attributes of the finished product.)" (Besemer and O'Quinn, 1986)

Elaboration and synthesis is the degree to which the product combines unlike elements into a refined, developed, coherent whole.

In its current form, the model tests 11 criteria or attributes of a product in the three dimensions, as demonstrated in Figure 5. The novelty dimension is tested by evaluating if the product is germinal, original and surprising. The resolution of the product is tested by analyzing if the product can be viewed as logical, useful and valuable. The elaboration and synthesis dimension is tested by evaluating if the product is complex, elegant, organic, well-crafted, and understandable.

DIMENSIONS AND CRITERIA OF THE CREATIVE PRODUCT

DIMENSION:	CRITERIA:
Novelty	Germinal
	Original
	Surprising
Resolution	Logical
	Useful
	Valuable
Elaboration &	Complex
Synthesis	Elegant
	Organic
	Well-Crafted
	Understandable

Figure 5. The Creativity Dimensions and the CPAM

2.1.4 The Creative Environment: It has been demonstrated that social and environmental factors play major roles in creative performance. Various researchers investigated the social influences on creativity, which may either enhance or undermine the creative process. The environmental influences are outlined in Figure 6. Amabile (1983, pp. 99-184) discusses several of them. Amabile and Gryskiewicz (1989) investigate the methods for assessing the creative environment and propose the creative environment scale.

Creativity enhancing factors:	***Creativity undermining factors:***
• evidence of choice	• expected external evaluation
• existence of reward for doing the task	• peer pressure
• intrinsic motivation for doing the task	• surveillance
• stimulation of the physical environment	• time constraints
• play and fantasy prior or during the task engagement	
• interpersonal detachment that allows for increased independence	
• expectation of creative result	

Figure 6. Environmental Influences on Creativity

Figure 7 presents the conceptual links among the Creative Person, Creative Process, Creative Product and the Creative Environment proposed by Woodman et al. (1993). It suggests that the individual, the group and the organization as well as the situation have an impact on the creative process, which in turn results in the creative product.

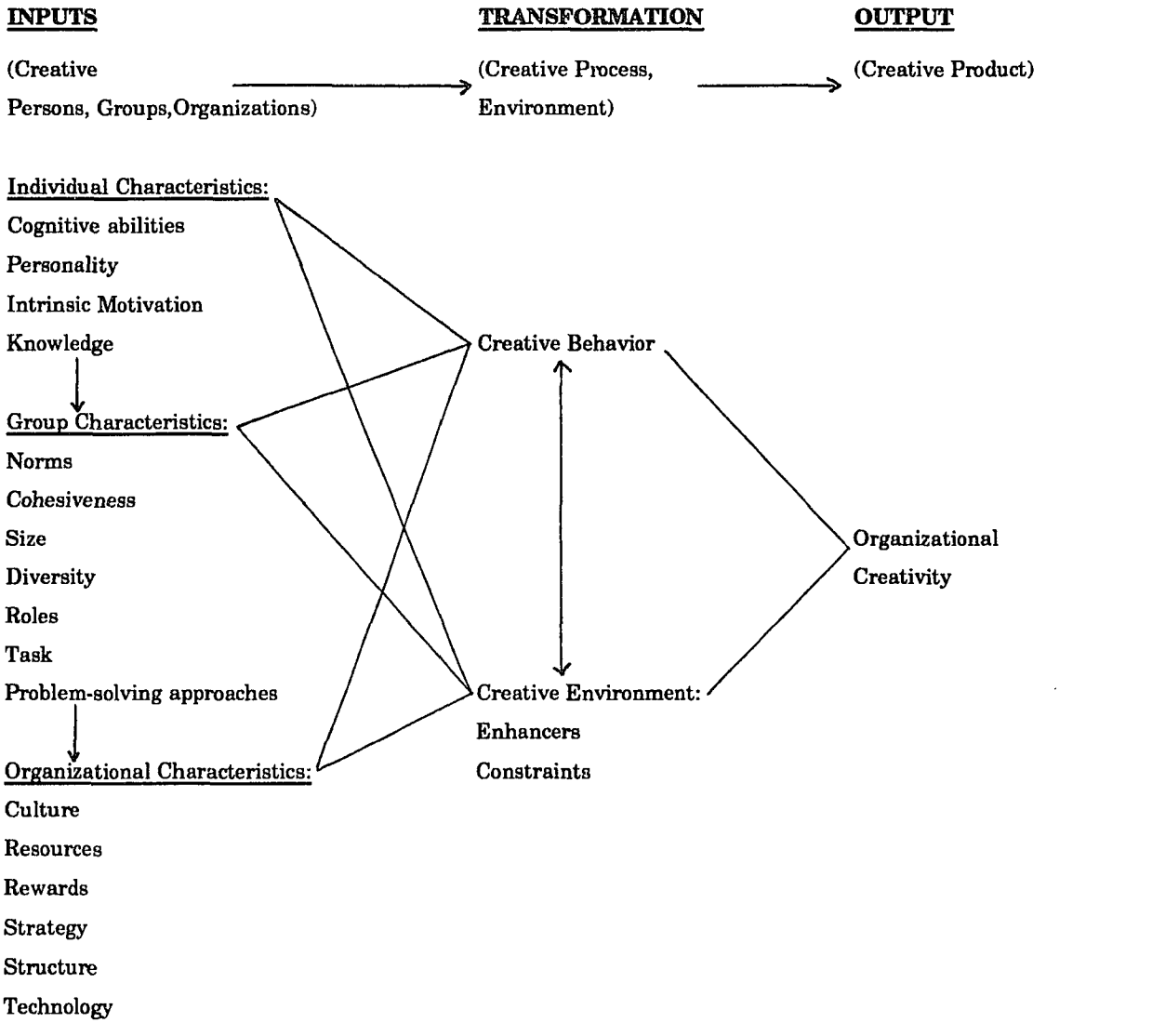


Figure 7. Conceptual Links Among the Creative Person, Process, Product and Environment (Source: Woodman et al., 1993)

2.1.5 The Measuring of Creativity: Creativity is measured by means of a test or a judging process. Most creativity researchers focus on assessing the creativity of a person and employ creativity tests toward that end. Researchers use one of three types of creativity assessment tests: personality inventories (e.g., Gough, 1957), biographical inventories (e.g., McDermid, 1965), and behavioral tests (e.g., Guilford, 1967, pp. 138-170).

Few researchers have attempted to determine the creativity of a product. Simonton (1980), in an unusual study, has been able to develop a reliable and objective method for quantifying originality of musical themes. Ghiselin (1963) suggests that researchers should establish an objective set of criteria for measuring the "intrinsic quality" of products, and assessing creativity on that basis. Thus far, there exists no objective test or set of criteria to determine whether a product is creative or not or whether one product is more creative than another (Amabile, 1983, p. 31). Most studies measuring the creativity of a product use the subjective judgements of experts in the domain to determine whether a product is creative or not (e.g., Sobel and Rothenberg, 1980; Getzels and Csikszentmihalyi, 1976, pp. 107-121; Hocevar, 1981; Dologite et al., 1993).

Amabile (1983, pp. 37-64) proposes a subjective methodology for assessing the creativity of a product in a broad range of domains and tasks within domains. The methodology is built around the subjective, consensual judgement of

experts in the domain. (This method will be referred to in text as a consensual approach.) First, judges are asked to assess creativity at a global level, and then they assess several other characteristics of the product. The creativity assessment is statistically verified to be reliable, i.e., consistent among all the judges, and then broken down into component parts to determine which objective characteristics of the product, for example, originality or elegance, predict the judgement of creativity. A few previous studies have used subjective methods of assessing creativity that are similar to Amabile's consensual assessment technique, e.g., Sobel and Rothenberg (1980), Getzels and Csikszentmihalyi (1976, pp. 107-121). Amabile's methodology has been used in several recent studies on creativity in information systems (Couger and Dengate, 1992; Elam and Mead, 1990).

Besemer and O'Quinn's (1986) CPAM model was operationalized by the Creative Product Semantic Scale (CPSS) instrument. The CPSS has been validated and used in a number of studies (Besemer and O'Quinn, 1986, 1987). The instrument, in its short form, is a 22 item, seven point, bipolar semantic scale (see Figure 8.) The developers suggest using the instrument as a development tool, to improve a product in process development, or to screen product ideas. Since creativity is a multifaceted concept, instead of generating a grand total creativity score for the product, three totals are calculated for each of the creative product dimensions: novelty, resolution, and elaboration

CPSS--Creative Product Semantic Scale

How to Use the CPSS...

Carefully consider the product. Look at the scales printed in the box on your CPSS Form. Think about the product at hand.

For each scale, select and circle an appropriate point between each of the alternatives. While not belaboring your selection, give careful thought to how each word relates to the product idea. Circle the point on each scale that shows both direction and proximity in meaning to the word that better describes the product. Don't be concerned if the words do not seem to be complete opposites. Some pairs are but some are related in other ways. Simply ask yourself, "Will the product, if developed, be more like one term or more like the other?" If you find that the product will be equally like one term and equally like the other, select a point near the middle of the continuum. Do not worry if you realize that people may define words differently, or that others may not agree with your definitions. Studies of reliability suggest that these differences do not cause much real difference in product evaluations.

1.	crude	* * * * * * *	well-crafted
2.	appropriate	* * * * * * *	inappropriate
3.	clear	* * * * * * *	ambiguous
4.	unique	* * * * * * *	ordinary
5.	revolutionary	* * * * * * *	average
6.	inessential	* * * * * * *	essential
7.	coarse	* * * * * * *	elegant
8.	operable	* * * * * * *	inoperable
9.	arranged	* * * * * * *	disarranged
10.	usual	* * * * * * *	unusual
11.	workable	* * * * * * *	unworkable
12.	astounding	* * * * * * *	common
13.	plain	* * * * * * *	ornate
14.	unnecessary	* * * * * * *	necessary
15.	attractive	* * * * * * *	unattractive
16.	organized	* * * * * * *	disorganized
17.	makes sense	* * * * * * *	senseless
18.	pioneering	* * * * * * *	unprogressive
19.	mystifying	* * * * * * *	understandable
20.	astonishing	* * * * * * *	commonplace
21.	meticulous	* * * * * * *	sloppy
22.	complex	* * * * * * *	simple

Figure 8. CPSS Form
(edited version)

and synthesis. Novelty score is derived by totalling the score for items 4, 5, 10, 12, 18, and 20. Resolution is calculated from scores in questions 2, 6, 8, 11, 14, 17. Elaboration and Synthesis score is based on questions 1, 3, 7, 9, 13, 15, 16, 19, 21, and 22. Rules for scoring , e.g.,

crude 1-2-3-4-5-6-7 well-crafted

organized 7-6-5-4-3-2-1 disorganized

and interpreting the results are provided. Often, at that point, the strongest points of the product surface, as the evaluated product scores high in particular dimension(s). Based on the low scores in other dimensions, ways of improving the product are suggested.

2.2 Creativity in Information Systems

Although the subject of creativity has been explored in many fields of study, it has received very little attention from information system (IS) professionals. Couger (1992) mentions the existence of a scarce number of IS articles that contain more than one page on the subject of creativity. Only recently has there been an emphasis in the IS field to investigate the role of creativity in IS problem solving (Freedman, 1987; Couger, 1990a; Couger et al., 1990; Galletta et al., 1992; Gogan and Cash, 1992; Couger and Dengate, 1992; Fellers and Bostrom, 1993). Couger (1992) proposes studying the uses of creativity in other fields and transporting some of these approaches over to IS.

2.2.1 The Creative IS Person: Since all computer information systems start with the generation of an idea, creative thinking is an important skill for systems analysts and designers. In the process of creating an IS system, creativity allows system analysts to depart from typical solutions and to overcome barriers. Thus far, no set of creative skills or traits has been identified that is of particular importance to IS personnel. However, research is on the way, e.g., at the Center for Research on Creativity and Innovation at the University of Colorado where Miller's (1989) Innovation Styles Profile Inventory is being used to determine how different innovation styles affect the creativity of IS personnel.

McLean and Smits (1993) identified four roles of IS leadership essential for the long-term success of business in the highly competitive markets of the nineties. The IS executive must function not only as a technologist and manager, but also as an innovator and a strategist. In their role as innovators, the IS leaders must promote creativity within an organization and re-engineer the business processes of the organization through the use of information technology. "The strategist role of the IS leader will only emerge after the innovator role is mastered by the re-engineering of the core functions of business." (McLean and Smits, 1993)

2.2.2 The Creative IS Process: Most of the research in this area focuses on introducing creativity approaches into the system development life cycle (SDLC). Couger (1990b,1991) suggests and illustrates the use of creativity techniques at each phase of system development, advocating delayed convergence on a solution. Galletta et al., (1992) describe another model of the creative IS process that augments each stage of the development cycle with creativity principles and techniques, for example:

- brainstorming (Osborn, 1957), an idea generating technique used to achieve open communication, could augment the requirements definition phase of the SDLC.
- morphological analysis (Allen, 1962), a technique that examines different dimensions of the problem to explore e.g., cause-effect relationships, is suggested for the evaluation stage.
- boundary examinations (Arnold, 1956), a technique that explores the basic assumptions of the problem in order to solve it, could be used during the requirements definition stage.
- nominal group technique (NGT) (Van de Ven and Delbecq, 1971), a technique using a collection of individuals working alone with deferment of judgement is recommended for the evaluation stage.

Wojtkowski and Wojtkowski (1993) provide a theoretical perspective on the effects of computer support on creativity in IS. They propose the use of a

Visual Process Language (VPL) to enhance inventiveness in the system development process, by assisting in the first insight, preparation and illumination steps of the creative process. The system development process in VPL incorporates explicitly creativity enhancing procedures.

Sampler and Galletta (1991) discuss the necessary changes that need to take place in order to introduce creativity techniques into the system development process. By increasing the emphasis on creativity in system development, usually more time is spent in the process and the cost of the system development increases. The increase, however, has been found to be only less than one-half percent and the benefits always far outweigh the costs (Couger, 1992).

2.2.3 The Creative IS Product: To this day, there exists no acceptable set of criteria as to what constitutes a creative product in the information systems domain. Knowing what attributes of a product make it creative would allow IS practitioners to innovate more easily and to develop more durable and responsive IS products (Couger and Dengate, 1992). In the domain of new system development, there exists a high degree of creative opportunity to produce a creative product, however, the only way to evaluate the artifact of the creative effort, i.e., the proposed system, would necessitate using the subjective judgement of experts in the field.

This has been the approach utilized in the research studies concerned with creativity evaluation of IS products (Higgins et al., 1990; Couger and Dengate, 1992; Dologite et al., 1993). In a ground breaking paper, Couger and Dengate (1992) discuss different examples of IS areas in which there are creative opportunities and where the creative results can be measured. The authors also directly deal with the topic of defining the attributes of a creative product in IS. They measure the creativity of several existing IS software products. The study addresses the issue of software creativity by applying two widely accepted creativity criteria: novelty and utility. To assist with the evaluation process, two sets of guidelines for three levels (low, medium and high) of novelty and utility scores have been established. Novelty and utility have been evaluated in terms of more detailed subcriteria, tailored to the IS field. In the study, utility has been evaluated, based on well-established criteria in the software quality literature, in terms of cost reduction, return on investment, market penetration, customer loyalty, efficiency, the number of new functions computerized, quality and reliability of application. Novelty has been evaluated on the basis of how the technology was utilized, if new technology has been used, if a new task has been computerized, if new algorithm or an original approach has been derived for computerization. The developed guidelines then have been provided to the expert judges who evaluated six, fully developed and market-tested software packages, by applying the subjective judgement methodology.

Amabile (1983, p.59) argues against this type of assessment of creativity, as it is based, to a large degree, on the subjective judgement of the psychometrician or primary researcher, who devises all the categories of evaluation and all the precise definitions for the scale. Amabile claims that since there exists no objective set of creativity criteria, the ideas of the primary researcher as to what constitutes high or low creativity may not coincide with the perceptions of the expert raters. She argues that the consensual approach, which starts with the overall assessment of creativity by expert judges, is more appropriate.

More often, the approach to creativity evaluation in the IS domain is less structured, and poses only one simple question to the expert judges: "Is this product creative or not?" (e.g., Dologite et al., 1993).

At an early stage of systems development, when there are still many ideas considered and the focus for the system must be narrowed down fairly quickly, it would be beneficial to consider all the ideas and evaluate them in terms of their creativity, among other things. Wojtkowski and Wojtkowski (1993) call for the establishment of a metric construct to measure "inventiveness" of the design.

Applying the Couger and Dengate (1992) criteria of software creativity, for system creativity, however, is inappropriate. It is especially difficult to translate the utility criteria from software products to systems. Therefore, the need for development of a metric or an instrument for evaluation of creativity of information system is apparent.

2.2.4 The Creative IS Environment: Snow and Couger (1991) document that creativity training, the establishment of a positive environment in IS organizations for creative thinking, the encouragement of creativity, and expectancy of creative solutions can result in major improvements in IS activities and IS products. Based on creativity research in other fields, Couger (1992) has identified three factors in common for all creative breakthroughs:

- the investigators expect a creative idea to occur.
- a methodical, systematic process is utilized to reach the result.
- there is a period of idea incubation .

McLean and Smits (1993) give an overview of the previous research in the area and identify the environmental conditions that facilitate innovation, which is the product of the creative effort.

2.3 Collaborative Group Work

Many of the inventions of the past were made by individuals working alone. This is no longer true. Modern research is increasingly a product of team

work: individuals collaborating on a project. For example, more than three quarters of Nobel prizes, in the years 1951-1972, were given out for collaborative work (Zuckerman, 1977, p. 176). The body of knowledge today is so big and complex, that it encourages narrow specialization. No one person has all the needed information and resources to make decisions, to plan, to create, to invent and to keep up with the exponentially growing body of knowledge. To complete a project, or to reach a major decision in an organization, an interdisciplinary group of specialists must be assembled. They interact with each other, communicate their ideas, challenge each other, build on each others knowledge. They must collaborate so closely that frequently it is difficult to isolate the creative work of any individual. Creative teams spanning disciplines, departments, organizational levels, and organizations are growing in use and impact (Barlow, 1990).

As the business environment becomes more complex in the 1990's, more and more time will be spent in meetings, which in turn will decrease the time spent in other professional activities (Huber, 1984). Miller (1992) reports that over ninety percent of Fortune 500 companies use decision making groups today to handle the complex problems confronting managers. The decisions confronted in meetings, in general, are more complex today and must be made more quickly than in the past (DeSanctis and Gallupe, 1987). IS organizations are confronted with these problems as well.

2.3.1 The Advantages and Disadvantages of Group Work: Group work can provide several advantages (Hughes, 1963, Nunamaker et al., 1991):

- less technical frustration, since more information is available to the group
- less individual responsibility
- "cross-fertilization of ideas" and synergy of information
- wider margins of error for individuals, since members of the group compensate for each other
- stimulation of individuals, since "creativity is contagious"
- more objective evaluation
- learning from other group members

Mosvick and Nelson's (1987, pp. 3-26) research indicates that between twenty five and eighty five percent of all professionals' time is spent in meetings. Yet over fifty percent of this time is wasted. Group meetings, in general, are unproductive (Shaw, 1981). The disadvantages, resulting from the common problems experienced include:

- attenuation blocking, i.e, if ideas are not voiced as they occur, they may seem irrelevant at a later time, and will be suppressed (Diehl and Stroeb, 1987; Lamm and Trommsdorf, 1973)
- attention blocking, i.e., new ideas are not generated since members of the group must constantly listen as others speak (Diehl and Stroeb,

1987; Lamm and Trommsdorf, 1973)

- concentration blocking, i.e., members make less comments, since they try to remember the comments that already have been made (Diehl and Stroeb, 1987; Lamm and Trommsdorf, 1973)
- air time fragmentation, i.e., the group must partition time among members (Diehl and Stroeb, 1987; Lamm and Trommsdorf, 1973)
- free riding, i.e., expectation to free ride on the ideas of others (Diehl and Stroeb, 1987)
- dominance of a discussion by one or more members (Diehl and Stroeb, 1987)
- group influence by high-status members and lack of acknowledgement of the ideas of low-status members (Diehl and Stroeb, 1987)
- failure to remember ideas of others (Diehl and Stroeb, 1987)
- pressure for conformity and associated low tolerance of minority or controversial opinions (Shaw, 1981)
- undue attention to social activities relative to the task activities of the group (Shaw, 1981)
- fear of speaking in public and of personal evaluation (Diehl and Stroeb, 1987; Lamm and Trommsdorf, 1973)
- information overload (Hiltz and Turoff, 1985)
- coordination problems (Hirokawa and Pace, 1983)
- information available is incomplete (Hirokawa and Pace, 1983)

2.3.2 The Techniques to Support Collaboration: The need to optimize group work and group decision making is a longstanding concern of organizations (DeSanctis and Gallupe, 1987). There have been dozens of techniques proposed to facilitate group interaction and to reduce conflict (Van Gundy, 1984,1988). In 1957, Osborn developed a technique for creative idea generation known as brainstorming. Other commonly used approaches include the use of structured group management techniques such as the Nominal Group Technique (NGT) (Van de Ven and Delbecq, 1971). Each of these approaches is briefly described below:

Brainstorming is a means of gathering ideas from a group of people. It consists of two stages. In the first stage, an individual or a group of people spontaneously generate voluminous, "wild" ideas, without explanation, and by withholding criticism or judgement. Improvements and combinations of ideas during the process are encouraged. In the second stage, the ideas are reviewed, and it is decided which ones will be further developed (Scott, 1989).

The intent of the technique is to force people to think freely by removing barriers of inhibition, self-criticism, and criticism of others. The technique allows individuals to generate more ideas and thus increases the chances of success. The quality, however, of generated ideas is not addressed by this technique (Amabile, 1983, p.191).

Brainstorming procedures and their effectiveness have been studied extensively (e.g., Bouchard, 1970, 1972a, 1972b; Dillon et al., 1972; Dunnettee et al., 1963; Jablin, 1981). Osborn (1957) claims that the technique of brainstorming could be beneficial in a group setting. Research provides evidence, however, that using group brainstorming, where a group of individuals discusses ideas out loud, is not any more effective than individual brainstorming, where individuals are writing ideas on their own (Amabile, 1983, p.191; Graham and Dillon, 1974). Also, nominal groups (collections of individuals working alone with deferment of judgement) produce more ideas than groups of people working together (e.g., Van de Ven and Delbecq, 1974; Street, 1974; Lamm and Trommsdorf, 1973). Although some results show that the quality of ideas might sometimes be better in a group (e.g., El Dreny, 1979; Thornburg, 1988), in general, brainstorming does not work as well in a collaborating group.

Nominal Group Technique (NGT) involves the silent generation of ideas in writing, round-robin recording of ideas, and serial discussion for clarification. It is perceived to be superior to brainstorming, when used in groups working together (Van de Ven and Delbecq, 1971).

Since group productivity and creativity are a reflection of the synergism among its members (Hughes, 1963), determining the optimal conditions under which

a group can complete a project or reach a decision is of high concern to the scientific and business communities. Barlow's (1990) study indicates that idea productivity explains little of the success of creative teams. Rather, insight and shifts in problem definition at the individual and at the group level prove to be the key success factors. Therefore, facilitating the groups with group creativity tools that result in insight is important.

Recently, researchers have shown increased interest in trying to better understand group processes to make meetings and group work more efficient (Stefik et al., 1987; Hirokawa and Gouran, 1989; Straub and Wetherbe, 1989; Abraham and Boone, 1991) by applying computer technology. One new approach involves the use of computer-based Group Support Systems.

2.4 Group Support Systems

While the first decade of personal computing, i.e., the 1980's, focused on enhancing personal productivity, the current industry focus is on enhancing work-group effectiveness (Myers and Ragusa, 1992). The 1980's advances in the microcomputer chip technology, graphics and local area networks have led to networked computer systems and environments that support group work (DeSanctis and Gallupe, 1985). The various systems emphasize either collaboration, meetings, group processes, coordination, decision-making, or communication aspects of group work. There have been many names given to

the group support technology. Literature often refers interchangeably to Group Decision Support Systems (GDSS), Group Support Systems(GSS), and Electronic Meeting Systems (EMS) or Groupware.

GSS's have been commercially available since 1989 (Bostrom et al., 1991). According to Bulkeley (1992), there are about two hundred electronic meeting rooms supporting groups across the U.S., and the number is growing rapidly. The new technology provides a group with a working environment which makes a group meeting more effective, more efficient and more satisfying (Nunamaker et al., 1991). Grohowski et al., (1990) report a fifty six percent saving in man-hours due to the use of GSS.

GSS usually involves several microcomputer workstations operating on a network, with a set of software tools and, possibly, a human facilitator. The workstations can be either in the same location, to facilitate face-to-face meetings, or in different locations, to facilitate meetings of individuals who do not meet regularly, but who must work together, in spite of the physical distance between them.

The technology allows for interactive sharing and for the use of information among group members by providing a dynamic, shared memory for documenting and running meetings. It makes the procedural structures

available to the group and facilitates their use (Bostrom et al., 1991). A typical GSS provides tools supporting idea generation, idea organization, prioritizing and policy development.

A GSS offers all the advantages of brainstorming and nominal group technique that are used for enhancing group creativity and much more. The various benefits have been extensively documented by, e.g., Dennis et al. (1988) and Pinsonnault and Kramer (1989).

One particular GSS tool that overcomes many of the disadvantages of group work mentioned earlier, is called **electronic brainstorming** or **brainwriting** - a non-verbal form of Osborn's brainstorming, where all the ideas are communicated to others in writing and anonymously. The electronic version of brainstorming works far better than the original technique. Gryskiewicz (1980) shows, in an experiment, that brainwriting groups produce more ideas than brainstorming groups. The technology changes the group processes that take place during the meeting. Removing inhibition from the process is the major contributing factor accounting for this result. According to Boje and Murningham (1982), the loss of social cues due to electronic communication encourages the open input of creative ideas, the discovery of optimal solutions and the selection of an alternative based on its merits rather than on compromise. "By providing a group with opportunities to speed up, change the

content, or change the direction of message exchange, GDSS technology aims to improve the outcomes of meetings" (DeSanctis and Gallupe, 1987).

The effects of GSS on group dynamics have been very well documented in literature (e.g., Jessup, 1987; Kramer and King, 1988). Many laboratory and field experiments have been performed to determine if and how GSS technology affects the group dynamics (Heminger, 1988; Miranda, 1991; Beauclair and Straub, 1990; Bui et al., 1987; George, 1989; Ellis et al., 1990; Jarvenpaa et al., 1988). Dennis et al. (1991) have extensively documented the major differences between the field studies and laboratory experiments. Researchers to-date have looked at the various factors, such as:

Outcome Variables:

- performance of different size groups (e.g., Steeb and Johnston, 1981; Valacich et al., 1989; Watson, 1987; Valacich et al., 1993)
- level of satisfaction with the group process (e.g., Nunamaker et al., 1987; Lewis, 1982; Vogel et al., 1987; Easton, 1988a; Easton, 1988b)
- quantity and quality of group output (e.g., Easton, 1988a; Easton, 1988b; Steeb and Johnston, 1981; Gallupe et al., 1988; Chidambaram, 1989; Fellers, 1989)
- confidence in the group decision (e.g., Gallupe, 1985)
- level of consensus (e.g., Raman et al., 1993)
- completeness of solution (e.g., Venkatesh and Verville, 1992)

Manipulated Variables:

- anonymity (e.g., Connolly et al., 1990; Dennis, 1991; Valacich et al., 1992a; Valacich et al., 1992b)
- group proximity (e.g., Valacich, 1989)
- group interaction (e.g., Kim, 1991)
- task type (e.g., Gopal, 1991; Raman et al., 1993; Mennecke and Wheeler, 1993)
- the communication medium (e.g., Raman et al., 1993)
- group coordination (e.g., Horton and Biolsi, 1993)
- different types of facilitation (e.g., Anson, 1990; Limayem et al., 1993; Beranek et al., 1993)
- cultural differences of GSS users (e.g., Tan et al., 1993)
- interaction frequency (e.g., Jessup and Connolly, 1993)
- the amount of structure in the GSS (e.g., Sambamurthy and Poole, 1991)

No study has manipulated, directly or indirectly, the creative group process or evaluated the creativity of ideas generated by the groups.

Research has shown that GSS's have been able to overcome many of the aspects of a group's dysfunctional behavior (e.g., Gallupe, 1985; Gallupe et al., 1988) that were outlined in the previous section. Fellers (1989), following Bostrom and Anson (1988), details a number of GSS support capabilities and

their benefits in meeting environments as identified in Figure 9. He has found that GSS's were unique in providing all these benefits, and in overcoming the disadvantages of group work.

More research is needed to determine *how* GSS changes the group processes (Mackay and Elam, 1992; Nunamaker et al., 1991). One particular area of interest involves examination of if and how GSS's can change the creative process of a collaborating group.

2.5 Group Support Systems, Creativity and Information Systems

Recently, researchers have begun addressing the issue of using software for the promotion of creativity. An experimental study by Elam and Mead (1990) is a preliminary demonstration that creativity can be enhanced, as well as undermined, by modifying the creative process through the use of software. Massetti et al.'s (1992) study further explores the influence of creativity support software on individual creative performance. Their study found no difference in individual performance, on a creativity task, solved with the aid of a pen and paper or creativity support system.

GDSS Support Provides	***Benefits in Meeting Environments***	
Anonymity	a)	reduced individual inhibitions due to: -fear of social disapproval -speaking anxiety -presence of authority or "expert figures"
	b)	focus on ideas rather than on the individuals who contribute ideas
	c)	enhanced "group ownership" of meeting outputs
Simultaneous input of ideas, comments, votes, etc	a)	broader, more active participation (more people inputing)
	b)	more efficient information generation (more input in less time)
	c)	reduced minority domination of communication
Means for Process Structuring	a)	improved application of group process structuring techniques (e.g., brainwriting)
	b)	separated idea generation from evaluation
	c)	improved topic focus (less topic wandering)
	d)	facilitated agenda control of meeting activities
Electronic Recording and Display	a)	immediate display of individual and group information
	b)	easier to modify information during processing
	c)	easier to prepare information inputs prior to meeting
	d)	easier to distribute information following meeting
	e)	reduced information loss
	f)	retained original wording and meaning of inputs
	g)	electronic integration of meeting information with other computer tools
	h)	enhanced group memory of previous meetings or events in current meetings
Extended Information Processing Capacity	a)	automated complex analysis tasks such as vote aggregation
	b)	easy access to external information
	c)	easy access to other computer tools
	d)	quick and efficient access to other ideas and opinions

Figure 9. GDSS Support Capabilities and Their Benefits in Meeting Environment (Source: Fellers, 1989)

A number of laboratory experiments have been performed in which group software has been used for creativity tasks (e.g., Lewis, 1982; Jessup et al., 1988; Fellers, 1989; Valacich et al., 1989; Connolly et al., 1990; Gopal, 1991; Robichaux, 1991; Olson et al., 1992). In these studies, only quantity and overall quality of the solutions have been measured. Information system design projects have never been the focus of the studies. Although it has been shown that creativity can lead to improvements in quality, cost effectiveness, durability and robustness of information systems, creativity has never been analyzed directly in the GSS studies.

Myers and Ragusa (1992) suggest that future research in GSS will focus on product development and design. They further stipulate that it will incorporate Electronic Joint Application Development (E-JAD) tools to supplement and interface with Computer Assisted Software Engineering (CASE) tools and Enterprise Analysis tools as a part of a GSS. Therefore, it is expected that many applications of the future will be developed in a GSS environment. Supporting their stipulations, several studies have already been conducted incorporating GSS technologies in the system or the software development process (e.g., Nunamaker et al., 1989; Ram et al., 1989; Daniels et al., 1991; Carmel et al. 1992a; Wanninger and Dickson, 1992; Tyran et al., 1993). Also, several research frameworks have appeared, including that of Nunamaker et al. (1992), Carmel et al. (1992b) and Vogel and George (1992), who discuss how

JAD and GSS or CASE, JAD and GSS can be used together to support groups engaged in analysis and design. The Automated Group Analysis and Design (AGAD) environment, described by Vogel and George (1992), provides tremendous opportunities to the IS community. Many challenges are still ahead. Software engineering and empirical research issues still remain to be addressed before operational status can be achieved.

The interface of GSS and creativity in information systems is a relatively new field of study. All the studies to date have been conceptual in nature. Several frameworks for the study of GSS and creativity have been proposed. Recently, Duncan and Paradice (1992) have suggested an integrative, theoretical model that synthesizes concepts of creativity, group dynamics and GSS. Their research shows how various creativity techniques and factors, together with the utilization of a GSS, can affect the decision making process of a group.

Based on Rhodes' (1981) creativity research, Fellers and Bostrom (1993) propose a conceptual model of Creative Problem Solving (CPS), outlined in Figure 10, that utilizes GSS. The lines in the figure designate the various interactions that take place. The model is dynamic, based on the feedback and continuous learning that takes place in the CPS. Elements in the model, either individually or collectively, affect other elements in the model. The authors explain how various GSS tools can be used for various elements of the

model in IS organizations to promote creativity. They point out that more CPS techniques should be embedded into GSS and that GSS can be used to promote each element of the CPS process.

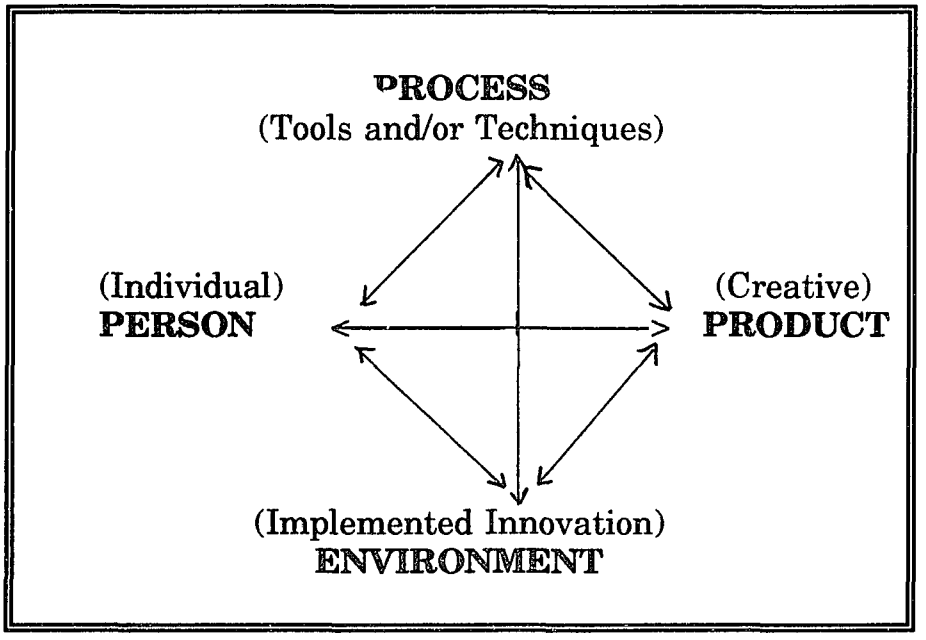


Figure 10. Creative Problem Solving in Organizations
(Fellers and Bostrom, 1993)

In a recent paper, Evaristo and Eierman (1993) examine creativity in a group setting and discuss the value of Group Support System as a means for enhancing group creative output. It is the first paper that explores the question "Are all the stages in the creative process required?" If incubation is absolutely required to produce a creative response, then GSS does not have

the potential of stimulating truly creative ideas, because while using GSS there is no incubation stage - no time allotted for work on other issues. There is no time for selective forgetting to take place and for new connections between ideas to be established. It is possible, however, that GSS itself may compensate for this problem by providing anonymity and immediate display of ideas. The authors postulate more empirical research into the effects of GSS on group creativity.

In the published literature, there have been, to date, no laboratory experiments performed to investigate the effects of GSS on the group creative process, or on the creativity of the generated ideas. In addition, no laboratory experiments have utilized a GSS for the study of creativity in information system development.

Chapter 3

Objective of the Study

Information systems design requires creative effort on the part of a number of individuals involved in an IS design project. It takes a group of specialists, from diverse fields, who need to communicate with each other and collaborate in order to put together a high quality system. System design is becoming more complex and Local Area Network (LAN) based team development is replacing other forms of collaboration. Joint Application Development (JAD) has been popular in the industry, for quite some time already. GSS technology can be found today in numerous organizations (Straub and Beauclair, 1988; Vogel et al., 1990). Exploratory studies (Myers and Ragusa, 1992) point out that JAD tools and GSS tools will soon be integrated to produce an integrated application development environment. An important issue that needs to be resolved is how best to support groups to take full advantage of the technology and of the groups (Nunamaker et al., 1991) to produce creative solutions. In particular, we need to determine if computer technology, namely Group Support Systems, can affect the creativity of the group and if so, how?

This study addressed two specific questions related to the above issue:

- Are the IS project proposals generated in teams with the aid of a GSS more creative than IS project proposals generated without GSS help?

- Can GSS shorten the group creative process by eliminating the need for incubation to take place and thus save time?

The objective of this research was to study the effects of Group Support System and idea incubation on creativity in information system design in order to explain, predict and change human behavior in organizations utilizing GSS technology for IS development. Specifically, this study proposed to address the question of *how* GSS can change the group creative process. The study attempted to determine whether the use of GSS can shorten the creative process by eliminating one of its stages, i.e., incubation, producing results that are not significantly different from the results generated when the incubation stage is present.

It has already been documented that by using GSS more ideas can be generated in less time (Grohowski et al., 1990; Steeb and Johnston, 1981; Gallupe, 1985; Gallupe et al., 1988). Barlow's (1990) study, however, has found that idea productivity does not lead to the success of creative teams. Therefore, the need to study the group creative process and the factors leading to their success, i.e., creativity of their output, became apparent.

Fellers (1989) and others have shown that the quantity and quality of ideas that are generated for a creativity task with the help of GSS are higher. While

quality and creativity are related concepts, they are certainly not synonymous. Ideas of high quality may or may not be creative. Quick and simple solutions are often considered of high quality in IS. Yet, they are not necessarily creative. The creative solutions of the 1990's lead to innovation. Since process innovation and business process re-engineering promise to revolutionize business in the 1990's, according to Hammer and Champy (1993, p. 2), this research proposed to address a timely topic.

It should be noted that no GSS research, to date, has attempted to address the creativity dimension with the depth of the social psychology field. No study evaluated directly the creativity of generated ideas and no study analyzed the group creative process that took place in the presence of a GSS. Previous research into group creative process using GSS was too simplistic and lacked realism. It only analyzed the group idea generation phase and did not implement any other stages of the group creative process. Therefore, for the current study, it was believed that a more realistic group creative process should be simulated - one that lead to a production of a creative artifact. Then, the issue of creativity as it related to time could also be studied, in the context of GSS, i.e.: can the creative process of a group be shortened (one of its stages-incubation-eliminated), through the use of a GSS.

3.1 Hypotheses

The following hypotheses were tested:

Main Effects:

H_{1A}: There is a technology effect on creativity. Groups provided with GSS will generate ideas with higher creativity than groups without GSS.

H_{1B}: There is an effect due to incubation. Groups provided with time for incubation to take place will generate ideas with higher creativity than groups not provided with time for incubation.

Interactions:

H_{1C}: There is an effect due to the interaction of technology with incubation period. Incubation is a factor only when GSS is not present.

Groups provided with GSS, regardless of whether incubation stage is present or not, will not differ significantly in the creativity of the generated ideas. Groups without GSS will generate ideas of higher creativity when the incubation stage is present.

Hypotheses H_{1A} and H_{1C} were of primary importance in this study. Hypothesis H_{1A} is of interest since no previous studies addressed themselves to the issue of the impact of GSS on the group creative output in the IS domain. Hypothesis H_{1B} is a control hypothesis, only relevant to studies in the field of creativity.

The rationale for these hypotheses was based on the potential benefits provided by the GSS tools, as outlined in the scientific literature. Incubation requires time for selective forgetting to take place and for connections between ideas to be forged. Using GSS without allowing time for incubation to take place may, however, prove to be as successful as GSS with incubation time since the group technology provides facilities for cross-fertilization of ideas, synergy of information, and stimulation of ideas. These processes may, in fact, be good substitutes for selective forgetting of ideas and for forging connection between ideas.

No study, to date, probed the depths of IS project proposal creativity, as this study has attempted to do. It is hoped that the results of this study will provide insight into the feasibility of developing an instrument for evaluation of creativity in IS project proposals. A creativity measuring instrument for IS project proposals could be used, e.g., for training purposes, to teach IS students and IS professionals how to distinguish between creative and less creative IS ideas, so that they produce more innovative IS products. Knowing what attributes of a product make it creative would allow IS practitioners to develop more durable and responsive IS products (Couger and Dengate, 1992). Therefore, identification of creative ideas early on in the IS development process is important.

PART II. THE STUDY

Chapter 4

Research Framework

Since this is an interdisciplinary work in the areas of GSS and creativity, the research framework of this study combined elements from both fields of study.

A number of research frameworks have been proposed in the GSS literature (Fjermestad et al., 1993). DeSanctis and Gallupe (1987) define the objective of GSS as improving the group decision making process by removing barriers and providing a spectrum of tools and techniques to facilitate the decision making process. Jelassi and Beauclair (1987) define GSS as an interactive computer information system that augments the group decision making within an organization with data handling, modeling, and dialogue requirements of groups. Dennis et al. (1988) emphasize the technology that supports the decision making activities and communications. Their model consists of group processes, group outcomes, methods and environment. Pinsonnault and Kramer (1989) distinguish the context, the process, the task related outcomes and the group related outcomes. Poole and DeSanctis (1989) believe that the GSS is just another variable added to the group environment and the group will engage in their activities, as usual. The Nunamaker et al. (1991) model

is an extension of the Dennis et al. (1988) model and emphasizes the process gains and losses. The GSS offers to the group a set of tools for process support and structure and task support and structure. The Applegate (1991) model stresses the transfer and assimilation of the GSS technology in the model. Hiltz et al. (1991) use the GSS to structure, store, process and distribute communication as well as the decision making of the group.

In this research, following Bostrom et al. (1987), the model of an Electronic Meeting System as an Information Processing System was utilized to study the GSS effects. To study incubation, Olton's (1979) paradigm was integrated into the EMS research framework.

4.1 The Electronic Meeting System

Bostrom et al.'s (1987) framework is a commonly accepted conceptual framework for GSS research (Fellers, 1989; Anson, 1990; Chidambaram, 1989). The modified model, as it applies to the current research study, is presented in Figure 11. The figure shows input, process and output phases. There are five inputs into the group idea generation process: individual factors, group factors, environment, task, and facilitation. The outputs are various outcomes to be analyzed. These are the basic elements of the Bostrom et al.'s model. An explanation of the model variables in this study follows.

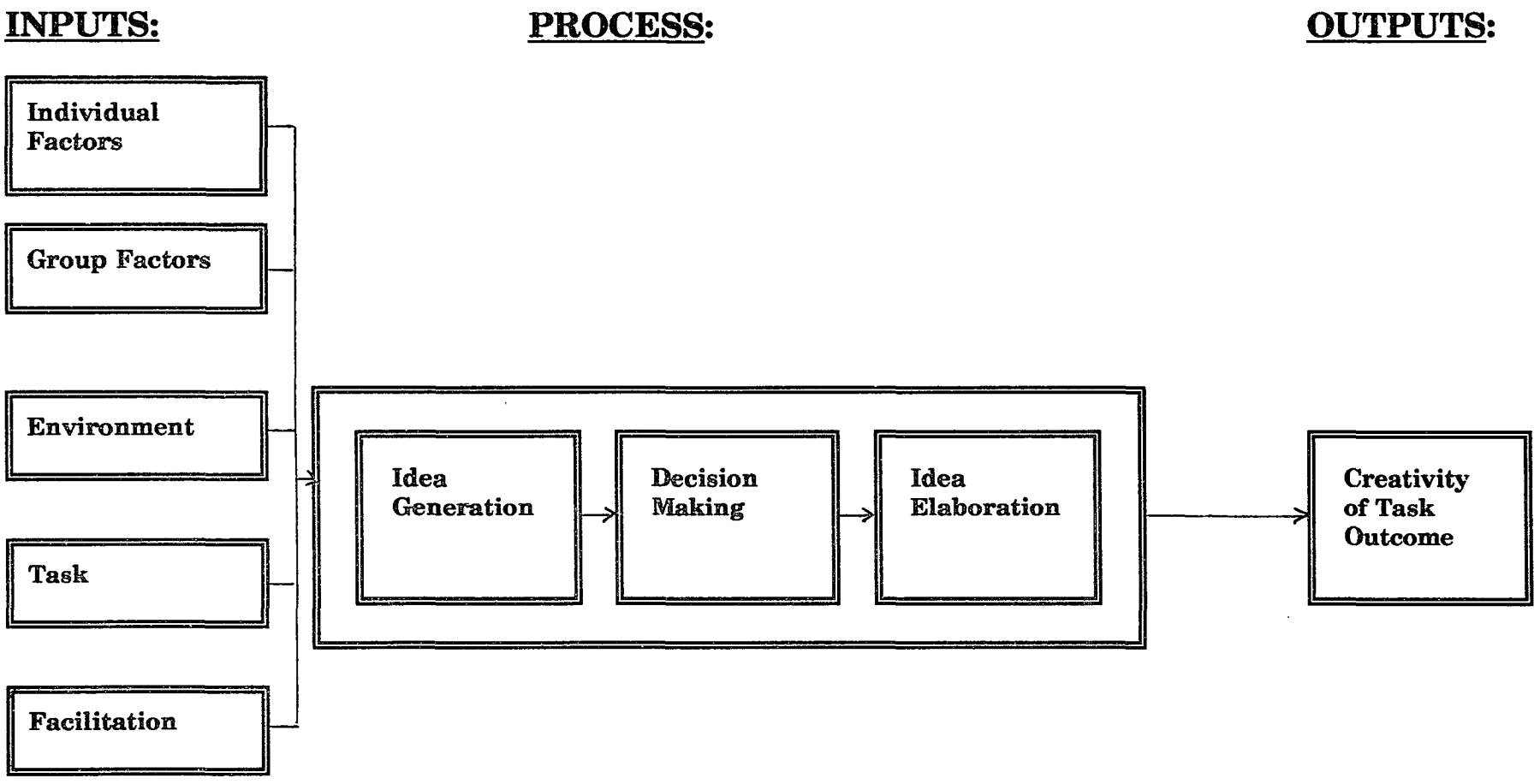


Figure 11. Electronic Meeting System as an Information Processing System
(Source: modified from Bostrom et al., 1987)

Individual Factors - These are the properties of individuals who participate in the research. They are the skills and traits that are brought to the study by each individual. Often individual factors account for major differences in group performance. In this study, individual factors were controlled by randomly assigning individuals to groups and groups to the different experimental categories.

Group factors - These are the properties that affect group interactions. They include norms, group objectives, group size, member status, group proximity, group history and cohesiveness. All factors were controlled. Undergraduate students were used. Each group was presented with the same objective. Each group was of size five or four, which is considered a small group size in GSS research. Much of the GSS research has been conducted with small groups. Gallupe (1985) cites group size five as an optimal size for small-group GSS research. Each group was working collaboratively, at the same time, in the same place. Each group had very little history, i.e., on average, a member of any group may have worked once or twice with some of the other members of the group. All the groups were randomly assigned to treatments - the different experimental categories.

Environment - These are the properties of the environment such as physical environment, organizational culture, evaluative tone, reward structure, support

for the group. All the factors were controlled, except for group support. Half of the groups had GSS support for the task, using brainwriting and other tools, the other half did not have the GSS support, but had to complete the task using brainstorming technique. All the characteristics of the physical environment were approximately the same. The organizational culture, the evaluative tone, the reward structure were identical.

Task - Researchers in social psychology have proposed a number of task classification schemes for task types (Hackman, 1969; Steiner, 1972, pp. 15-37; Davis et al., 1976) Based on their work, McGrath (1984, pp. 60-66) developed a circumplex categorization of task types, distinguishing among eight different tasks: planning, creativity, intellective, decision-making, cognitive conflict, mixed-motive, competitive tasks and performance/ psych-motor tasks. This study utilized a complex task composed of three types of tasks: creativity, decision making, and performance.

Two tasks were utilized in this study - the main experimental task and a "toy task" used to simulate an incubation period. The main experimental task was developed just for this study. The incubation task has been used in previous GSS studies. Up to this point, most of the GSS experimental research used only "toy problems," such as the task utilized for the incubation period. Following DeSanctis' (1989, p.65) calls for use of more realistic tasks, this

study opted to introduce a higher degree of realism and a more complex task was developed. The task was aimed at a simulation of a group creative process that lead to a production of a creative product in the IS domain.

The task was composed of two different task types: creativity and decision-making. The task first required a production of many novel ideas for a Computer Information System component of a current Student Information System at a major urban university, then, selection of the "best" idea(s) generated, and finally, a generation of a proposal, based on the selected ideas that were previously generated. First, idea generation took place, then decision making and then the proposal was prepared. The task output, analyzed for creativity at a group level, was the dependent variable.

Facilitation - Involves the set of " ...activities carried out before, during and after the meeting to help the group achieve its own outcomes" (Bostrom et al., 1991). A facilitator is not a member of the group, but a meeting specialist who aids the group in acting to meet its objectives. In this study, limited human facilitation was provided for the meetings. The groups worked towards the goal primarily on their own.

Idea Generation Process - The initial idea generation process followed Olton's (1979) experimental model for the studying of incubation, which is fully

described in section 4.2. Half of the groups had to complete the task without any intervention in a pre-specified time (to be determined during a pilot study), while the other half had the same allotted time split into two periods, with an intervening period dedicated to a solution of another task, thus allowing for the incubation period to take place. The groups using GSS were advised not to communicate verbally during the idea generation phase. They only communicated electronically. The groups without GSS, using only Osborn's (1957) brainstorming techniques to support task completion, communicated only verbally. Subjects completing the original task with an interruption were instructed not to communicate with each other about the task. All the other aspects of the process were the same.

Decision Making Process - The decision making process was not the focus of this study; therefore, the groups were given much freedom as to how to proceed with the selection of the ideas to be elaborated on in the proposal. The non-technology groups, without any coaching, engaged in the initial evaluation of ideas and then discussed at length narrowed down alternatives. The technology supported groups were given a GSS tool to be utilized in the initial evaluation of the ideas and then, informally, engaged for a short period of time, in a verbal discussion regarding the final selection of the idea(s) to be implemented into a system.

Idea Elaboration Process - Once a consensus was reached as to what ideas should be selected for implementation, the group engaged in a proposal development. The non-technology supported groups utilized pencil and paper to prepare their short document. The technology supported groups utilized a GSS tool to elaborate on their selected ideas.

Task Outcome - The task outcomes were evaluated for their creativity. The creativity of the generated information system proposals was analyzed using expert judges and a questionnaire. The questionnaire solicited the judge's opinion as to the creativity of the task outcomes using a bipolar, seven-point Likert scale, where a score of one represented an uncreative proposal and a score of seven represented a creative proposal. The three independent judges used in the study were not coached in any way. They were instructed to use their own definition as to what is considered creative in the information systems field. The scores derived from the three judges were averaged to provide an overall creativity rating for the proposals.

Figure 12 presents the summary of all the variables.

Variables:

Manipulated

Technique support: GSS vs brainstorming and pencil and paper

Creative process: Incubation period vs No Incubation period

Control

Task

Individual factors

Group factors

Environment, except for technique support

Facilitation

Dependent

Creativity of task outcome, i.e., IS project proposal

Figure 12. Summary of Variables

4.2 Paradigm for Studying Incubation

Olton's (1979) research paradigm for the study of incubation has been adopted in most recent studies of incubation, including Silveira (1971), Dominowski & Jenrick (1972), Dominowski (1972), Olton & Johnson (1976), Kirkwood (1984). The paradigm is presented in Figure 13.

According to Olton, "...subjects in both the incubation group and the control group spend the same amount of time (a+c) in the direct, conscious work on the problem; thus both groups have an equal opportunity to complete the task

..." The incubation group, however, spends an intervening, additional time (*b*) devoting attention to an unrelated task or activity.

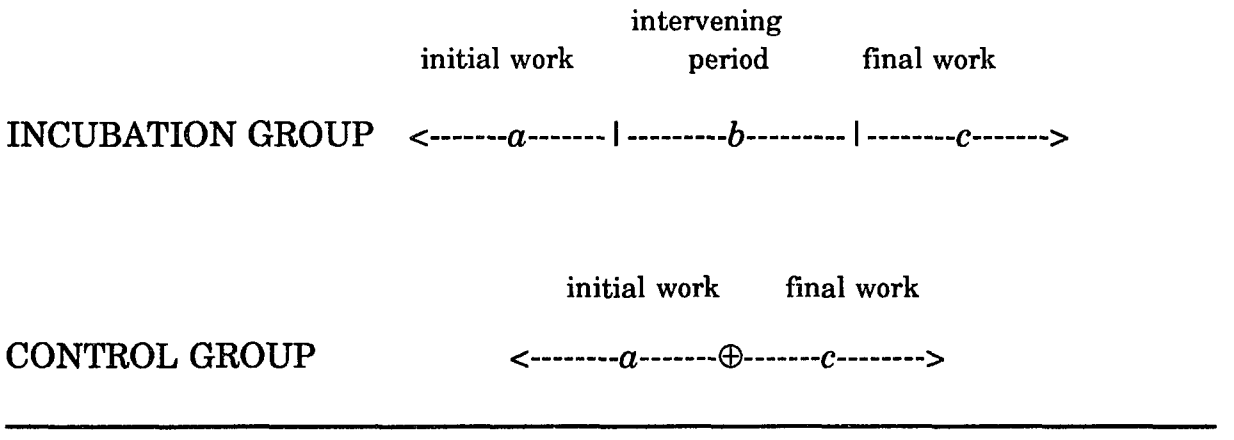


Figure 13. Experimental Paradigm for Studying Incubation (Olton, 1979)

In this study, the incubation group subjects spent time periods *a* and *c* working on the idea generation for a student information system project, described in Appendix A4. Time period *b* was spent working on an unrelated, fun problem, referred to as a tea bag problem (see Appendix A5), used in other GSS studies for a warm up exercise (e.g., Fellers, 1989; Gryskiewicz, 1980) that gets subjects' mind off the original task. The control group only worked on the student information system project, without an intervening period.

To determine the appropriate length of each time interval, *a,b,* and *c,* incubation literature was consulted and a pilot study was conducted. In

Fulgosi and Guilford's (1967) study, for example, incubation effects were seen after a period of twenty minutes. In Kirkwood's (1984) study, incubation effects were noticeable after ten minutes, as long as the incubative task was unrelated to the original task. Based on Kirkwood (1984) study and on the experience with the experimental subjects during the pilot study, it was agreed that ten minutes for each period was sufficient.

Chapter 5

Research Design

To test the hypotheses, a controlled laboratory experiment was conducted within the context of the research framework of Chapter 4.

5.1 Experimental Design

A 2X2 completely randomized, factorial experiment with replications was conducted (Hicks, 1965, pp.75-92). There were two variables, with two levels each: subject groups were either provided with GSS support or not, and a period of time for incubation to take place was either provided or not. The experimental design is outlined in Figure 14.

All the groups, consisting of four or five individuals each, were assigned to one of four experimental categories as follows:

(1) groups conducting the student information system task with the support of a GSS and with an interruption of a tea bag task, allowing for incubation to take place.

(2) groups conducting the student information system task without the support of a GSS and with an interruption of a tea bag task, allowing for incubation to take place.

(3) groups conducting the student information system task with the

support of a GSS and without any interruptions

(4) groups conducting the student information task without the support of a GSS and without any interruptions

Creative process ▸ / Technology ▾	**Incubation**	**No Incubation**
GSS support	*interruption, brainwriting* (1)	*no interruption, brainwriting* (3)
No GSS support	*interruption, brainstorming* (2)	*no interruption, brainstorming* (4)

Figure 14. Experimental Design

5.2 Experimental Setting

All the experimental sessions were conducted on the campus of large northeastern, urban university in the department of Statistics and Computer Information Systems. (For the layouts of the experimental facilities refer to Appendix C.) A faculty meeting room facility was utilized for the sessions without the technology support. The subjects were sitting around two sides of a rectangular table, in comfortable arm chairs, facing a white board with a flip chart and instructional posters. The posters included Osborn's (1957) brainstorming instructions, task instructions, and an example of a proposal. All the generated ideas were communicated orally. The ideas were recorded

on a large size, flip chart pad by the facilitator. At all times, the group members had access to all the previous ideas that had been generated.

The Educational Computer Center laboratory was utilized for the sessions with the GSS support. The subjects were sitting in a row, in comfortable chairs, facing a white board with the same instructional posters as the non-supported groups, and additionally, there was a large computer screen in front of them.

In order to perform the study, a group support system was required which would possess the following capabilities: decision tools to aid idea generation, idea evaluation and selection of alternatives generated. The tools should allow for parallel communication, for anonymity, for sharing of software, and for shared view of the group work.

Figure 15 lists the major group support systems, currently used in academic or corporate environments, together with their features. As outlined in Figure 15, there are several systems possessing these capabilities: GroupSystems (Dennis et al., 1988; Nunamaker et al., 1991), SAMM (Software Aided Meeting Management) (Watson et al., 1988; Zigurs et al., 1988), OptionFinder (Watson et al., 1991) and VisionQuest (Collaborative Technologies Corporation, 1991).

Features:	Decision Tools	Process Tools	Parallel Communication	Anonymity	Shared Software	Shared View
GroupSystems	✓	✓	✓	✓	✓	✓
SAMM	✓	✓	✓	✓	✓	✓
OptionFinder	✓		✓	✓	✓	✓
VisionQuest	✓	✓	✓	✓	✓	✓

Figure 15. Major Group Support Systems
(Source: adapted from McLeod and Liker, 1992)

VisionQuest software has been selected for this particular study. The software has been chosen for its richness of features, ease of use, and most importantly, because it is readily available.

All technology supported sessions were conducted using VisionQuest. The type of GSS used, of which VisionQuest is representative, is different from other group support tools, such as computer conferencing, electronic mail, bulletin boards, electronic meeting systems, and structured communication systems. Figure 16 compares these other tools with VisionQuest.

VisionQuest provides nine group decision support tools: Brainwriting, Comment Cards, Compactor, Point Allocation, Ranking, Rating, Scoring, Subgroup and Voting. For the experiment, only Brainwriting, Comment Cards

and Rating tools were selected.

Group Support Software	Applications and Conditions of Use	VisionQuest comparison
Electronic Mail Computer Conferencing Bulletin Boards	Support non-structured dialogue through message creation, message handling, message delivery capabilities.	Establishes the concept of goal-directed dialogues to focus group activities on desired outcomes.
Other Electronic Meeting Systems	Require or encourage a technical/process facilitator. Enforce a specified style of communication, which is dictatorial in nature.	Does not require a facilitator. Provides a loose, user-friendly and flexible structure.

Figure 16. Comparison: Group Support Software and VisionQuest (adapted from the VisionQuest User's Manual)

Brainwriting a method for generating alternatives, which allows everyone to "talk" at the same time and see all the "talk," as it is going on.

Comment Cards a method for gathering information about an issue.

Compactor enables the participants to take a large number of alternatives and compress them into categories.

Point Allocation enables the participants to distribute a specified number of points across alternatives in a list.

Ranking enables each participant to sort a list of alternatives in ascending priority order.

Rating	allows participants to estimate the importance of individual alternatives in a list, by assigning a value on a pre-specified rating scale.
Scoring	a tool that allows participants to rate each alternative against several criteria, against which the participants are judging the quality or goodness of the alternatives.
Subgroup	allows participants to select a range of choices from a list.
Voting	allows participants to accept or reject alternatives by voting yes, no or abstain.

All generated ideas were entered into the computer and no verbal exchange took place among the group members during the idea generation phase. Group members could see ideas as they were generated, either on a large, public viewing screen or on their own monitors. The screen of the VisionQuest brainwriting module contained an upper and a lower window. In the upper window, all of the previously entered ideas were displayed. The bottom window was used to insert new comments. When a comment was entered, it appeared on all the upper screens of the group members. Each person could move between the upper and the lower window to review the information and enter a new comment.

5.3 Subjects

Individual differences were controlled in this study by randomly assigning individuals to groups and groups to experimental treatments. Groups of four or five individuals were formed using undergraduate junior and senior level students, at a large urban university. The subjects of the study were either majoring or minoring in Computer Information Systems and were currently enrolled in an IS course. The students were solicited from five different computer information system classes. In order to participate in the study, a subject must have either completed or have been in a process of completing a systems analysis and design course.

The decision to use students was made primarily based on Gallupe's (1986) research, which recommends using students as subjects in GSS research, since their performance is similar to the performance of managers, and based on Jablin's et al. (1977) research which reports that ad hoc groups in idea generation studies perform just as well as ongoing groups. DeSanctis (1989) points out that student subjects have the advantage of having a common organizational experience, and are readily available to achieve the statistical power necessary. Also, the task selected for the study was one that students could easily relate to. They felt that they had a stake in completing it, and the knowledge to perform it. The knowledge level to perform the task was approximately homogeneous. By providing the student with a task that they

took seriously, it was possible to increase the richness of "worldly reality" in the experiment.

Initial power calculations (see Appendix G) required the use of sixteen groups, four groups for each experimental condition, to achieve a power of .91. This necessitated use of approximately 80 subjects. Actually, 75 subjects participated in this study. Although every attempt was made to keep the groups size at five, events beyond the control of the experimenter caused the use of groups which consisted only of four subjects each. In GSS research, groups of size four and five are considered small groups. As indicated in Chapter 8, statistical testing revealed no significant differences in outcomes between the creative performances in groups of size four and five.

Prior to the experimental session, subjects were asked to complete a questionnaire (see Appendix B1). The questionnaire was used to collect background and demographic data on the subjects and to assess subjects' familiarity with technology and the systems analysis and design process. Also, the questionnaire assessed the subjects' willingness to participate in the study. Through randomization, the researcher assured that the domain-relevant skills were approximately homogeneous among the subjects in the study.

Subjects were notified of the day on which a session would be conducted. No more than a week's notice would be provided to the students. The names of the subjects who were supposed to participate on a particular day were called at the beginning of the class. If a subject scheduled to participate was absent on any particular day, a randomly selected student from the next scheduled session would be called on to participate. This procedure allowed the most efficient use of the pool of available subjects who volunteered to participate in the study.

Since task motivation has been found to have an effect on an individual's effort to find a good solution, a high level of motivation was desirable. High extrinsic motivation for the task was assured through the introduction of a contest. The best performing group received a $250 cash prize. To stimulate a high level of intrinsic motivation, students were encouraged to participate in the experiment in order to get an opportunity to work with the new GSS technology and to work on a realistic IS task that concerned them.

5.4 Task

Research into group processes searches for tasks that can be performed in a laboratory setting. GSS researchers developed and used a number of tasks that were aimed to be realistic exercises that motivate the subjects and simulate real world behaviors. Mennecke and Wheeler (1993) compiled a

listing of tasks that were previously used in the laboratory studies. The task types varied from creativity through decision-making and intellective to mixed motive tasks. Most of them, however, were "toy problems" - rather simplistic and not very stimulating. The task used in a GSS study should be selected in such a way, so the subjects posses the domain knowledge, feel challenged, and can get involved. The task needs to generate results that are valid and generalizable to the real world setting.

In this study, the domain selected was Information Systems development. The subjects of the study were junior and senior undergraduate students from a large urban university attending or having completed a systems analysis and design course. After a review of GSS task literature, the experimenter found that there was no appropriate creativity task that would fit the domain and the subjects used in this study. Therefore, a new task was developed.

Following DeSanctis' (1989, p.65) call for use of more realistic tasks, this study introduced a higher degree of realism into the experiment. The new task used in this study aimed to mimic the group creative process that does not stop with idea generation, but leads to a production of a creative artifact.

In any group process study, a new task should possess the following characteristics (Mennecke et al., 1992):

"• It should be appropriate to the students.
• It should be engaging.
• It should evoke student's assumption and biases.
• It should be sufficiently complex.
• It should possess ill-defined problem.
• It should be conjunctive rather than disjunctive,"

The last point also required participation of all group members in order for the group to be successful.

Gallupe (1986) suggests that any experimental task for GSS research needs to meet the following criteria:

- the task must be realistic and interesting.
- the task description must be accurate and consistent.
- the task must be applicable.
- the task must be appropriate for GSS support.

The task developed for this study met all of the above criteria. It involved generating a short proposal for a new, innovative component of the current Information System at a large urban university. To the subjects, the task was interesting, engaging and real. Many of them were grateful for the opportunity to participate in the study. Most of them voiced the hope that their work will be seriously considered, since they felt that their ideas were good and useful.

Using "wishful thinking," each group prepared an abbreviated version of an initial investigation report, i.e., a paragraph proposal for either a new subsystem or an improvement to a current system. The document addressed:

- the objective and the benefits of the proposed system.
- the technology or hardware and software used.

A full script used to describe the assigned task can be found in Appendix A4. The task required the subjects to generate a large number of ideas first, then to select the idea(s) to be incorporated into the proposal, and elaborate on the idea(s) selected.

The clarity of the task description was tested in a pilot study. The condition of applicability was also met, since students were selected from systems analysis and design classes and welcomed an opportunity to work on an IS task that was so closely related to them. The task was open-ended to permit flexibility and novelty in a response and did not depend on special skills; however, it required some knowledge in the domain of Computer Information Systems. The student-related, IS task, was selected to generate a fair amount of enthusiasm among students, who complained about the current system at the university. The students were happy to generate ideas and proposals that were subsequently presented to the Director of the Administrative Computer Center at the college.

The task was appropriate for computer support since it involved the production of a large number of ideas by the group, the selection of the best one, and collaboration on the proposal development. Tasks such as idea generation, idea organization and evaluation are supported by VisionQuest, the GSS software used in the study.

5.5 Experimental Procedures

The experiment took place approximately half way through the participants' academic term. The experimenter procedure checklist and experimenter scripts are presented in Appendix A. The subject experimental materials are contained in Appendix B.

Prior to the study, student subjects in five computer information system classes were approached and invited to participate in the project (see Appendix A2). The research project and the associated cash-prize-contest were briefly outlined to them, by stating the research objectives, and what was involved. At that time a preliminary questionnaire (Appendix B1) was distributed to all the students who were interested in participation. Based on a pool of approximately one hundred and ten students, groups of five subjects were randomly created and assigned to experimental categories.

On the day of the announced experimental session, conducted during the students' regular class time, the facilitator met with the group of subjects at the beginning of their class and transported them to the experimental facilities. According to university regulations guiding the use of human subjects in experiments, at the beginning of the experimental session, each student was asked to sign a consent form (see Appendix B2) in order to participate in this study. The group was then provided with a verbal agenda for the meeting (see Appendix A3), detailed task description (see Appendix A4), an example of what a completed task should look like, and instructions for idea generation (see Appendix A6). There were instructional posters hanging in the room (Appendix B4) and all the instructions were explained in detail by the facilitator. Subjects were clearly told to be creative and innovative, in order to establish a high baseline of creativity in the study. The facilitator then answered all the questions that arose during the presentation. The group then engaged in the task.

Groups completed the task in three phases. During the first phase, groups generated as many ideas as it was possible for the task presented. During the second phase, groups evaluated the generated ideas, until they reached a consensus. In the final stage of the meeting, the group engaged in the proposal development, by elaborating on the ideas selected for implementation.

The idea generation for the information system took twenty minutes. Half of the groups engaged in the idea generation for twenty minutes straight. The other half, in order to allow time for incubation period, after the initial ten minutes, were given another task to work on - the Tea Bag Task (see Appendix A5) - for ten minutes. Their information system ideas were saved and during the second ten minute session on the IS task, following the incubation period, more idea generation was encouraged.

To assist in the tea bag problem, the facilitator presented the group with a tea bag during the task explanation. While working on the tea bag task, students were instructed not to communicate regarding the original task.

With the brainstorming groups, the facilitator wrote down all the ideas that were generated on a flip chart, made sure that no idea evaluation took place, encouraged to generate more ideas, and answered any questions. With the brainwriting groups, the facilitator navigated the group through the meeting agenda (see Appendix B3), occasionally instructed on keystrokes, eliminated duplicate ideas entered into the system, moved alternatives around, encouraged to generate more ideas, and answered questions. The subjects were instructed not to concern themselves with spelling errors, since the final proposals would be put through a spelling checker. This was to alleviate any typing apprehension that subjects could have experienced.

After the twenty minute period of idea generation for an information system, the groups engaged in the initial evaluation of ideas that were generated. The technology supported groups utilized a rating tool in order to accomplish this task. The non-technology supported groups engaged in a discussion.

After the initial idea evaluation phase, all the groups engaged in the discussion regarding the final proposal, i.e., what idea(s) should be incorporated. Following Noel and Herschel (1992) and Wachter et al. (1992), the GSS groups were told to interact verbally at this stage, in order to facilitate high quality idea selection. At this stage, individuals expressed their preferences, elaborated on the ideas they considered "best." In some instances, the group selected an individual idea for development into a proposal. In most cases, the group decided to incorporate several ideas into the proposal. Often, new ideas were generated to complement the original idea that started the discussion.

After the decision was made as to what system the group was going to propose, the individuals engaged in elaboration of their idea, i.e., the development of the system proposal. The non-technology supported groups worked with index cards and pencils. Their proposals were usually prepared by one individual and the others in the group verbally communicated the ideas to be written. The technology supported groups worked with the Comment Cards tool of the VisionQuest system in order to elaborate on the system description, benefits,

hardware used and software used. Individuals were able to contribute their ideas simultaneously.

Once all the ideas were contributed and the proposals were considered ready by the group, the facilitator asked the group members to fill out the post-session questionnaire (see Appendix B5). Subjects were asked to report their perceptions of the entire experiment in a post-session questionnaire. The post session questionnaire collected information on:

- motivational level
- the group dynamics
- the level of satisfaction with the group process, and the outcome of the process
- the perceived usefulness of the task outcome
- the effects of technology and the importance of GSS for task completion
- clarity of instructions

Pre- and post-session questionnaires were used to conduct a qualitative investigation of the individuals and of the GSS effects on the group and on the creative processes. Pre- and post-session questionnaires are widely used in GSS research (e.g., Fellers, 1989; Nunamaker et al., 1987). Post-session questionnaire type of data, as suggested by Nunamaker et al. (1991), enables

the full documentation of all the variables in the experiment.

After the post-session questionnaires were completed, the group members were thanked for their participation, debriefed as to the purpose of the research, and reminded not to discuss the session procedures or the task used in the study with other students, until the study is finished (see Appendix A7).

The average total time to complete the experiment was 80 minutes and it varied between 70 and 90 minutes. The variations in time were primarily due to the decision making process that had to occur in order to prepare a proposal. The general breakdown of time elapsed in each activity of the experimental session is illustrated in Figure 17. The time periods for the different stages of the process are reported here for interest, but are not outcome variables that are a part of this particular study.

Since there is no prescribed amount of time for incubation period in literature, other incubation testing experiments were followed. As a result, ten minutes were assigned to the intervening task. It was presumed that during this period enough time elapsed for selective forgetting to take place and for new connections between ideas to be established.

Activity	Average Time (min)	Range of Time (min)
Instructions	10	8-12
IS Idea Generation	10	10
Tea Bag Task	10*	10
IS Idea Generation	10	10
IS Idea Evaluation & Discussion	14	2-25
Proposal Development	22	15-30
Post-Session Questionnaire & Debriefing	4	3-5

* Applies only to sessions with Incubation period provided

Figure 17. Time Breakdown of the Experimental Sessions

5.6 Data Preparation

To facilitate a fair evaluation of the proposals generated in this study, and to eliminate presentation media or format bias, all the session outputs were transcribed and put into a template, so they would appear to the judges identically organized and equally neat. A trained evaluator double checked all the transcripts to assure that no ideas were missed, and that no repetition of ideas occurred within each proposal. In the case of the non-technology

supported groups, the system proposals were simply word processed into the template. In the case of the technology supported groups, a printed transcript was generated for each session, the ideas were rearranged, duplicates eliminated and similar ideas connected. That involved the computer editing of the electronic meeting transcript generated during each GSS session.

5.7 Pilot Study

A pilot study was performed to evaluate the:

- appropriateness of tasks
- number and length of idea generation sessions
- length of time for the incubation period
- clarity of instructions, procedures, task descriptions and instruments
- functionality of software and the group support laboratory

Each of the four experimental conditions was tested with one group. A total of 21 subjects participated in the pilot study. Based upon the feedback from the subjects, the techniques instructions, the task description and the post session questionnaire were clear, complete and understandable. The student subjects considered the task interesting and fun, and overall, they expressed the feeling that the sessions were worth attending. The subjects exhibited enthusiasm for the task regardless of whether they were using the GSS or not,

although the GSS groups believed that the software was useful, assisting in the completion of the task.

The experimental procedures were changed only in the case of technology supported groups. The final decision making process considering the proposed system was changed from an electronic to a verbal form. This required a slight modification of the agendas for the meetings. Also, initially, brief VisionQuest instructions were prepared for the subjects (see Appendix D5), however, they were discarded and substituted with occasional verbal instruction since the pilot study subjects did not use the handouts.

The originally allocated twenty minute period for idea generation was determined to be appropriate, as well as the ten minute period for incubation. The facilities and the group software were satisfactory.

The only other necessary change required modification of the creativity assessment questionnaire. A test proposal was generated by the experimenter and given to the expert judges for evaluation (see Appendix D2). The judges suggested rephrasing some of the questions and changing the scale. For the various versions of the creativity evaluation questionnaire, see Appendices D3 and D4.

Chapter 6

Creativity Assessment

Creativity assessment in the IS domain is a relatively unexplored area. Direct creativity evaluation of the task outcomes, in a GSS study, to judge the group creative effort, has not been previously performed. Up to this point, the GSS research addressed the issue of group creativity evaluation by appraising the volume of creativity, i.e., by counting the number of total ideas and/or the number of unique ideas generated by the group. Often, the measures were calculated on the per person basis. Sometimes, an overall quality rating would also be solicited from the experts, which would indicate the feasibility of the idea implementation or its "goodness." (e.g., Easton, 1988a; Easton, 1988b; Steeb and Johnston, 1981; Gallupe et al., 1988; Chidambaram, 1989; Fellers, 1989; Wood and Nosek, 1993) The quality of the group creativity has not been studied directly, as yet.

6.1 The Research Framework

In this study, to evaluate the creativity of the task outcomes, the researcher adapted methodologies and instruments used in the creativity field. A creativity questionnaire was developed, based on the Creative Product Semantic Scale (CPSS) (Besemer and O'Quinn, 1986, 1987), and it was used in conjunction with Amabile's consensual approach methodology (Amabile,

1983, pp. 37-64), to measure the creativity of the prepared proposals. Two approaches were used, as suggested by DeSanctis (1989, p.67), who calls for use of multiple methods, whenever possible, in order to assess the dependent variables.

In this study, the dependent variable was assessed in two different ways using the creativity assessment questionnaire (see Appendix F2): an overall creativity assessment score was solicited (SCU), as well as detailed, itemized total creativity score was obtained using the remaining twenty two items of the questionnaire. Both creativity assessments obtained from the judges were manipulated to test the hypotheses.

If this research can demonstrate the feasibility of creativity assessment of IS project proposals very early in the System Development Life Cycle, then in the future, a creativity assessment instrument can be developed just for that purpose. Once the instrument is validated, it could be used in a proactive way, e.g., for screening and learning purposes, so thatpoorly developed system ideas can be reworked before they ever reach the developmental stage.

6.1.1 Amabile's Consensual Approach

Amabile (1983, pp.31-33) distinguishes two types of definitions of a creative product: conceptual definition and operational definition. The conceptual

definition is used for theoretical discussion of creativity. The operational definition, which is meant for empirical research, is based on a consensus that a product is creative: "a product... is creative to the extent that appropriate observers independently agree it is creative. Appropriate observers are those familiar with the domain in which the product was created."

Working with the assumptions that experts in any domain, using their own definition of creativity, will be able to consistently assess it, Amabile proposes a research methodology built around consensual definition. The methodology involves an assessment of a product's creativity using first an overall assessment of creativity. This assessment is then verified to be statistically reliable. Amabile argues, that if the creativity evaluation is consistent among experts in the domain it is also valid. Then, she suggests breaking the assessment into the component parts of the judgement in order to determine which objective features of the product explain the judgement of creativity.

6.1.2 The Creativity Questionnaire

To facilitate creativity assessment and solicit expert opinions, this study utilized a creativity assessment questionnaire that incorporated many items from the Creative Product Semantic Scale (Besemer and O'Quinn, 1986). The CPSS form, in its original form, has been previously used in the IS domain by Howe (1990). Howe's project involved evaluation of creativity in computer-

aided design projects. In this research, CPSS in its original form was deemed inappropriate, as some of the items could not have been meaningfully applied to the domain of study. Therefore, the creativity assessment questionnaire was developed.

The creativity questionnaire required the judges to assess the information system proposal in three different categories: the presented project idea; the implications of the system from the technical point of view and the implications of the system from the organizational point of view. Based on the expert judges' initial feedback on the questionnaire in the pilot study, it became clear that these distinctions had to be clearly made in order to make the evaluation feasible. The original creativity dimensions, as defined in Besemer and O'Quinn (1986), novelty, resolution and elaboration and synthesis, were preserved, by keeping most of the original items, however, they were transparent to the evaluators. Additional changes were made in the content of the CPSS instrument, as follows:

- Four items were deleted from the original short CPSS form (see Figure 8, p. 27): unnecessary/necessary (item 14), arranged/disarranged (item 9), plain/ornate (item 13), mystifying/understandable (item 19). Items 9 and 13 were deemed inappropriate for the domain of evaluation. Item 14 was hard to differentiate from item 6: essential/inessential. Item 19

was hard to differentiate from item 3: clear/ambiguous.

- Two new items were introduced: Useful/useless and Inexpensive/costly. These additions were made on suggestions from the expert judges. The suggestions were considered reasonable in view of the fact that usefulness and value are the dimensions of the resolution subscale.
- Two items were repeated in two separate section of the questionnaire - in the organizational and technical evaluations (see Figure 8): astounding/common (item 7), and complex/simple (item 22).
- Overall assessment of the proposed system creativity was solicited, following Amabile (1983).

Figure 18 presents a cross reference of different creativity dimensions with evaluation perspectives of the items on the creativity assessment questionnaire. The creativity questionnaire can be found in Appendix F2. The form required a judge to respond to several questions, some of which related to the assessment of creativity of the group's information system proposal, and the others to the assessment of technical goodness of the proposal.

EVALUATION▸ PERSPECTIVE / CREATIVITY DIMENSION▾	PROJECT IDEA	ORGANIZATIONAL	TECHNICAL
NOVELTY	unique unusual astonishing	revolutionary astounding	astounding pioneering
RESOLUTION	appropriate	operable inexpensive useful	workable sensible
SYNTHESIS & ELABORATION	well-crafted clear elegant attractive organized meticulous	complex	complex

Figure 18. The Creativity Dimensions and Evaluation Criteria in the Creativity Assessment Questionnaire

6.2 The Expert Judges

The expert judges selected for evaluation of creativity were three MIS faculty members from a large urban university. As suggested by Baker (1978), they were not preselected on any dimension other than familiarity with the domain. All of them taught undergraduate and/or graduate sections of the systems analysis and design course for a number of years. The judges were familiar with the problem presented to the students, with the college information

system currently used, and they could easily apply their expertise in the evaluation process.

Prior to evaluating the actual proposals, the judges were presented with a test proposal prepared by the experimenter (see Appendix D2). It gave the judges the opportunity to familiarize themselves with the format of the proposals, with the written instructions, and with the questionnaire used to evaluate the task outcomes. It also allowed the judges to ask for clarifications and to provide invaluable comments on the content of the evaluation questionnaire.

The judges made their assessment independently and without any coaching. They were instructed to rate the ideas relative to one another, on the dimensions in question. The instructions for the judges can be found in Appendix F1. The list of dimensions and the evaluation scale can be found in Appendix F2. Since the meaning of inter-judge consistency can be questioned in studies where the experimenters present judges with their own definition of creativity, the judges were first instructed to use their own notion of what is considered creative (Amabile, 1983, p.38).

The generated proposals (see Appendix E) were evaluated by the judges in different random orders. The judges' ratings are presented in Appendix F4. After the evaluations were performed, the judges were asked to comment

briefly on the features and/or characteristics that a highly creative system needs to possess and on the strengths and weaknesses of the proposals that they reviewed (see Appendix F3). The judges repeatedly defined the creative IS system criteria using similar adjectives: unusual, original, novel, exciting, offering a new way of doing things, creating a synergy between different subsystems, worth the investment. Their biggest complaint about the IS proposals reviewed pertained to the fact that there were too many proposals generated and that too many were alike.

PART III. RESULTS

The statistical results presented in this section were obtained on a desktop computer with a 486 processor and with the aid of Statgraphics (STSC, Inc., 1991) and SPSS/PC+ (Norušis, 1990).

Chapter 7

Subject Background Information

This chapter presents the results of the pre-session survey and some of the post-session survey which solicited background information from the subjects. The descriptive statistics are presented for all 75 subjects in the study, as well as for each experimental condition subgroup. The comparisons were made to assure that there were no major individual differences among the subgroups that could account for the results of the study. The results presented in this chapter verify that the experimental manipulation of individuals was successful. None of the interactions were significant and therefore they are not reported here.

7.1 Demographic Data

Figures 19A and 19B present the demographic data on all the subjects that participated in the study. All this information was collected using a pre-session

questionnaire - Student Information Sheet - contained in Appendix B1. The subjects were, on average, 23.84 years old, with an average GPA of 2.92. There were 48% males and 52% females; 92% of all the subjects were CIS majors, and 8% were minoring in CIS; 76% of the participants worked at the time of the experiment.

Characteristic▾ (n=75)	Mean	Standard Deviation
Age	23.84	4.59
Grade Point Average (GPA)	2.92	0.70

Figure 19A. Subject Demographic Data

Characteristic▾ (n =75)	Frequency (%)
Work currently	57 (76%)
Female	39 (52%)
CIS Major	69 (92%)

Figure 19B. More Demographic Data on the Subjects

Using χ^2-tests and ANOVA, comparisons of demographic data among the subgroups revealed no significant differences. The data is summarized in

Figures 20A and 20B. All p values were greater than .10. All the interactions were also not significant.

Charac-teristic	No GSS (n=39) Mean	St. Dev.	GSS (n=36) Mean	St. Dev.	F-value 1 d.f.	No Incubation (n=37) Mean	St. Dev.	Incubation (n=38) Mean	St. Dev.	F-value 1 d.f.
Age	23.6	5.3	24.1	3.7	.13	23.5	5.3	24.2	3.9	.4
Grade Point Average (GPA)	2.9	0.8	2.9	0.6	.09	2.8	0.8	3.0	0.6	1.4

Figure 20A. Demographic Comparison of Subgroups

Characteristic▾	No GSS (n=39)	GSS (n=36)	χ^2 1 d.f.	No Incubation (n=37)	Incubation (n=38)	χ^2 1 d.f.
Female	17 (44%)	22 (61%)	2.3	23 (62%)	16 (42%)	2.3
Work currently	31 (79%)	26 (72%)	.54	25 (68%)	32 (84%)	2.0
CIS Major	35 (90%)	34 (94%)	.56	33 (89%)	36 (95%)	.78

Figure 20B. More Demographic Comparisons of Subgroups

7.2 Computer Background

Several questions in the questionnaire addressed the issue of the subjects' use and experience with computers. The students completed an average of 3.51

CIS courses and had an average of 3.62 years of PC experience. They rated their word processing experience, on a scale of 1 to 5, to be 3.15; 68% of the students owned PC's at home and 59% of the subjects used PC's at work. Only 19% of all the subjects had any previous system analysis and design experience. Figures 20A and 20B present the relevant statistics. Given the students' familiarity with computers and with word processing, it was assessed that the subjects would not have any trouble using keyboards in order to enter the ideas in the GSS supported sessions.

None of the subjects previously used the VisionQuest system that was utilized in the study.

(n=75) Characteristic[v]	Mean	Standard Deviation
Number of CIS courses completed	3.51	2.30
Years of PC experience	3.62	2.65
Word Processing experience (1=beginner, 5=master)	3.15	1.26

Figure 21A. Subject Computer Background

Characteristic▾ (n=75)	Frequency (%)
Own PC at home	51 (68%)
Use PC at work	44 (59%)
Have Systems Analysis and Design Experience	14 (19%)

Figure 21B. More on Subject Computer Background

Comparison of the subgroups on the computer background characteristics, presented in Figures 22A and 22B, revealed only one significant difference. There were unequal proportions of subjects with systems analysis and design experience in the two subgroups ($p < .01$). The incubation group had a higher proportion of subjects with experience.

Charac-teristic	No GSS (n=39) Mean	St. Dev.	GSS (n=36) Mean	St. Dev.	F-value 1 d.f.	No Incubation (n=37) Mean	St. Dev.	Incubation (n=38) Mean	St. Dev.	F-value 1 d.f.
Number of CIS courses finished	3.8	2.5	3.2	2.1	1.2	3.8	2.3	3.3	2.3	.77
Years of PC exper.	3.8	3.1	3.5	2.1	.21	3.5	2.1	3.8	3.1	.22
Word Process. exper.	3.3	1.2	3	1.3	1.4	3.2	1.1	3.1	1.4	.19

Figure 22A Computer Background Comparison of Subgroups

Characteristic▾	No GSS (n=39)	GSS (n=36)	χ^2 1 d.f.	No Incubation (n=37)	Incubation (n=38)	χ^2 1 d.f.
Own PC at home	27 (69%)	24 (67%)	.06	22 (59%)	29 (76%)	2.4
Use PC at work	22 (56%)	22 (61%)	.17	18 (49%)	26 (68%)	2.3
Have Systems Analysis and Design Experience	9 (23%)	5 (14%)	1.0	2 (5%)	12 (32%)	8.5*

* significant at p< .01

Figure 22B. More Computer Background Comparison of Subgroups

7.3 Attitude Toward Group Work

In addition to the information collected using the pre-session questionnaire, data was collected in the post-session questionnaire on the subjects' attitudes toward group work. Each subject was asked to express how he/she felt about two statements dealing with group work. The subjects were working with a seven- point preference scale, where 1 was "Strongly Disagree," 4 was "Undecided/Neutral," and 7 was "Strongly Agree." The statements and the summary statistics on the responses are presented in Figure 23. Comparison of the attitude toward group work and public speaking, presented in Figure 24, revealed no significant differences among the subgroups.

Question▾ (n=75)	Mean	St. Dev.
Q1 = In general, I like to participate in groups:	5.37	1.38
Q2 = In general, I fear speaking in public:	3.67	1.72

Figure 23. Subject Attitude Toward Group Work

Quest'n:	No GSS (n=39) Mean	St. Dev.	GSS (n=36) Mean	St. Dev.	F-value 1 d.f.	No Incubation (n=37) Mean	St. Dev.	Incubation (n=38) Mean	St. Dev.	F-value 1 d.f
Q1	5.5	1.3	5.3	1.5	.55	5.4	1.3	5.4	1.4	.03
Q2	3.5	1.6	3.8	1.9	.46	3.7	1.7	3.6	1.8	.11

Figure 24. Comparison of Attitudes Toward Group Work Among Subgroups

7.4 Group History

The post-session questionnaire also solicited information from the subjects on each group's history (question 20). The group members were asked to answer the question: "How well did you know everyone in your group?" (1= "First time working with those present," 2="Worked once or twice with some of those present," 3="Worked once or twice with most of those present," 4=" Worked a lot with one or some of those present," and 5="Worked a lot with most of all of those present.") The average response was 2.01 with a standard deviation

of 1.24. Comparison of group history among the different subgroups, presented in Figure 25, revealed again that no significant differences were present.

Quest'n:	No GSS (n=39)		GSS (n=36)		F-value 1 d.f	No Incubation (n=37)		Incubation (n=38)		F-value 1 d.f
	Mean	St. Dev.	Mean	St. Dev.		Mean	St. Dev.	Mean	St. Dev.	
Q20	1.9	1.2	2.1	1.3	.43	2.0	1.1	2.0	1.4	.01

Figure 25. Group History Comparison Among Subgroups

Chapter 8

The Analysis

8.1 Hypotheses

The following hypotheses were presented earlier and are repeated here for easy reference:

Main effects:

H_{1A}: There is a technology effect on creativity. Groups provided with GSS will generate ideas with higher creativity than groups without GSS.

H_{1B}: There is an effect due to incubation. Groups provided with time for incubation to take place will generate ideas with higher creativity than groups not provided with time for incubation.

Interactions:

H_{1C}: There is an effect due to the interaction of technology with incubation. Incubation is a factor only when GSS is not present. Groups provided with GSS, regardless of whether incubation stage is present or not will not differ significantly in the creativity of the generated ideas. Groups without GSS will generate ideas of higher creativity when the incubation stage is present.

8.2 Statistical Techniques

To test the hypotheses in this study, statistical techniques were used that allowed determination of how each of the two factors considered contributes to the variation in the assigned creativity score, and how the interaction of the two factors affected the variation in the creative performance. Comparisons of the scores among the four experimental treatments were done using two-way ANOVA with interactions. The fixed-effects model was used (Berenson et al., 1983, p. 153).

The hypotheses were tested using data obtained with two different methods of creativity assessment: an overall assessment and an itemized assessment.

In the process of overall creativity assessment of the group proposals, three creativity scores were derived, from the three judges, for each proposal. In order to perform analysis of variance, an individual creativity score had to be assigned to each group's proposal. Therefore, an average creativity rating was calculated, based on the three scores assigned by the judges to each proposal. The averaging of the judges' scores was justifiable, since there was agreement among the judges as to the relative level of creativity present in all the projects. By computing the Kendall's coefficient of concordance on the overall assessment of creativity score, it was possible to reject the null hypothesis that the judges' ratings were unrelated to each other (W=.5759; p= .0001) (Siegel

and Castellan, 1988, pp. 262-272). Therefore, it was concluded that there was good consensus among the judges and that they were essentially applying the same standards in evaluating the proposals' creativity

In the process of itemized creativity assessment, twenty two scores were obtained, from the three judges, for each proposal. Each proposal's scores were summed and averaged over the items and over the judges. Again, the averaging of the judges' scores was justifiable, since there was agreement among the judges as to the relative level of creativity present in all the projects. Kendall's coefficient of concordance on the average itemized assessment of creativity, revealed that the judges were applying approximately the same standards in the detailed creativity evaluation of the proposals (W=.375; p= .0143).

The average creativity scores thus obtained were then used to run ANOVA two different times. Even though the ANOVA procedure is a robust test, it strictly requires testing for homogeneity of variances in the different experimental treatments. To test for the equality of variances Hartley's F-test (Berenson et al., 1983, pp. 66-67) was used. The F_{max} statistic calculated with the data obtained in the overall assessment yielded a value of 3.18097, which did not allow us to reject the null hypothesis that the variances were equal (at alpha of .05). Therefore, it was concluded that the assumption held. The F_{max}

statistic calculated with the data obtained in the itemized assessment yielded a value of 5.56453, which again did not allow us to reject the null hypothesis that the variances were equal (at alpha of .05).

8.3 Potential Problems

There are many factors which could confound the results of an experiment, such as e.g., facilitator effects and various group sizes. Facilitator effects can be present if more than one facilitator ran the experimental sessions. In this study, one facilitator was used and therefore, there should be no facilitator effects. This research used groups of size four or five. Therefore, the group size variable was used as a covariate in the analysis of variance, to make sure that there were no differences in creativity scores based on the group size. No such differences were detected, as shown in the analysis presented in the subsequent sections.

8.4 Power of the Test

Initially, sample size was estimated with the best estimates available, to require four replications of the experiment, a total of 16 groups of five subjects, i.e., eighty subjects. This guaranteed a test power (see Appendix G for calculations) to be over .9, based on an alpha level of .05. Baroudi and Orlikowski (1989) state that for Management Information Systems research a statistical power of .8 is satisfactory.

After the results of the study were obtained, including the means and the standard deviations of creativity scores, the actual power of the test was recalculated. The results are presented in Figure 26.

D = difference in any 2 means to be detected (σ = .220396)	$\Phi = \sqrt{\Phi^2}$	Type II error β* (α=.05)	Power of the test 1-β
2	4.26	<.01	>.99
1	2.13	.2	.8

* from the Operating Characteristics Curves for the Fixed Effects Model Analysis of Variance (Source: Montgomery, 1984)

Figure 26. Power of the Test Calculations

There is over 99% probability that the alternative hypotheses, H_1, from section 9.1, would be proven when H_1 were indeed true, if detecting a difference of 2 between any two subgroup mean creativity scores. There is 80% probability that the hypotheses H_1 would be proven, when detecting a difference of 1 between any two subgroup mean creativity scores. Therefore, there is very little probability that the results obtained are due to chance and hypotheses H_{1B} and H_{1C} were not proven accidentally.

8.5 Statistical Test Results

The results of analysis are presented in Figures 27A and 27B. The means and standard deviations in all the experimental subgroups, are presented in Figures 28A and 28B.

Overall, with either method, only hypothesis H_{1A} was proven. The experimenter was able to detect the technology effect quite clearly. Neither the incubation effect nor the interaction effect was detected.

Source of Variation	Sum of Squares	d.f.	Mean Square	F-ratio	Signif. Level
Covariate: GroupSize	.0127	1	.0127	.099	.7625
Main Effects:	1.581	2	.7906	6.152	.0161
Incubation	.0776	1	.0776	.604	.4616
Technology	1.4574	1	1.4574	11.34	.0063
2-Factor Interactions	.2982	1	.2982	2.321	.1559
Residual	1.4137	11	.1285		
Total (corr.)	3.30594	15			

Figure 27A. Analysis of Variance of the Average Overall Creativity Scores

Source of Variation	Sum of Squares	d.f.	Mean Square	F-ratio	Signif. Level
Covariate: GroupSize	.0006	1	.0006	.001	.9720
Main Effects:	1.805	2	.9023	2.142	.1638
Incubation	.0117	1	.0117	.028	.8724
Technology	1.7690	1	1.7690	4.199	.0651
2-Factor Interactions	.4530	1	.4530	1.075	.3220
Residual	4.6338	11	.4213		
Total (corr.)	6.89198	15			

Figure 27B. Analysis of Variance of the Average Creativity Scores Using 22 Items

Subgroup:	Mean	St. Dev.
No Incubation	4.21	.208
Incubation	4.38	.117
No Technology	4	.141
Technology	4.58	.122
4=No Incubation & No Technology	3.83	.215
1=No Incubation & Technology	4.58	.25
2=Incubation & No Technology	4.17	.167
3=Incubation & Technology	4.58	.084

Figure 28A. Means and Standard Deviations of the Average Overall Creative Scores in the Experimental Subgroups

Subgroup:	Mean	St. Dev.
No Incubation	4.04	.219
Incubation	4.13	.273
No Technology	3.79	.253
Technology	4.39	.181
4=No Incubation & No Technology	3.65	.209
1=No Incubation & Technology	4.44	.278
2=Incubation & No Technology	9.92	.492
3=Incubation & Technology	4.35	.273

Figure 28B. Means and Standard Deviations of the Average Creative Scores in the Experimental Subgroups Using 22 Items

While there were no significant differences detected in the mean performances for the incubation and the interaction effect, it is interesting to observe that collected data was in the hypothesized direction, using either assessment method. The average creativity score of the GSS groups was higher than the average creativity score of the non-GSS groups. The average creativity score in the incubation groups was higher than in the non-incubation groups. The average creativity scores in groups provided with GSS, regardless of the whether incubation stage was present or not, did not differ significantly in the creativity of the generated ideas. The average creativity score in groups without GSS and provided with incubation was higher than the mean creativity score of no-GSS groups without incubation.

Overall, the GSS groups (1 and 3) performed the best, with the non-GSS incubation groups (2) following second and the non-GSS, non-incubation groups (4) last. Figure 29 illustrates these relations.

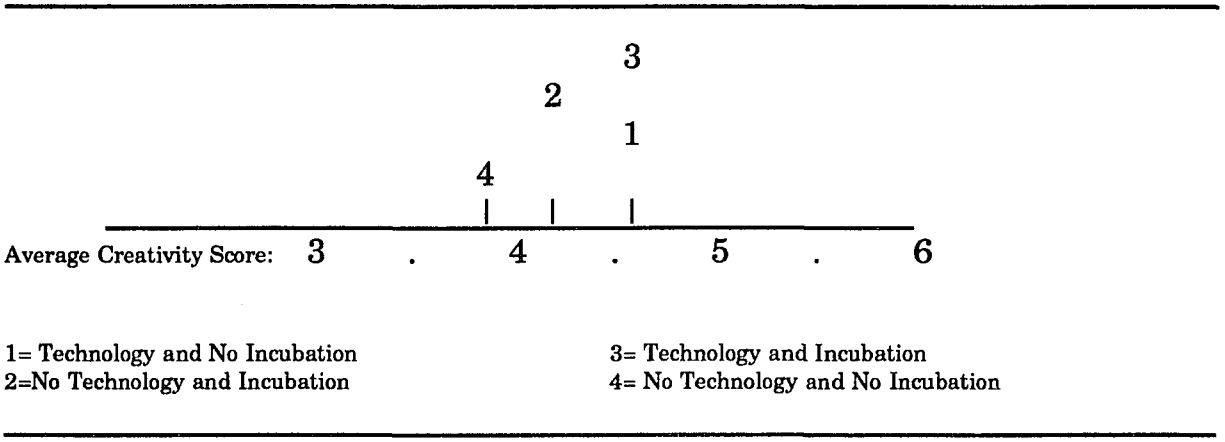


Figure 29. Sample Means for the Four Experimental Treatments (Using the Overall Scores)

8.6 More on Creativity Assessment

In this study, two methods were used to assess the dependent variable, i.e., the creativity of generated proposals. The overall creativity score of a proposal - item SCU in the creativity questionnaire (see Appendix F2) and the average score from the remaining twenty-two-items on the creativity questionnaire.

To check if the judges were using the creativity standards captured in the newly developed creativity questionnaire, the average itemized assessment calculated for each proposal was correlated with the average overall creativity

score. The total correlation, as summarized in Figure 30, was high for two of the judges, with a standardized item alpha coefficients of over .9, while for one of the judges the standardized item alpha coefficient was over .5242. The results obtained indicate that the questionnaire was able to capture in this study the different dimensions present in the creativity evaluation of IS proposals at the initial investigation stage.

JUDGE	STANDARDIZED ITEM α
1	.9168
2	.9390
3	.5242

Figure 30. The Correlation Between Total Score and Overall Creativity Assessment, per Judge

Additionally, exploratory analysis was performed to shed light on how the GSS helped the group creative process, and the creative dimension of the IS project proposals that were improved through the GSS use. The creativity dimensions, as defined by Besemer and O'Quinn (1986), novelty, resolution or elaboration and synthesis, were defined as dependent variables and three ANOVA's were run. The technology effect was revealed in the novelty dimension ($p=.0167$) and elaboration and synthesis ($p=.0583$). GSS did not have an effect on resolution ($p>.1$).

The novelty sample mean of the GSS group was 3.7 with a standard deviation of .32, while the non-GSS group had a sample mean of 2.7 with a standard deviation of .27. The elaboration and synthesis sample mean in the GSS group was 4.69 with a standard deviation of .2, while the non-GSS group had a sample mean of 3.9 with a standard deviation of .3.

These results would indicate that the GSS groups were able to generate and select more creative ideas and to develop them better, than the non-GSS group, through the use of the software tools utilized in the study.

Chapter 9

Subjects' Post-session Feedback

The post-session questionnaire provided the experimenter with the further information as to the overall subject perception of the experiment, their experience with the group process and with the GSS. It also enabled the experimenter to determine if there were any differences in the experiences of the subjects or in their perceptions among the different experimental subgroups. Such differences could provide insight into the results obtained in the previous section. Comparisons of the different experimental subgroups were performed along each one of the independent variables: technology support and incubation. Analysis of variance methods and, in some instances, t-tests were used to detect the difference in average responses among the subgroups.

Overall, the post-session survey revealed that all the instructions were clear, and the subjects' motivational level was high. The subjects perceived their creative effort as very useful and they were satisfied with the generated results. Their appraisal of used technology revealed that the group support system was very useful for the completion of the task and in no way did it impede the process.

The comparison of perception of the different experimental subgroups revealed that there were some differences among the technology and non-technology supported session. The GSS groups assessed their comfort and involvement level in the group process at a lower level than the non-GSS groups. The technology groups also perceived differently some of the group dynamics. They did not perceive that all the group members worked as closely together as in the non-technology groups but they found the idea generation technique easier to use then the non-technology groups, which would indicate that brainwriting is easier than brainstorming for college students. The GSS group members also expressed higher perception of equality of participation, which confirms findings that the GSS makes the meeting process more democratic. There were no interaction effects detected ($p > .1$).

The post session questionnaire used a seven point preference scale, anchored at 1="Strongly Disagree," 4="Undecided/Neutral," and 7="Strongly Agree." Detailed analysis of the post-session survey data follows.

9.1 Clarity of Instructions

The clarity of instructions was verified on the post-session questionnaire, by confirming that the task was clear and the instructions, in general, were clear (questions 12 and 14). The subjects' assessment revealed that the descriptions provided were adequate. The overall summary statistics of the subjects'

assessments are presented in Figure 31. Figure 32 verifies that there were no differences among the subgroups in the understanding of the task or in the understanding of the techniques used.

Question ▾ (n=75)	Mean	Standard Deviation
Q12 = The task description was clear and easy to understand:	6.07	1.22
Q14= All the instructions were clear:	6.29	0.85

Figure 31. Subjects' Assessment of the Clarity of Instructions

Quest'n:	No GSS (n=39)		GSS (n=36)		F-value	No Incubation (n=37)		Incubation (n=38)		F-value
	Mean	St. Dev.	Mean	St. Dev.	1 d.f.	Mean	St. Dev.	Mean	St. Dev.	1 d.f.
Q12	6.1	1.4	6.1	1.1	.3	6.0	1.4	6.2	1.1	.33
Q14	6.2	1.0	6.4	0.7	.82	6.2	1.0	6.3	0.8	.21

Figure 32. Comparison Among the Experimental Subgroups of the Subjects' Assessment of the Clarity of Instructions

9.2 Motivation Level

Motivation level as well as several related factors were assessed in the post-session questionnaire. Figure 33 presents subjects' assessment of the motivation level present during the experimental sessions. Question 9 directly addressed the issue of motivation, while questions 8, 10, 15 and 16 dealt with the issues of having fun, enjoying the task, being involved in it and having a perception of task difficulty. These are related issues that often affect the motivation level of the subjects. The results indicate that the motivation level present during the experiment was rather high. On a scale of 1 to 7, students rated their average motivation level to be 5.84 with a standard deviation of 1.49.

Question ▿ (n=75)	Mean	Standard Deviation
Q8 = I enjoyed completing the task:	5.99	1.41
Q9 = I was motivated to complete the task:	5.84	1.49
Q10 = I got totally involved in the group effort to complete the task:	5.91	1.36
Q15= It was fun to participate in the session:	6.25	1.15
Q16= It was easy to generate ideas for the task presented:	5.8	1.08

Figure 33. Subjects' Assessment of the Motivation Level Present

Figure 34 compares the different experimental subgroups and their average motivational levels present during the experimental session.

Quest'n:	No GSS (n=39)		GSS (n=36)		F-value	No Incubation (n=37)		Incubation (n=38)		F-value
	Mean	St. Dev.	Mean	St. Dev.	1 d.f.	Mean	St. Dev.	Mean	St. Dev.	1 d.f.
Q8	6.1	1.5	5.9	1.3	1.12	5.8	1.5	6.2	1.3	.79
Q9	6.0	1.5	5.7	1.4	1.15	5.8	1.5	5.9	1.5	.00
Q10	6.1	1.4	5.7	1.3	4.3[1]	5.8	1.4	6.0	1.4	.04
Q15	6.3	1.2	6.2	1.0	.18	6.2	1.1	6.3	1.2	.01
Q16	6.0	0.9	5.6	1.3	2.62	6.0	0.9	5.7	1.2	1.18

[1] significant at $p < .05$

Figure 34. Comparison Among the Experimental Subgroups of the Subjects' Assessment of the Motivation Level Present

The results of statistical analysis indicate that there were no statistically significant differences among them, except for the level of individual involvement in the group effort present in the technology treatments. The GSS group had a perception of lower average level of individual involvement in the group effort. This is understandable, since the individuals interacted with each other indirectly, i.e., through the system, in most stages of the process.

This lower perception of involvement in group effort, however, has not impeded the creative process of the technology groups. On the contrary, they still outperformed the non-technology groups in terms of creativity of the task outcome.

9.3 Group Dynamics

The group process was assessed by asking the subjects questions dealing with their level of participation and their satisfaction with participation (questions 3 and 4). Domination of the process was assessed using questions 5 and 6, while collaboration of individuals was evaluated using question 11. Subjects were also asked to comment on the equality of participation (question 17), and on the ease of use of the group idea generation technique (question 13).

Figure 35 presents the summary statistics for all the subjects, while Figure 36 compares the different experimental subgroups.

As expected, statistical analysis revealed differences in group dynamics along the technology variable. The GSS and the non-GSS subjects perceived differently the level of collaboration present during the experimental session among the group members ($p < .01$). The non-GSS groups had a perception that all the members of the group worked together closer. They were also more comfortable contributing ideas than the GSS group members ($p < .1$). There were also differences among the subjects' perception of equality of

participation and in the ease of use of the idea generation technique. The GSS groups found the brainwriting technique easier to use than the non-GSS groups utilizing a brainstorming technique ($p < .02$). They also felt that their idea presentation process was more democratic than the non-GSS group members ($p<.1$). There were no statistically significant differences found between the subgroups along the incubation variable.

Question ▾ (n=75)	Mean	Standard Deviation
Q3=I felt comfortable contributing ideas:	5.87	1.24
Q4 = I was able to contribute all my ideas:	5.6	1.27
Q5 = I felt pressed to conform to others in my group:	2.37	1.46
Q6 = The group process was dominated by one or more individuals:	3.13	1.92
Q11 = All the group members worked closely together:	5.25	1.44
Q13 = The idea generation technique was easy to use:	6.21	1.08
Q17 = Everyone in the group had equal opportunity to present ideas:	6.52	0.86

Figure 35. Subjects' Feedback on the Group Dynamics

Quest'n:	No GSS (n=39)		GSS (n=36)		F-value	No Incubation (n=37)		Incubation (n=38)		F-value
	Mean	St. Dev.	Mean	St. Dev.	1 d.f.	Mean	St. Dev.	Mean	St. Dev.	1 d.f.
Q3	6.1	0.9	5.6	1.5	3.01[1]	5.8	1.2	5.9	1.3	.07
Q4	5.8	1.1	5.4	1.4	2.67	5.4	1.4	5.8	1.1	2.43
Q5	2.5	1.6	2.3	1.3	.27	2.5	1.6	2.3	1.4	.23
Q6	3.0	1.7	3.1	2.1	.55	3.1	2.0	3.2	1.8	.04
Q11	5.7	1.5	4.8	1.4	10.4[2]	5.2	1.5	5.3	1.5	.04
Q13	5.9	1.4	6.5	0.6	6.23[3]	6.1	1.3	6.3	0.9	.45
Q17	6.3	1.1	6.7	0.5	3.66[4]	6.5	1.0	6.6	0.7	.27

[1] significant at p<.10
[2] significant at p<.01
[3] significant at p<.02
[4] significant at p<.10

Figure 36. Comparison Among the Experimental Subgroups of the Subjects' Feedback on the Group Dynamics

9.4 Level of Satisfaction

The subjects' level of satisfaction with the group process was assessed in question 7 and their level of satisfaction with the outcomes of the process was evaluated in question 19. The summary statistics are presented in Figure 37. The statistics indicate an overall high level of satisfaction. Figure 38 compares

the subgroups along the two independent variables as to their level of satisfaction. There were no differences found.

Question ▾ (n=75)	Mean	Standard Deviation
Q7 = I was satisfied with the idea generation process:	5.84	1.39
Q19= I am satisfied with the outcome of the group process:	6.08	1.29

Figure 37. Reported Level of Satisfaction Present

Quest'n:	No GSS (n=39)		GSS (n=36)		F-value	No Incubation (n=37)		Incubation (n=38)		F-value
	Mean	St. Dev.	Mean	St. Dev.	1 d.f.	Mean	St. Dev.	Mean	St. Dev.	1 d.f.
Q7	6.0	1.4	5.7	1.4	1.78	6.0	1.4	5.7	1.4	1.19
Q19	6.1	1.3	6.0	1.3	.10	6.2	1.1	6.0	1.4	.29

Figure 38. Comparison Among the Experimental Subgroups of the Reported Level of Satisfaction Present

9.5 Outcome Usefulness

It is interesting to note that the subjects' perceived usefulness of their group effort is very high (see Figure 39). On a scale of 1-7 the subjects' mean

response was 6.49, indicating a sense of accomplishment present in the subjects. That impression was communicated to the experimenter repeatedly after the experimental sessions. There were no differences revealed between the different experimental subgroups in the perception of outcome usefulness (see Figure 40).

Question ▾ (n=75)	Mean	Standard Deviation
Q18= The idea generated by my group can be useful:	6.49	0.90

Figure 39. Subjects' Perceived Usefulness of the Task Outcome

Quest'n:	No GSS (n=39)		GSS (n=36)		F-value	No Incubation (n=37)		Incubation (n=38)		F-value
	Mean	St. Dev.	Mean	St. Dev.	1 d.f.	Mean	St. Dev.	Mean	St. Dev.	1 d.f.
Q18	6.5	0.9	6.5	0.9	.01	6.5	0.8	6.5	1.0	.04

Figure 40. Comparison Among the Experimental Subgroups of the Subjects' Perceived Usefulness of Task Outcome

9.6 Technology Effects

The effects of the utilized GSS technology and the perceived importance of the GSS for the task completion were assessed utilizing a separate questionnaire,

that was distributed only to the members of the GSS supported sessions. The questions in the questionnaire are presented in Figure 41. Again, the subjects were working with a seven- point preference scale, where 1 was "Strongly Disagree," 4 was "Undecided/Neutral," and 7 was "Strongly Agree."

The summary statistics, along with the comparison of the responses in the two GSS supported subgroups - incubation and non-incubation - using t-test, are presented in Figure 42. In general, the subjects felt that the software system was easy to use (94% strongly disagreed or disagree with the statement that the software was difficult to use), and neither their typing skills, nor lack of verbal communication impeded their ability to participate. The overall perception was that the GSS software was helpful in aiding the groups to complete the task presented. Seventy percent of the subjects strongly agreed with the statement that "It was helpful to use the software for this task."

Q21= The amount of information I could enter at any one time limited my expression of ideas:
Q22=My typing skills slowed down my participation:
Q23=The lack of verbal communication restrained my ability to participate:
Q24=It was difficult to read the ideas of others as they were displayed on the screen:
Q25=It was difficult to use the software:
Q26=It was helpful to use the group software for this task:

Figure 41. Technology-Related Questions in the Post-Session Questionnaire

Question▾	all GSS subjects n=36		GSS/No Incubation n=17		GSS/ Incubation n=19		p
	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.	
Q21	3.8	1.6	3.5	1.5	4	1.7	>.1
Q22	2.4	1.5	2.1	1.1	2.7	1.8	>.1
Q23	2.2	1.3	2.2	1.3	2.3	1.5	>.1
Q24	2.3	1.3	1.9	1.1	2.6	1.5	>.1
Q25	1.5	1.2	1.2	0.4	1.8	1.6	>.1
Q26	6.5	0.9	6.5	0.8	6.5	0.9	>.1

Figure 42. Comparison Among the Experimental Subgroups and Overall Assessments of the Subjects' Experiences with the GSS Technology

PART IV. CONCLUSIONS

Chapter 10

Discussion of Results

10.1 Summary of Results

This study set out to answer the following questions:

1) Are the IS project proposals generated in teams with the aid of a GSS more creative than IS project proposals generated without GSS help?
2) Can GSS shorten the group creative process by eliminating the need for incubation to take place and thus save time?

Although the questions and the associated hypotheses were well grounded in theory, this study was able to answer positively only the first question posed and there was not enough evidence found to answer positively the second question. Out of the three hypotheses that were formulated (see section 9.1), only one was proven. Most of the results, however, were in the hypothesized direction.

This study was unable to detect the incubation effect. There may be many explanations generated for the lack of statistically significant incubation effect. It is possible that incubation did not occur. It is also possible that incubation

did occur, however, its effects were covered up by the subsequent group process that took place.

It sould be noted that the incubation effect was not observed in spite of the fact that the creativity literature was carefully followed to increase the chances for incubation to occur, e.g.,

- following Kirkwood (1984), ten minutes were assigned to the incubation period, and during that period, the subjects were involved in a topic radically different from the main problem.
- following Torrance (1979), intellectual and emotional functions were brought into play during the experiment. There was also a realistic encounter with the problem and intense involvement on the part of the subjects.
- following Amabile (1983, pp. 180-182), the creative environment incorporated several creativity enhancing factors, such as play and fantasy during the incubation period, and fantasy (wishful thinking technique) during the task itself.
- following Olton (1979), the assigned task was not trivial, but realistic, and the subjects were motivated to complete it.

The results obtained in this research caused the experimenter to carefully examine the questions that were originally posed. In view of the reviewed

literature, the research frameworks and the models utilized - The Electronic Meeting System (see section 4.1), Olton's Incubation Research Paradigm (see section 4.2), and Wallas' creative process model (see section 2.1.2) - the questions appeared justifiable. Therefore, the experimenter compared the research models to the experimental process that took place in the laboratory conditions.

10.2 Conjectures

Closer examination of the gathered data clearly revealed that the group creative process that took place in the experimental session differed significantly from the creative process model proposed in Wallas (1926), and corroborated by numerous others in the social psychology literature (see section 2.1.2).

Wallas' model identifies four different stages in the creative process: preparation, incubation, illumination, and verification. Wallas' model works at the level of an individual. When a group, however, works on a creative task requiring an artifact, the individuals operate at two different levels: at the individual level and at a group level. The creative process at an individual level interacts with the group process that takes place.

The group creative process that took place during the experiment, at the level

of an individual might have followed Wallas' model. At the level of the group the creative process followed a general problem-solving model, presented in Figure 43.

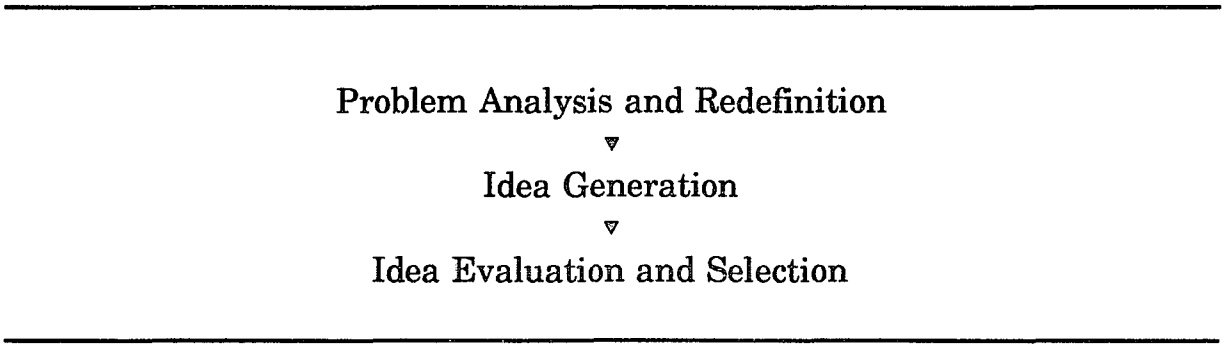


Figure 43. General Problem-Solving Model
(Source: Adapted from Van Gundy, 1988, p.6)

The research data gathered led the experimenter to propose an alternative model of a group creative process. The model is presented in Figure 44. It shows the interactions present in the group creative process between the Wallas' model of the creative process and the general problem solving model. Several new stages are added. The explanation of the model follows. Whenever possible, the previous research relevant to each stage is pointed out within the context of this new model.

It is important to note that the model could apply only to groups working on a creativity task requiring the group to produce an artifact. Although the model does not require a GSS to be relevant, it is particularly applicable to a GSS-aided group creative process.

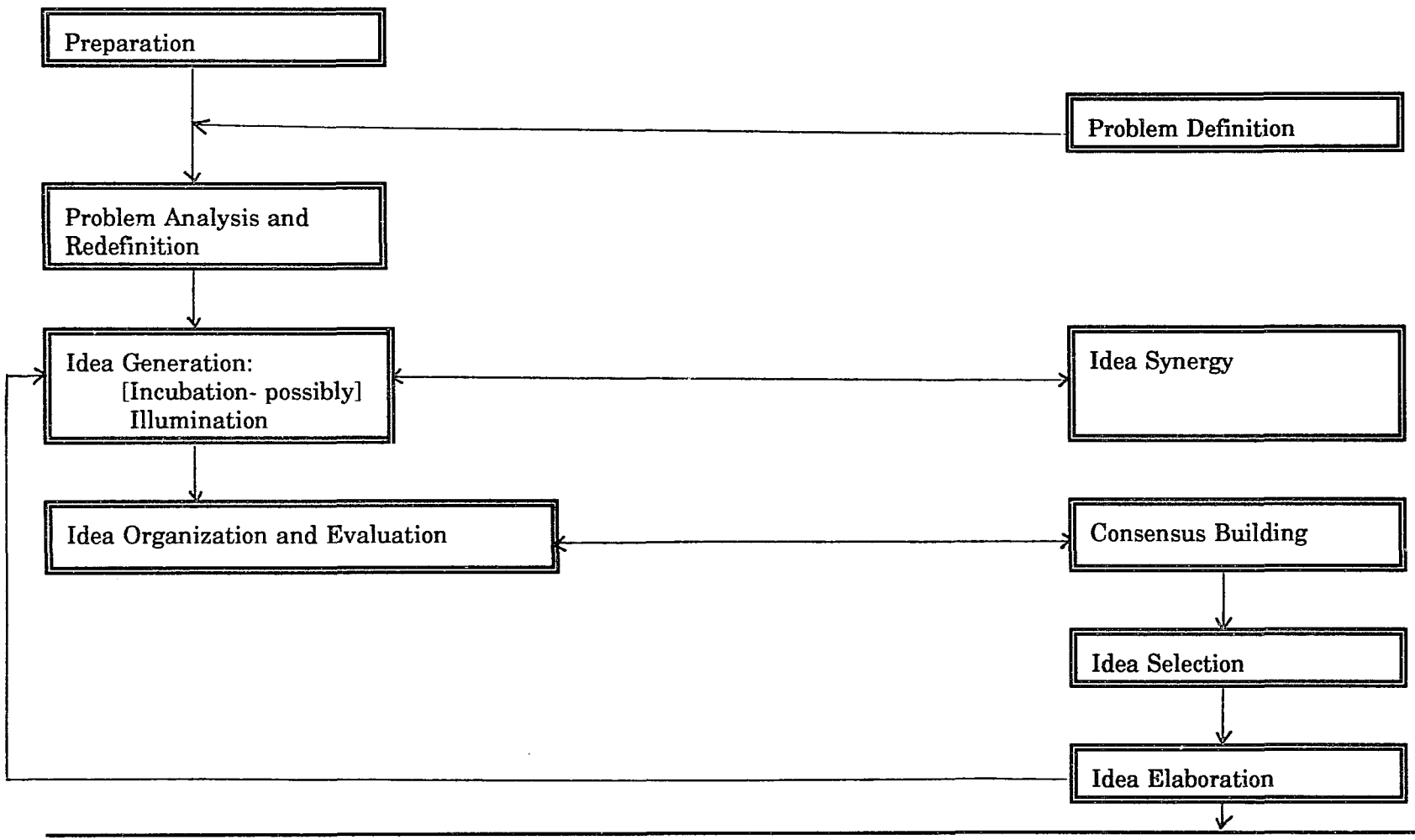


Figure 43. The Model of a Group Creative Process

10.3 The Model of a Group Creative Process

The task is presented to a group of individuals with different background characteristics and different preparation for the assigned task. Each individual's creative performance is a function of domain-relevant skills, creativity-relevant skills and task motivation, as Amabile (1983, p. 68) proposes, or as Woodman and Schoenfeld (1989, 1990) propose, it is a function of past history, biographical variables, personality factors, cognitive factors, intrinsic motivation, relevant knowledge, contextual influences and social rewards.

The individuals form a group. As suggested by the general problem-solving model (see e.g., Van Gundy, 1988, p. 6), each individual processes the information regarding the assigned task somewhat differently and redefines the task's objectives within the context of its own background.

Then, the idea generation process starts, in which the individuals in the group voice their own ideas and process the ideas of others. During the idea generation phase there is a possibility that at the individual level incubation will occur, which is then followed by illumination, as Wallas' model suggests. Illumination, or the "aha" phenomenon, occurs often even without the incubation, as the individuals involved are stimulated by others. As ideas of others are processed, new ideas are triggered and idea synergy occurs. The

degree of idea synergy, as suggested by Woodman et al. (1993), is a function not only of the individual characteristics, but also of the group and environmental characteristics, such as group size, norms, diversity, history, technology, etc.

Once the idea generation phase is finished, the individuals in the group organize the ideas and begin to evaluate them on their own. Their individual opinions are voiced to the group. This stage corresponds to the Wallas' verification stage.

The rest of the process follows mostly the general problem-solving model. The group begins to collectively evaluate the ideas, by eliminating the ones that are agreed to be useless, and by focusing on the ones that are popularly accepted. In the process of idea selection, the group builds a consensus as to what idea(s) should be implemented. As a result of previously voiced opinions, individuals may change their opinions. It is possible, for example, for an individual with a strong personality to gain consensus for an idea that was initially unpopular.

Once the group reaches a consensus, the idea(s) are selected. At this point, the group engages in the implementation of the idea(s) and collaboratively elaborates on the idea(s). More idea generation may be required and the group may have to loop through the process.

10.4 Necessary Events in the Group Creative Process

Several events must occur in the group creative process, in order to allow the generation of a creative solution. First, an idea must be generated by an individual and effectively communicated to the other group members. Then, the idea must be identified by one or more individuals to be creative. Then, the group must reach a consensus that the idea is indeed the best creative solution and should be implemented. Figure 45 summarizes the necessary events that must occur within a group to generate a creative artifact.

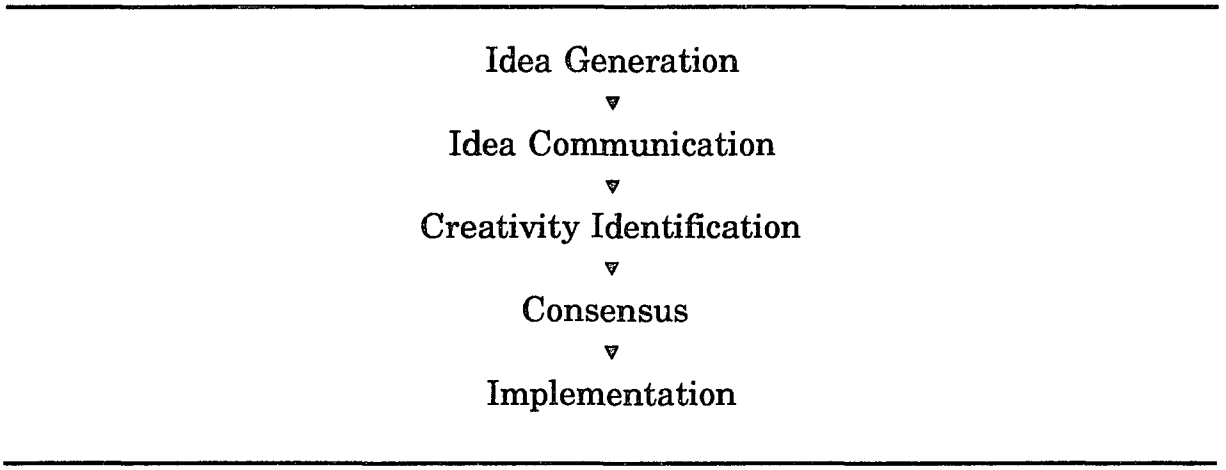


Figure 45. Summary of the Necessary Events for a Group Generation of a Creative Artifact

It may happen that a good idea is generated during a session, but it is not effectively communicated, or it is not identified by others as creative, or the consensus cannot be built to select the idea for implementation. Often, in the evaluation phase, an idea gets lost because too much and/or disorganized information is presented.

In the course of this study, an interesting observation was made, which is in line with the proposed model. It became clear that although the subjects were generating a lot of innovative system ideas during the experimental sessions, they hardly ever incorporated those ideas into their final project proposals. Most of the time they were selecting conservative ideas that solved a problem with an impact on their daily lives. Clearly, either no one was able to identify the magnitude of creativity present in those ideas, or lack of group consensus interfered with the process of the most creative idea selection.

Our findings indicate that there might be limits to the level of support that a GSS can offer for a group process requiring a creative artifact. GSS can stimulate individuals to produce creative ideas and communicate them effectively. It can provide the group with the tools to evaluate and select ideas, however, it can not make the individuals in the group think and identify creative solutions.

As it has recently been voiced by Noel and Herschel (1992), it is possible that the reduced pressures to conform and reduced evaluation apprehension contribute to more effective idea generation, but the benefits of GSS may not necessarily translate into better use of information gathered, or better decisions.

10.5 GSS Support for the Group Creative Process

This section presents conjectures, based on experience with experimental subjects, regarding the various benefits offered by the GSS technology. The benefits that a GSS offers could enhance the group creative process. The benefits of the GSS technology in a meeting environment were previously presented in Figure 9. The relevant benefits are reiterated in Figure 46 and each one of them is explained how it may enhance the group creative process presented in the previous section.

Event in the Group Creative Process:	**GSS Support for the Event:**
Idea Generation	Anonymity; Simultaneous Input of Ideas
Idea Communication	Electronic Recording and Display of Information
Creativity Identification	Anonymity
Consensus	Anonymity
Implementation	Electronic Recording of Information; Simultaneous Input of Ideas; Process Structuring; Extended Information Processing Capacity

Figure 46. GSS Capabilities Supporting the Group Creative Process

Anonymity can possibly contribute to the generation of an idea. Ideas may often not be voiced, because the contributor feels that they are not good enough to be spoken, but they may be good enough to be contributed anonymously.

Anonymity may enable evaluation of idea based on merit rather than based on the traits of the individual who suggested it. With anonymity there is no reason to accept an idea simply because there is someone aggressively rooting for its acceptance. This may contribute to a better environment for consensus building. As King and Anderson (1990) postulate, group creativity is the highest when the group leadership is democratic and collaborative. Therefore, the anonymity feature of GSS may indirectly lead to higher group creativity.

Simultaneous input of ideas overcomes production blocking, thus more ideas may be generated in a given period of time than without the GSS. The access to all the ideas of others may stimulate individuals and a series of illuminations may occur. More ideas and more information mean that the idea generation phase and the implementation phase can be richer.

Electronic recording and display of information may contribute to better idea communication and idea implementation. Individuals may modify their input. More information is retained from the session, thus reducing information loss. The ideas entered by many individuals are integrated into an appropriate document.

Process structuring may enhance the idea implementation, especially if there are many different ideas that need to be addressed in the process of idea

elaboration and preparation of the creative artifact. Hackman and Morris (1975) claim that group creative performance may be lower when group coordination losses occur. The process structuring feature inherent in GSS overcomes the problem of coordination losses almost thoroughly, by providing tools to integrate creative efforts of group members.

Extended Information Processing Capacity, which allows for the use of other computer tools and access to e.g., collaborative writing tools, could improve the idea implementation stage as well.

Therefore, it is believed that GSS supports all stages of the group creative process: idea generation, organization, evaluation and selection and it can substantially improve the group creative performance.

Chapter 11

Limitations

Two factors need to be considered when evaluating the results of this research. To study the relationships in question, this scientific inquiry utilized an experiment and subjective assessments of expert judges.

11.1 Experimental Setting Concerns

Experiments are widely used in research, since they provide means for studying relationships under controlled conditions and can be used to build theory. As is the case with most laboratory experiments, however, this study suffers from the same limitations often associated with the use of experimental groups (e.g., DeSanctis, 1989) and artificial settings (e.g., Benbasat, 1989): non-generalizability of results or limited external validity.

External validity is concerned with the degree to which the causal relationship observed can be generalized to other populations, settings, times, etc (Benbasat, 1989, p.34). In this study the results may only be generalized to the domain of the task and the domain of the subjects. Therefore, any conclusions that may be drawn from this research can only be generalized to group creativity tasks in the IS domain, requiring an artifact at the end of the process, and performed by college students.

While the generated system proposals were not professional and the individuals who created them were not professionals, the students did posses the minimum skill level and the domain knowledge to generate what can be considered a valid IS idea/IS project proposal, at least from the end-user point of view. By utilizing a task that was relevant to the subjects, and by making the subjects believe in the experimental task and approach it seriously, the study achieved a greater degree of face validity and external validity, than is usually present in experimental investigations.

Unlike many experimental studies, this research incorporated a high degree of realism, i.e., a high degree of correspondence between natural events and the events in the labs. The laboratory settings utilized in this study were selected in such a way as to maximize the impression of a "real world" setting that could be expected in a similar situation. At the same time, strict procedures were utilized to ensure that all the groups in the study received the same treatment. Using a detailed script, all the instructions and introductions were presented verbally by the experimenter, rather than handed out on a piece of paper, in order to mimic a real world meeting. Subjects worked with the knowledge that the results generated in the sessions would be considered for implementation by the appropriate bodies. Their self-reported level of involvement and motivation was high.

The rich "worldly reality" was introduced, to some degree, at the expense of tightness of control. While the idea generation phase was strictly controlled, the decision making phase and elaboration phase varied in time. (It should be noted, however, that exploratory correlation analysis, between the decision making time, the proposal development time and the average creativity of the proposals, did not reveal existence of a relationship between creativity and the time variables.)

Also, at this point in the study, we are unable to determine whether the higher creativity of proposals generated with the aid of GSS was due to the fact that more ideas, and/or higher creativity ideas were generated in the GSS sessions, or whether the GSS allowed the users to have superior decision making tools, or whether the GSS tools allowed the users to collaborate closer on the final document preparation and elaboration. These issues will have to be examined in the future.

Any results obtained in this study (or lack of them), are also limited by the experimental setting in which incubation was simulated. While no study can actually show incubation or guarantee its occurrence, the positive effects of an incubation period have often been demonstrated. In this study, no incubation effects were detected, in spite of an extensive effort to induce incubation. The lack of incubation effect can only be generalized to comparable situations.

11.2 Creativity Assessment Concerns

The other limiting factors that should be considered deal with the evaluation of the experimental task outcomes. The sample of expert judges selected was fairly small and represented a homogeneous type of experts - the academicians. Therefore the creativity assessment in this study is, possibly, limited by the sample of judges utilized. In the future, the evaluations should be done with a larger number of experts of diverse background - public and private sector practitioners so the total set of responses can be representative of the 'population' of the expert judges in IS.

It should be noted that the reliability and the validity of any creativity assessment is also limited by time and place variables. Criteria for creativity in any domain change over time and differ across cultures. Therefore, it is possible that factors which determine creativity of an information system today will change in the future.

Also, it may be difficult to apply Amabile's (1983) consensual methodology to product ideas that are at the frontiers of the IS domain. The revolutionary nature of the ideas can make it difficult for judges, even when they are experts in the domain, to agree on the level of creativity that is evident. One possible solution to this problem may involve the use of a panel of expert judges, rather than a group of expert judges performing the evaluations independently.

Chapter 12

Future Research

The findings of this study raise a number of related issues for further research. The future research should be pursued in several direction. This could include further exploration of the issues relevant to the impact of GSS on the group creative process, and the measurement of creativity in IS project proposals.

12.1 The Impact of GSS on the Group Creative Process

To explain the results obtained in this study, future research should include analysis of the relationship between creativity of the final proposal, creativity of the pool of ideas generated by each group, the decision-making process and the idea elaboration process. Studies should be undertaken to determine whether the higher creativity of proposals generated with the aid of GSS is due to the fact that more ideas, and/or higher creativity ideas were generated in the GSS sessions, or whether the GSS allowed the users to have superior decision making tools, allowing the identification of the most creative ideas, or whether the GSS tools allowed the users to collaborate closer on the final document preparation and elaboration, thus making the proposals more thorough.

Future research should include the analysis of individual ideas generated during each session. This would enable the study of the idea generation phase of the proposal development process. By compiling a listing of generated ideas, for each group, obtaining creativity scores for each idea separately, and conducting statistical analysis on the number of creative ideas generated, and on the average creativity of ideas generated in a session, insight can be gained into the first stage of the process.

In the future studies, process analysis should be performed to trace the different cognitive activities taking place in the decision-making phase with and without the aid of the GSS. The relationship between creativity of ideas generated and the ideas chosen should be closely examined, so we can gain an understanding of the GSS tools that are particularly helpful in increasing the creativity of the system proposal.

Detailed analysis should also be performed of the document elaboration stage. Use of collaborative writing tools is advocated for future studies to realize the full benefits of existing technology.

The impact of place and time in collaboration should also be examined. It would allow for implementation and examination of a more realistic incubation stage, if several days were allowed to pass by before subjects re-engaged in

further idea generation for the assigned task. However, this would entail sacrificing some of the tightness of control in order to simulate the events that are taking place in the real world.

The investigation of the impact of individual creative differences on the group creative process should be considered. In particular, it might be interesting to explore how innovative style profiles of the members of a group contribute to the overall group creative performance.

The analysis of the results obtained in this study indicated that groups of students from low level, introductory systems analysis and design classes, who have not been fully exposed to the analytical and structured approaches of the IS field, came up with more creative system proposals than students who have completed the systems analysis and design course and who were enrolled in the higher level courses. This finding has some potentially interesting implications. It is possible that individuals not exposed to the structured, analytical methods of systems analysis and design think better conceptually and are more innovative. It is therefore possible that end-users might develop better concepts for new information system. A further study should be undertaken to research the above finding in view of the renewed interest in participatory design in the IS development.

Investigating the creative output of groups using GSS should also be performed over a long period of time. In the future studies, groups should be allowed to use the technology for a period of time and acquaint themselves with the system, before the actual study is undertaken.

12.2 Measurement of Creativity in IS Project Proposals

The future studies should fill an important gap in Information Systems body of knowledge, by advancing the research to develop a creativity metric for information system proposal evaluation. The study should be undertaken to determine the principal factors that contribute to the perception of creativity in new information systems. It is hoped that the results of this study will provide insight into the feasibility of developing an instrument for the creativity evaluation of IS project proposals. Creativity measuring instrument for IS project proposals could be used e.g., for training purposes, to teach IS students and IS professionals how to distinguish between creative and less creative IS ideas, so that they produce more innovative IS products. Knowing what attributes of a product make it creative would allow IS practitioners to develop more durable and responsive IS products (Couger and Dengate, 1992).

The principal attributes, a set of agreed-upon criteria or standards of judgement, that contribute to the perception of creativity in Information Systems products should be determined. A study should be undertaken to

explore how the IS experts decide what dimensions of the IS project proposal contribute to the perception of creativity.

Using the data already collected in this study with the CPSS-based questionnaire, an exploratory study can be performed to determine how each of the creativity dimensions: novelty, resolution, elaboration and synthesis, correlate with the overall creativity score, for each judge, to see whether the same dimension(s) correlate the highest with the creativity perception.

Survey research should be conducted using the creativity assessment questionnaire developed in this study. The creativity evaluation should be solicited from a variety of experts with different IS backgrounds in the public and private sectors. The collected data would allow analysis of how different dimensions contribute to the perception of creativity and whether there is a minimum necessary score that needs to be achieved in some/all dimension(s) in order for an IS product to be creative.

The future research agenda should also include utilization of a panel of judges collaborating on the evaluation, as opposed to a group of judges performing the evaluations independently. The results obtained from the panel should be compared with the results obtained with a survey, to check for consistency of approaches.

Chapter 13

Summary

Creative team project proposal development and team business process reengineering through information technology is becoming prevalent in organizations of the 1990's. As creativity concerns and team work in IS departments and organizations are also becoming increasingly important, this research hopes to contribute timely information.

The undertaken research was interdisciplinary in nature and bridged research from three different fields: social psychology of creativity, small group behavior, and information systems (IS). The study explored creativity in group information system development projects along several avenues.

In particular, this study assessed the impact of group support systems technology and idea incubation on creativity in team information system development projects. A laboratory experiment was used to study the effects. The following research questions were posed:

- Are the information system project proposals generated in teams with the aid of a GSS more creative than IS project proposals generated without GSS help?

- Can GSS shorten the group creative process by eliminating the need for incubation to take place and thus save time?

In order to perform the experiment a new, realistic small group task was developed for the IS domain. The task required preparation of a proposal for a new IS module at a large, urban university. In McGrath's (1984, pp. 60-66) task type classification, the task is composed of two task types: creativity and decision-making.

The experimental task outcomes were evaluated in terms of their creativity by three independent, expert judges. Unlike in the previous studies, creativity was assessed directly. Rather than focusing on quantity of the creative effort, the quality of the creative effort was evaluated. To accomplish this, a creativity assessment questionnaire was developed and used.

This study showed the feasibility of evaluating information system ideas, in terms of their creativity, at an early stage of the System Development Life Cycle. Using Couger's (1992) approach of studying the uses of creativity in other fields and transporting the approaches over to IS, this study utilized creativity assessment methods from the creativity domain. Amabile's (1983) consensual approach was adopted and a creativity questionnaire was developed, based on a validated instrument used to measure creativity of

products, the Creative Product Semantic Scale (Besemer and O'Quinn, 1986).

To test the formulated hypotheses data was obtained using two different evaluation methods: an overall creativity assessment and a detailed creativity assessment. The ANOVA results obtained with either method enabled the experimenter to positively answer the first research question posed, however, there was not enough evidence found to answer positively the second research question. The GSS support showed to significantly improve the creativity of team proposal development.

Further exploratory analysis shed light on how the GSS changed the creative performance of a group. ANOVA results revealed that the GSS groups were able to select more creative ideas and to develop them better, than the non-GSS group, through the use of the software tools utilized in the study.

This laboratory experiment produced results that can be made available to those who would like to bring Group Support System technology into their organizations or who are interested in the enhancement of the group creative process of their work force.

APPENDICES

APPENDIX A

EXPERIMENTER MATERIALS

APPENDIX A1. Procedure Checklist

The form was used by the experimenter, during each experimental session, to assure strict adherence to the experimental sequence and to record time periods necessary to complete each step.

APPENDIX A2. Pre-session Survey Script

The script was used by the experimenter to solicit the subjects for the experiment.

APPENDIX A3. Introduction Script

The script was used by the experimenter, at the beginning of each experimental session, to introduce the agenda for the meeting.

APPENDIX A4. Student Information System Task Description

The SIS task description was presented by the experimenter to every group.

APPENDIX A5. Tea Bag Task Description

The Tea Bag task description was presented by the experimenter at every session that included incubation period.

APPENDIX A6. Technique Instructions

The instructions on how to proceed with the task were presented by the experimenter to each group.

APPENDIX A7. Post-session Survey Script

The post-session script was presented by the experimenter at the conclusion of every experimental session.

APPENDIX A1 **PROCEDURE CHECKLIST**

Group #: _____ DATE: _____ TIME:_____

Experimental Category : 1 2 3 4

STEPS:	COMPLETED:
1) Introduction	_____
2) Consent Form	_____
3) Task Description	_____
4) Technique Instructions	_____
5) Experiment/ task	_____
6) Post Session Survey	_____
7) Debriefing	_____

APPENDIX A2 **PRE-SESSION SURVEY SCRIPT**

Several faculty in our department are conducting a research project in Information Systems Development. We are looking at the effects of new technology, namely Group Support System technology, on team Information System development. At this time, I would like to invite you to participate in the study.

Let me tell you what is involved in this project, as far as you are concerned. During class time, some time during the months of March and April, I will remove a group of five students out of class and ask you to complete a real, information systems task. The task does not require any preparation on your part. I cannot disclose the task to you at this time, but I want you to know that you will not be wasting your time. All the work completed during the sessions will be evaluated by three faculty members from our department, and passed on to the appropriate officials to be considered for implementation. All the work is anonymous. You will be identified only by the last four digits of your social security number. Some of you, randomly selected, will be given an opportunity to work with state of the art technology, VisionQuest system, that supports team work.

Participation in this study is totally voluntary, however, I would like to encourage you to participate, since we are also conducting a contest among the

APPENDIX A2 continued

participating teams. The team that does the best work will receive a cash prize of $250.

Today, I would like you to complete a brief, demographic questionnaire, so I can get an idea about your background and whether you want to participate in the project or not. Please read the instructions carefully and fill out the forms. Please remember to place the last four digits of your social security number in the top right-hand corner of the form.

Are there any questions?

APPENDIX A3

INTRODUCTION SCRIPT

Thank you for participating in this study. Before we begin, I need you to sign a consent form. This is routinely done in all the studies at Baruch College. Please take time to read it before you sign it. If you have any questions, do not hesitate to ask. I will be happy to answer them now or at any time during the session. When you read it and sign it, please return one copy to me and keep one for your records. (AT THIS TIME THE EXPERIMENTER WENT OVER THE MAIN POINTS OF THE CONSENT FORM WITH THE GROUP.)

Next, I will tell you what we are going to do here and how we are going to accomplish it. This session will last approximately an hour and fifteen minutes, depending on how you are going to work together. I want to assure you that you are not going to waste your time here. This is a project where all the generated ideas are going to be given careful consideration.

APPENDIX A4

STUDENT INFORMATION SYSTEM TASK DESCRIPTION

The college would like to provide a flexible, responsive Information System that is cost-effective and improves student satisfaction with offered services. You are going to work on a proposal for a new module of the College Information System. You may want to seek improvements to the current system or you may propose to computerize a totally new task that has not been computerized, as yet. You are working with a goal to improve life at the college in some way, through Information Systems. Using wishful thinking, I want you to prepare a paragraph proposal for either a new subsystem or an improvement to a current system, that would meet the college's goal.

Your document should mention:

1) the objective, or the functions of the proposed system and its anticipated benefits

3) the technology or the hardware and the software used

Do not be inhibited by things as they are. Existing structures and methods should not be accepted as constraints on your recommendation. They are simply a starting point. I want you to think about some of the problems that you have experienced during your tenure at the college and to come up with Information Systems solutions to those problems. We are looking for creative,

APPENDIX A4 continued

innovative solutions. Your proposals will be evaluated for innovation and creativity.

Example:

I have prepared an example of a proposal for you to clarify what I want you to do. You all have the new ID cards, right? The new ID system, that we currently have, generates an ID card with a magnetic strip on the back. It was implemented using a video camera that takes the picture of the student and stores it in a computer database; a scanner is used to scan the signature into the computer database, as well. On a mainframe computer, we have a database with all the student information, e.g., names, social security numbers, date of birth, etc. Using a 486 machine, that is connected to the mainframe computer, the system can process a request for an ID card. A specialty printer prints the ID card, with a special magnetic strip. The system is driven by a special custom-made software that puts together all the information necessary to produce an ID: the signature, the picture, the personal data, and then the ID is sent to the printer.

What are the benefits of the new system? They are not realized, as of yet, however, once the security entrance stalls are installed in all the buildings,

APPENDIX A4 continued

access to all the campus facilities will be limited, thus increasing security on campus. Another benefit of the new ID cards is similar to the benefit of a magnetized credit card or an ATM machine card. Instead of keying in your long account number, you can just have the card scanned and quickly gain access to all your records. In the future, during registration, instead of writing your social security number on paper and then having the terminal operator typing your social security number in, you will just have your card scanned in. Registration will be faster. Similarly, access to other college records will be faster, as well.

This is an example of what I want you to prepare by the end of this session - a proposal for an innovative information system that solves a current problem. This is what I want you to work on.

APPENDIX A5

TEA BAG TASK DESCRIPTION

Most people know what a tea bag looks like. (THE EXPERIMENTER DISPLAYS A TEA BAG ON A STRING.) Many of us handle them every day. The gauze-like paper pouch contains bits of tea leaves. When placed in a teapot, hot water passes through the bag and the tea can brew. The bag permits the tea to diffuse without dispensing the leaves throughout the water. The bag can be retrieved and the strength of the tea maintained.

The tea industry has spare capacity for producing tea bags. More can be produced than is currently needed for the consumption of tea. The current demand underutilizes the resources that are presently dedicated to tea bag production. Instead of cutting back production and the number of jobs, or reallocating these resources, the industry would like to take advantage of this spare capacity to generate additional revenues.

How else might tea bags be used?

Be specific, complete and concise - yet you need to provide enough information so that someone else can fully understand your idea.

To help you get started, here is an idea:
You could put pre-measured amounts of detergent into the bags so that you would not have to measure detergent for each load. Just toss them into the washer with the clothes and you're all ready to go.

APPENDIX A6

TECHNIQUE INSTRUCTIONS - GSS GROUPS

Let me tell you now how I want you to work. You are going to generate a solution to the problem, by working in three stages and by using VisionQuest group support software on the network.

First, generate as many ideas as possible in the time given and do not be afraid to suggest "wild" solutions. Enter every suggestion that comes to mind. Think about a problem that you may have encountered at the college and how you would solve it through information systems. Be creative!

Do not criticize! Withhold all your judgements until everyone is ready to evaluate ideas.

Use ideas of your own, or of others, that were previously suggested to stimulate your thinking, and to improve the solutions. You may combine several ideas.

Continue with the process until you are told to stop. Do not talk!

APPENDIX A6 continued

My role at this stage is to facilitate the process. I will help you with the software, answer any questions that you may have, and in general, help you along.

In the second stage, you will start by evaluating the generated ideas using the software and then you will discuss the general direction for the system that you will propose. You may want to select one of the generated ideas for your system or incorporate several of them into a bigger system.

Once you decide what system you are going to propose, you will use the system to elaborate on your ideas. You will select a name for the system, describe the functions that the system will perform and its benefits. You will also elaborate somewhat on the hardware and software components that you anticipate for the system.

At the end of the session, I will ask you to fill out a brief questionnaire about what happened in the meeting.

Is everything clear? So let's start.

APPENDIX A6 continued

TECHNIQUE INSTRUCTIONS - NON-GSS GROUPS

Let me tell you now how I want you to work. You are going to generate a solution to the problem, by working in three stages.

First, generate as many ideas as possible in the time given and do not be afraid to suggest "wild" solutions. Make sure you tell me every suggestion that comes to mind. Think about a problem that you may have encountered at the college and how you would solve it through information systems. Be creative!

Do not criticize! Withhold all your judgements until everyone is ready to evaluate ideas.

Use ideas of your own and of others, that were previously suggested to stimulate your thinking, and to improve the solution. You may combine several ideas.

Continue with the process until you are told to stop.

APPENDIX A6 continued

My role at this stage is to facilitate the process. I will write your ideas on the flip chart, answer any questions that you may have, and in general, help you along.

In the second stage, you will start by evaluating the generated ideas and discussing the system that you will propose. You may want to select one of the generated ideas for your system or incorporate several of them into a bigger system.

Once you decide what system you are going to propose, you will write a proposal, on the index cards provided to you on the table, similar to the ID system on the board, elaborating on your ideas. You will indicate the name for the system, describe the functions that the system will perform and its benefits. You will also elaborate somewhat on the hardware and software components that you anticipate for the system.

At the end of the session, I will ask you to fill out a brief questionnaire about what happened in the meeting.

Is everything clear? So let's start.

APPENDIX A7 **POST-SESSION SURVEY SCRIPT**

I would like you to complete a survey about this session. Please be sure to put the last four digits of your social security number at the top of the form. Take time to read the instructions and answer the questions as best you can. Remember, there are no right or wrong answers. We are only interested in your personal experiences and opinions.

Thank you again for your participation. Hopefully, it has been both fun and a learning experience. I would ask that you not discuss with others either the procedures or the results of your session. We will be running this project using the same task and similar procedures, over the next several weeks. It is therefore imperative that others do not come prepared by you. If you tell them the task, they will think about the potential solutions and instead of generating new ones, they will be coming with solutions that they already thought about. That is not our objective. So we would greatly appreciate your help in this area. Also a reminder: do not forget that the team that does the best gets the cash prize. I think it is to your advantage not to talk to others about the task or the session.

You will be able to pick up a copy of the tape recorded lecture and a copy of the lecture notes tomorrow, in room 460. Thank you again and good luck!

APPENDIX B

SUBJECT MATERIALS

APPENDIX B1. Preliminary Questionnaire

Prior to the experiment, the questionnaire was handed out to the student subjects and the filled out forms were collected by the experimenter.

APPENDIX B2. Consent Form

At the beginning of each experimental session, the forms were handed out to the students, read aloud, signed be the students and collected by the experimenter.

APPENDIX B3. GSS Meeting Agendas

The agendas for the group meeting were presented and read, by the experimenter, to each GSS group.

APPENDIX B4. Posters

Posters with meeting objective, technique instruction and system example, were posted and prominently displayed in the rooms during all the sessions.

APPENDIX B5. Post Session Questionnaires

At the conclusion of each experimental session, the questionnaires were handed out to the subjects and the filled out forms were collected by the experimenter. The A form was used in all the groups. The B form was used only in the GSS groups.

APPENDIX B1 **STUDENT INFORMATION SHEET**

INSTRUCTIONS: Please be sure to answer all the questions.

- ID # (last 4 digits of your soc. sec. #): _____
- Course # and section code:_____
- MAJOR: Computer Information Systems___ OTHER:____
- Gender: MALE___ FEMALE___
- Age:____
- Cumulative Grade Point Average (GPA):_____
- CIS courses completed (at Baruch or elsewhere):

  _____

  _____

- Personal Computer Experience: YEARS:____ MONTHS:____
- Personal Computers Used:

  IBM-PC or Clone____ Apple/Macintosh___ Other:_____
- Do you have a computer at home? YES_____ NO_____

  If yes, specify type_____
- Do you work? YES_____ NO_____

  If yes, do you work with computers? YES_____ NO_____

  If yes, what software do you use?

  _____
- Do you have any experience as an analyst/designer? YES____ NO__
- Would you be willing to participate in an Information Systems study?

  YES____ NO__

APPENDIX B1 continued

Software packages used; please also circle level of experience
(Scale 1= beginner, 5=expert)

Spreadsheet package

□ Lotus 1-2-3
Other:_____
Spreadsheet experience 1 2 3 4 5

Word processing package

□ WordPerfect
Other:_____
Word processing experience 1 2 3 4 5

Database package

□ dBASE
Other:_____
Database experience 1 2 3 4 5

Other packages (with experience):

_____ 1 2 3 4 5
_____ 1 2 3 4 5
_____ 1 2 3 4 5

Programming experience; please also circle level of experience
(Scale 1=beginner, 5=expert)

□ BASIC 1 2 3 4 5
□ dBASE 1 2 3 4 5

Other programming (with experience):

_____ 1 2 3 4 5
_____ 1 2 3 4 5

APPENDIX B2 **CONSENT FORM**

Principal Investigators: Dorothy Dologite, Beata Lobert

Subject: Research Project: Student Information System

A research project in Information Systems is being undertaken at Baruch College. It will require participants to take part in a group session that will last about one hour and fifteen minutes.

1) I understand that my participation in this project is strictly voluntary and that I may withdraw at any time without prejudice.

2) All information collected will be kept confidential and I will not be identified by name in any written records.

3) I understand that my participation in the project does not pose any personal risk to me.

4) I also understand that I may ask questions of the researcher at the time I sign this document, or at any time during the project, pertaining to issues that I do not understand.

5) I also agree not to discuss the procedures, or outcomes of any sessions, until the research project is completed. I may obtain information on the results of this project, once they become available, by contacting one of the principal investigators.

6) Any complaints can be directed to the Baruch College Human Subjects Committee.

NAME:
PRINT:_____SIGN:_____

AGE:_____

PARENT/GUARDIAN'S SIGNATURE:
(if under 18 years of age) _____

WITNESS:_____

DATE:_____, NEW YORK, NY.

APPENDIX B3

GSS MEETING AGENDAS FOR THE NON-INCUBATION SESSIONS

	ACTIVITY DESCRIPTION	ACTIVITY
1	Investigating Innovative SIS Ideas	Topic
2	Idea Generation for a System	Brainwriting
3	Initial Idea Evaluation	Rating
4	Discussion of the Proposed Idea(s)	Non-Computer Based
5	SIS Proposal Development	Topic
6	Idea Generation for a System's Name	Brainwriting
7	Name Selection	Rating
8	System Description	Comment Cards
9	System Benefits	Comment Cards
10	System Hardware	Comment Cards
11	Software	Comment Cards

APPENDIX B3 continued

GSS MEETING AGENDAS FOR THE INCUBATION SESSIONS

	ACTIVITY DESCRIPTION	ACTIVITY
1	Investigating Innovative SIS Ideas	Topic
2	Idea Generation for a System	Brainwriting
3	Warm-up Exercise	Brainwriting
4	Initial Idea Evaluation	Rating
5	Discussion of the Proposed Idea(s)	Non-Computer Based
6	SIS Proposal Development	Topic
7	Idea Generation for a System's Name	Brainwriting
8	Name Selection	Rating
9	System Description	Comment Cards
10	System Benefits	Comment Cards
11	System Hardware	Comment Cards
12	Software	Comment Cards

APPENDIX B4 **POSTERS**

THE SIS TASK

Prepare a proposal for a new subsystem of the Student Information System.

Mention:

1. Brief description /objective of the subsystem.
2. Benefits of the new module.
3. Hardware and Software used to implement the system.

THE RULES

1. Generate as many ideas as possible.
2. Do not be afraid to suggest 'wild' solutions.
3. Do not criticize!
4. Expand on previous ideas.

THE ID SYSTEM

Hardware

Video Camera	- takes picture
Scanner	- scans the signature
486 machine	- processes the ID request
Specialty printer	- prints the ID with a magnetic strip

Software

DBMS - student information; picture information; signature information
custom-made software
- puts the picture, the signature and the student info together

Benefits

- increased security on campus,
  e.g., limited access to campus facilities once entrance stalls ar installed
- increased efficiency of major campus services,
  e.g., quicker access to records once magnetic strip scanners are installed

APPENDIX B5 **PARTICIPANT SURVEY A**

ID #(last 4 digits of soc. sec. #):_____

INSTRUCTIONS: Please put your ID # above and check off the answer that is most appropriate. Pleases remember: there are no right or wrong answers. We are only interested in your feelings and experiences.

In general, I like to participate in groups:

Strongly	Neutral/	Strongly
Disagree	Undecided	Agree
1--------2--------3--------4--------5--------6-------7		

In general, I fear speaking in public:

Strongly	Neutral/	Strongly
Disagree	Undecided	Agree
1--------2--------3--------4--------5--------6-------7		

I felt comfortable contributing ideas:

Strongly	Neutral/	Strongly
Disagree	Undecided	Agree
1--------2--------3--------4--------5--------6-------7		

I was able to contribute all my ideas:

Strongly	Neutral/	Strongly
Disagree	Undecided	Agree
1--------2--------3--------4--------5--------6-------7		

I felt pressed to conform to others in my group:

Strongly	Neutral/	Strongly
Disagree	Undecided	Agree
1--------2--------3--------4--------5--------6-------7		

The group process was dominated by one or more individuals:

Strongly	Neutral/	Strongly
Disagree	Undecided	Agree
1--------2--------3--------4--------5--------6-------7		

APPENDIX B5 continued

I was satisfied with the idea generation process:

Strongly Disagree		Neutral/ Undecided		Strongly Agree
1	2	3	4	5	6	7

I enjoyed completing the task:

Strongly Disagree		Neutral/ Undecided		Strongly Agree
1	2	3	4	5	6	7

I was motivated to complete the task:

Strongly Disagree		Neutral/ Undecided		Strongly Agree
1	2	3	4	5	6	7

I got totally involved in the group effort to complete the task:

Strongly Disagree		Neutral/ Undecided		Strongly Agree
1	2	3	4	5	6	7

All the group members worked closely together:

Strongly Disagree		Neutral/ Undecided		Strongly Agree
1	2	3	4	5	6	7

The task description was clear and easy to understand:

Strongly Disagree		Neutral/ Undecided		Strongly Agree
1	2	3	4	5	6	7

The idea generation technique was easy to use:

Strongly Disagree		Neutral/ Undecided		Strongly Agree
1	2	3	4	5	6	7

APPENDIX B5 continued

All the instructions were clear:

Strongly Disagree		Neutral/ Undecided		Strongly Agree
1	2	3	4	5	6	7

It was fun to participate in the session:

Strongly Disagree		Neutral/ Undecided		Strongly Agree
1	2	3	4	5	6	7

It was easy to generate ideas for the task presented:

Strongly Disagree		Neutral/ Undecided		Strongly Agree
1	2	3	4	5	6	7

Everyone in the group had equal opportunity to present ideas:

Strongly Disagree		Neutral/ Undecided		Strongly Agree
1	2	3	4	5	6	7

The idea generated by my group can be useful:

Strongly Disagree		Neutral/ Undecided		Strongly Agree
1	2	3	4	5	6	7

I am satisfied with the outcome of the group process:

Strongly Disagree		Neutral/ Undecided		Strongly Agree
1	2	3	4	5	6	7

How well did you know everyone in your group? (choose one)

___ First time working with those present
___ Worked once or twice with some of those present
___ Worked once or twice with most of those present
___ Worked a lot with one or some of those present
___ Worked a lot with most of all of those present

APPENDIX B5 continued

What did you like best about the process?

What did you like least about the process?

Any other comments:

APPENDIX B5 cont. **PARTICIPANT SURVEY B**

ID #(last 4 digits of soc. sec. #):_____

INSTRUCTIONS: Please put your ID # above and check off the answer that is most appropriate. Pleases remember: there are no right or wrong answers. We are only interested in your feelings and experiences.

The amount of information I could enter at any one time limited my expression of ideas:

Strongly		Neutral/		Strongly
Disagree		Undecided		Agree
1	2	3	4	5	6	7

My typing skills slowed down my participation:

Strongly		Neutral/		Strongly
Disagree		Undecided		Agree
1	2	3	4	5	6	7

The lack of verbal communications restrained my ability to participate:

Strongly		Neutral/		Strongly
Disagree		Undecided		Agree
1	2	3	4	5	6	7

It was difficult to read the ideas of others as they were displayed on the screen:

Strongly		Neutral/		Strongly
Disagree		Undecided		Agree
1	2	3	4	5	6	7

It was difficult to use the software:

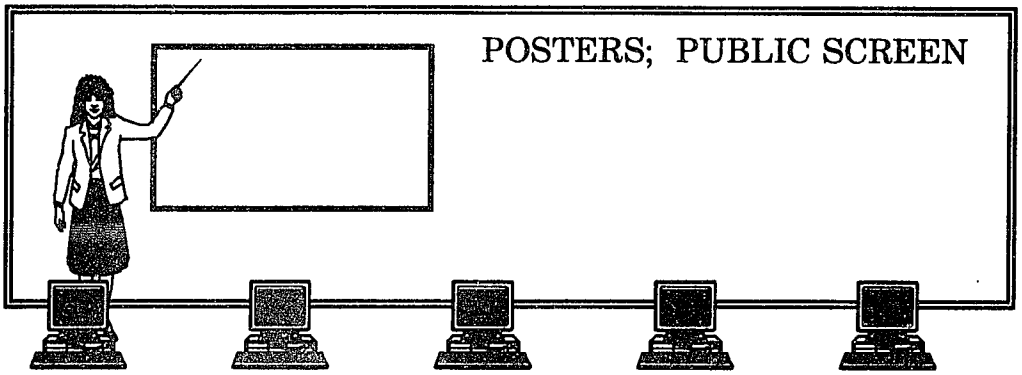
Strongly		Neutral/		Strongly
Disagree		Undecided		Agree
1	2	3	4	5	6	7

It was helpful to use the group software for this task:

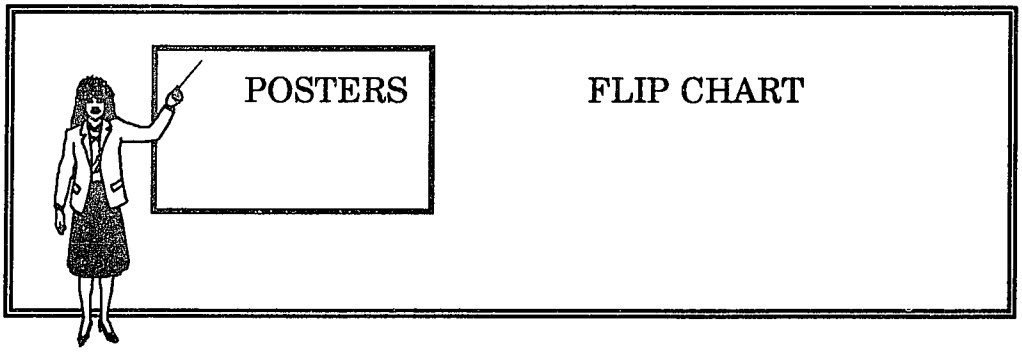
Strongly		Neutral/		Strongly
Disagree		Undecided		Agree
1	2	3	4	5	6	7

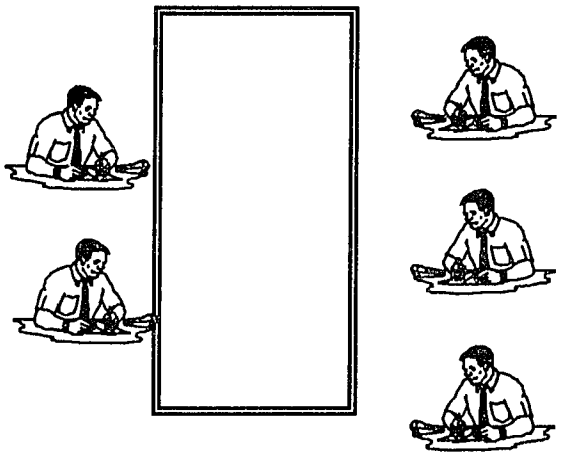
APPENDIX C **EXPERIMENTAL FACILITIES**

LAB FOR THE TECHNOLOGY SUPPORTED SESSIONS



MEETING ROOM FOR THE NON-SUPPORTED SESSIONS





APPENDIX D

PILOT STUDY MATERIALS

APPENDIX D1. Judges' Instructions

The experimenter sent the memo with instructions to all the individuals who agreed to be the expert judges.

APPENDIX D2. Test Proposal

The experimenter prepared the test proposal and presented it to the expert judges for evaluation.

APPENDIX D3. Initial Project Evaluation Form

The expert judges received the initial project evaluation form to evaluate the test proposal and to provide feedback.

APPENDIX D4. Creativity Assessment Questionnaire

The expert judges received the test proposal with the revised version of the evaluation form - the CPSS-based Creativity Assessment Questionnaire.

APPENDIX D5. VisionQuest Instructions

The VisionQuest instructions were prepared and used only during the first GSS session.

APPENDIX D1

TO: Mort Norman, Bill Ferns, Michael Palley

FROM: Beata M. Lobert

RE: Evaluations of the proposals for a Student Information System

DATE: April 19, 1993

I would like to gently remind you that you have agreed to perform the function of an 'expert judge' in my dissertation research project. If it is all right with you, I would like to seek a little of your expertise, now.

Enclosed is a proposal for a module of a Student Information System at Baruch College and a brief questionnaire. To pilot test the questionnaire, I would like you to evaluate the enclosed proposal in several categories. Please answer all the questions as best you can, and return the enclosed materials to me as soon as you can (preferably this week.) If you have any problems answering the questions, please write me a brief note on the back of the questionnaire, so I can clarify ambiguities in the future.

Also, note that this is only a preliminary study. There will be more proposals to evaluate in the next few weeks.

If you have any questions, please call me at home any time of day or night. Thanks a lot!

APPENDIX D2

TEAM: TEST

A PROPOSAL FOR A STUDENT INFORMATION SYSTEM MODULE

NAME: THE ID SYSTEM

DESCRIPTION/BENEFITS:

DESCRIPTION: The system will identify students with an ID card that contains a magnetic strip on the back with encoded information about the student

BENEFITS: - increased security on campus, e.g., limited access to campus facilities once entrance stalls are installed in all the buildings

- increased efficiency of major campus services, e.g., quicker access to records once magnetic strip scanners are installed everywhere

HARDWARE: - Video Camera - takes picture of the student

- Scanner - scans the student signature

- 486 machine - processes the ID request

-Specialty printer - prints the ID with a magnetic strip

SOFTWARE: - DBMS: - student information; picture information; signature information

- custom-made software - puts the picture, the signature and the student info together

APPENDIX D3 **PROJECT EVALUATION FORM**

INSTRUCTIONS: Please put the group number in the space below, and answer all the questions by placing an 'X' in the appropriate box on the scale.

GROUP #:_____

	SCORE: LOW 1	2	3	MEDIUM 4	5	6	HIGH 7
What is the amount of effort and thought evident in the proposal?	☐	☐	☐	☐	☐	☐	☐
To what extent the proposed system will overcome conventional constraints and boundaries?	☐	☐	☐	☐	☐	☐	☐
What is the proposed system's cost savings potential?	☐	☐	☐	☐	☐	☐	☐
How appropriate is the proposed solution in light of the problem?	☐	☐	☐	☐	☐	☐	☐
How feasible is the proposed solution to implement?	☐	☐	☐	☐	☐	☐	☐
To what extent the proposed system, if implemented, will change the organization?	☐	☐	☐	☐	☐	☐	☐
How simplistic does the proposed solution appear?	☐	☐	☐	☐	☐	☐	☐
How clearly is the proposed system described?	☐	☐	☐	☐	☐	☐	☐
How frequently did the proposed solution occur?	☐	☐	☐	☐	☐	☐	☐
To what extent the technology is utilized in a new way in the proposed system?	☐	☐	☐	☐	☐	☐	☐
To what extent the proposed system will increase the efficiency of student services?	☐	☐	☐	☐	☐	☐	☐
To what extent the proposed solution is unexpected or surprising?	☐	☐	☐	☐	☐	☐	☐
Using your own notion of creativity, what is the overall creativity of the proposed solution?	☐	☐	☐	☐	☐	☐	☐
To what extent the proposed solution is combining concepts of simplicity and complexity?	☐	☐	☐	☐	☐	☐	☐

APPENDIX D4 **Creativity Assessment Questionnaire**

(used for evaluation of information system projects in the initial investigation phase)

The idea presented is:

ICW	crude	* * * | * * *	well-crafted
IAI	appropriate	* * * | * * *	inappropriate
ICA	clear	* * * | * * *	ambiguous
IUO	unique	* * * | * * *	ordinary
ICE	coarse	* * * | * * *	elegant
IUU	usual	* * * | * * *	unusual
IAU	attractive	* * * | * * *	unattractive
IOD	organized	* * * | * * *	disorganized
IAC	astonishing	* * * | * * *	commonplace
IMS	meticulous	* * * | * * *	sloppy

From the technical point of view, the proposed system, if implemented, will be:

TCS	complex	* * * | * * *	simple
TWU	workable	* * * | * * *	unworkable
TMS	making sense	* * * | * * *	senseless
TPU	pioneering	* * * | * * *	unprogressive
TAC	astounding	* * * | * * *	common

From the organizational point of view, the proposed system, if implemented, will be:

ORA	revolutionary	* * * | * * *	average
OIE	inessential	* * * | * * *	essential
OUN	unnecessary	* * * | * * *	necessary
OMS	making sense	* * * | * * *	senseless
OPU	pioneering	* * * | * * *	unprogressive
OIC	inexpensive	* * * | * * *	costly
OOI	operable	* * * | * * *	inoperable
OAC	astounding	* * * | * * *	common
OCS	complex	* * * | * * *	simple

Overall, the proposed system is:

SCU	creative	* * * | * * *	uncreative

APPENDIX D4 continued

Creativity Assessment Questionnaire

(used for evaluation of information system projects in the initial investigation phase)

About the Questionnaire...

The Questionnaire, on the reverse side, is a revised version of the CPSS product development tool. The original CPSS is used to analyze existing products. The revised version is designed to assist IS professionals in evaluating information system project proposals in the initial investigation stage.

How to Use the it...

This is not a test of your aptitude or of your ability as a judge. It is a tool for clarifying your own view of the project idea that you are considering. All answers are "right" answers, since you are simply evaluating the project idea as you imagine it. You may have confidence that whatever you do, if you follow these simple guidelines, you are "doing it right."

Carefully consider the project proposal in relation to the scales printed in the box on the reverse side of this form.

For each scale, select and circle an appropriate point between each of the alternatives. While not belaboring your selection, give careful thought to how each word relates to the project proposal. Circle the point on each scale that shows both direction and proximity in meaning to the word that better describes the project. Don't be concerned if the words do not seem to be complete opposites. Some pairs are but some are related in other ways. Simply ask yourself, "Will the project, if accepted, be more like one term or more like the other?" If you find that the project will be equally like one term and equally like the other, select a point near the middle of the continuum. Do not worry if you realize that people may define words differently, or that others may not agree with your definitions. Studies of reliability suggest that these differences do not cause much real difference in project evaluations.

APPENDIX D5 VISIONQUEST INSTRUCTIONS

GETTING TO VISIONQUEST:

Login:	VISION
Password:	JAMESBROWN
User Name:	9768, 1
Password:	press [ENTER]
Select Dialogue:	A1

ENTERING RESPONSES IN VISIONQUEST:

To **add** a response:
- -press [INS] key
- -type in response
- -press F4 to save

To **edit** a response:
- -position the highlight bar on the response
- -press F2 and select EDIT

APPENDIX E

STUDENT PROPOSALS

The student proposals presented here were generated in sessions belonging to the following experimental treatments:

Creative process▸ Technology▾	Incubation	No Incubation
GSS support	J,M,R,U	B,D,E,N
No GSS support	F,O,P,S	C,G,K,L

TEAM: B

A PROPOSAL FOR A STUDENT INFORMATION SYSTEM MODULE

NAME: InfoStudent

DESCRIPTION/BENEFITS:

DESCRIPTION:

The system is focused on providing information to each student on individual basis: It will provide:

- Quick access to schedule of classes, necessary courses, and professor info
- Easy-access menus systems that are easy to understand and operate
- Information about students pertaining to all classes previously taken and the grades, courses,fin. aid, billing, etc
- Computerized counselor, for all info. concerning courses associated with major; the best alternative if you cannot fit the course in your schedule; classes that must be taken in order to receive Junior status; classes that should be taken together and during what semester.
- printouts of all the information

BENEFITS:

- Decrease time spent in individual offices
- Better informed students.
- Less confusion on course outline for a degree-
- Students will know what is required prior to their last semester.
- Students will love going to Baruch college
- Baruch will have a better image in other CUNY schools
- Less staff needed in different offices, e.g., less guidance counselors
- Students will not take courses of which they will not get credit for.

HARDWARE:

- Network based system: 386's+ with decent monitors
- lots of memory to run the database
- printers
- Custom terminals located all around campus and a monitor in each building.
- place to store the information on disk if that is what the student wants

SOFTWARE:

- a great, fast, robust dbms
- Custom- made software: with windowed, iconed, pull down menu system.

TEAM: C

A PROPOSAL FOR A STUDENT INFORMATION SYSTEM MODULE

NAME: Registration/Payment System

DESCRIPTION/BENEFITS:

DESCRIPTION:

On-line registration and payment system to be used by students using their PC's at home or wherever terminals or PC's are available.

- payment - choice of type of payment, e.g., installments, credit cards
- check on-line when next payment is due and what the penalty for non-payment is.
- check on-line if classes are closed and add your name to a waiting list
- registration broken down by student status(e.g., seniors register first;they are given time limit to register; juniors cannot register until seniors' -time limit is up.)

BENEFITS:

- 24 hour availability of class schedule on PC
- cut down registration time and lines
- user friendly, step-by-step process when registering

HARDWARE:

The system uses existing hardware :
- mainframe to store dbms
- dummy terminals- for students to retrieve the desired information.

SOFTWARE:

- communication package
- DBMS - class schedules, class info, registration info, bursar-payment plan
- custom-made software to access DBMS for student status info, class availability, and to tie the information together.

TEAM: D

A PROPOSAL FOR A STUDENT INFORMATION SYSTEM MODULE

NAME: Integrated Intelligence Registrations System (IIRS)

DESCRIPTION/BENEFITS:

DESCRIPTION:

The system will combine all the information needed in the registration system. It will also allow students with computers and modems to register from home. Payment of tuition fees will be made through the computer. It will provide information such as pre-requisite/ co-requisite requirements, liberal arts requirements, major requirements etc, along with class availability, professor rating, which will allow students to have easy access to information necessary for quick registration. Also to facilitate the students, the system will provided the students with quick program changing capabilities that is three or four alternative schedules based on the student's first choice. Students can hold on to the classes that are available and work around them. Department heads or representative will be able to give authorization for classes via terminal. Financial aid status, academic status and requirements to graduate will also be provided, when needed.

BENEFITS:

- Easier registration, shorter lines - time saving
- Quicker access to needed classes
- Professors who are harder than others would be blacklisted
- Save manpower.
- Aid students in schedule selection, provide valuable information to students, reduce the cost of the registration process, and increase student satisfaction.

HARDWARE:

- Existing hardware- including mainframe to store student database
- More 486 computers
- More printers
- 50 terminals - for prerequisite checking
- Increased storage capacity

SOFTWARE:

- Update existing software
- DBMS
- Communication software, supporting high speed transmissions
- Custom-made software-puts data together, adds the data to the database, deletes the closed sections and list those closed sections on a monitor

TEAM: E

A PROPOSAL FOR A STUDENT INFORMATION SYSTEM MODULE

NAME: Baruch-Info-System

DESCRIPTION/BENEFITS:

DESCRIPTION:

The system will have :

- open accounts for every student and will have a public bulletin board for any news and info on many subjects, including available facilities, and help in various aspects of student life.
- telephone registration via the computer
- open professor rating system with essay, anonymous responses
- course descriptions that are more detailed: course work load, the textbooks used including professor evaluation, teaching methods and years of experience that particular professor has in that course.

BENEFITS:

The students will:

- have an easier time communicating with each other
- more campus information at their disposal.
- get information quickly, and in a more convenient fashion
- have more professor information available and will be able to fairly determine their own choices for professors.

The school will :

- be able to alleviate the problem of overcrowded labs.
- have a more organized way of handling registration

HARDWARE:

- System could be connected via a mainframe system or it could be a large network of servers with a large disk space to store the database info
- There will have to be a way of handling an overflow of data compiled, for example a tape system which stores info in another location.

SOFTWARE:

- The system will have to have a word processor for the students
- DBMS for all campus information, including evaluations and registration
- Custom-made software that will allow students to enter opinions

TEAM: F

A PROPOSAL FOR A STUDENT INFORMATION SYSTEM MODULE

NAME: Job Bank/Job Net

DESCRIPTION/BENEFITS:

DESCRIPTION:

The system should be able to :
- communicate with employers internationally
- store resumes
- match students with certain qualifications to potential employers who need that particular expertise
- store company profiles

BENEFITS:

- cut job search time drastically
- help students determine the job market skills in demand

HARDWARE:

- Pentium-based PC network with terminals connected to it
- File server
- Centralized database
- Printers
- Hard drives

SOFTWARE:

- DBMS
- Customized front-end with resume input screens

TEAM: G

A PROPOSAL FOR A STUDENT INFORMATION SYSTEM MODULE

NAME: Baruch Databanking System

DESCRIPTION/BENEFITS:

DESCRIPTION:

A system that allows students and teachers the ability to get data by using any computer:
- Access to syllabi before registration
- Updated, computerized version of the bulletin
- Teachers can put in grades at home
- Students can access grades from home
- Students can reserve books from the bookstore or the library

BENEFITS:

- Flexibility
- Faster, more efficient registration

HARDWARE:

- Computers
- Modems
- Printers
- College ID
- Phone

SOFTWARE:

- Database with student, class and teacher information

TEAM: J

A PROPOSAL FOR A STUDENT INFORMATION SYSTEM MODULE

NAME: Schedule Planner

DESCRIPTION/BENEFITS:

DESCRIPTION:

- System will be able to produce a schedule according to your request, such as number of classes you want, professors you want, time and day you want to have classes. It will tell you which classes you need to fulfill requirements. It will give you other alternative classes in case your requested course is closed. The computer will scan the ID card and will then be able to access the student records including status, transcript, etc.The system will also be able to tell remaining credits needed.

BENEFITS:

- Saves guidance counselor's time
- Less time wasted at registration- don't have to wait to find out if classes are closed and do another schedule
- No confusion - students can start graduating on time since they will know what classes they are required to take
- Students will not take unnecessary classes - they will only take the classes they need
- Eliminate cost of registration
- Schedule will fit the student's schedule since students are able to choose their own times

HARDWARE:

- Networking
- Existing mainframe
- Scanners
- Scanner that reads the student's id card
- Printers
- Dumb terminals

SOFTWARE:

- Database system
- Custom-made software

TEAM: K

A PROPOSAL FOR A STUDENT INFORMATION SYSTEM MODULE

NAME: The Registration System

DESCRIPTION/BENEFITS:

DESCRIPTION:

The system should be able to do the following:
- provide on-line, "friendly" bulletin information
- perform pre-registration with department of student's major, by phone or by mail
- automatically design schedules, based on students preferences
- automatically update the evaluation record for every student at the beginning of each semester
- provide on-line student book exchange information

BENEFITS:

- Reduce the time for registration
- Reduce the problems with registrations that students currently experience, e.g., no conflicts

HARDWARE:

- Terminals (located in different buildings)
- High speed modems
- Printers (to print out information)

SOFTWARE:

- DBMS with student information, bulletin information, registration information, book exchange information
- custom made software to perform the scheduling and link all the information

TEAM: L

A PROPOSAL FOR A STUDENT INFORMATION SYSTEM MODULE

NAME: Remote-Access Registration System

DESCRIPTION/BENEFITS:

DESCRIPTION:

- Combine student info.,course info. and financial aid info into an on-line system which will automatically generate courses needed by registrant according to his/her major; give open course list accordingly and will process student's request with all the relevant info. (financial aid, probation, etc.). As a result a confirmation will be mailed by the system to the registered student. Connection can be made either by modem or phone.

BENEFITS:

- quick access and processing
- efficiency - minimize crowding of college facilities
- fewer staff- only operators needed for help and to process registrants with rotary service - less cost
- simplify process
- waiting list option available
- faster notification of teachers re: students taking their classes

HARDWARE:

- modems
- touch-tone phones
- LAN
- 486 machines
- high speed printers

SOFTWARE:

- DBMS
- LAN operating system
- telecommunications software
- custom GUI
- spreadsheet

TEAM: M

A PROPOSAL FOR A STUDENT INFORMATION SYSTEM MODULE

NAME: Voice-Info System

DESCRIPTION/BENEFITS:

DESCRIPTION:

The computer will sent a notification to each student telling when to call the school for registration. At that specific time, student will call the school. Before they start to register, they push buttons on the telephone for the inquiries of any information they want before they decide to register. For example, they might want to know whether a section has been close or not, or the grading/ evaluation of any professor, or any changes to the schedule of classes, or detailed requirements of classes. Then, student will push another button to begin to register for their courses by saying the course number and section number. If the course has been closed, then computer will response through the phone and student can immediately change the choice. After student completes the registration, computer will sent the info to the bookstore to have all the books ready. At the same time, (before student hangs up) computer will tell the student when to pick up their books and pay. This voice mail system will enable pre-registration, access to student records, access to professor records, information of students of all important deadlines and upcoming school events, as well as career info.

BENEFITS:

- More efficient, easier registration process
- Faculty more aware of each student's educational need and students have the ability to match their needs with the professors
- Students will be well informed about the activities at Baruch.
- Access to up-to-date information, at any time
- System will save time and money for the students and the faculty

HARDWARE:

- Network
- PC's with astronomical ram and hard drive storage space for a database
- Server
- Peripheral for receiving and sending out voices
- CD ROM for storage of the data (if PC's are used)
- Large amount of telephone lines
- Modem for sending info to bookstore (if PC's are used)

SOFTWARE:

- Customized program for changing from info on voice to info in database
- Database package to store all info (student, course number & name etc.)
- User friendly system with strict security features where no one can gain access to other student records or change grades
- Global Directory Service

TEAM: N

A PROPOSAL FOR A STUDENT INFORMATION SYSTEM MODULE

NAME: BCIRS - Baruch College Information Resource System

DESCRIPTION/BENEFITS:

DESCRIPTION:

The system will provide:

- information about careers based on different majors,and jobs that are available to students at Baruch.
- information concerning financial aid, scholarships, application deadlines, procedures for them.
- information about tutoring services, medical services, counseling or curricular guidance services.
- information about student clubs, special events
- on-line ability to locate the rooms and the building where the resources they want are located.
- E-Mail to those we wish to contact for quick response to questions
- appointments with anyone we wish to see

BENEFITS:

- Quick and easy access to most current information
- Easier for students to find what they want
- Information is more organized
- Students will be better informed about the school's services of which they may otherwise not be informed.

HARDWARE:

- Mainframe hooked up to terminals in a network
- Personal computers
- Printers
- Modem connections for easier transfer of information
- Distributed memory management system

SOFTWARE:

- DBMS with student clubs, guidance/counseling, financial aid/scholarships, jobs/career information
- Interactive query system with some IA
- Custom made program with easy to understand terminology

TEAM: O

A PROPOSAL FOR A STUDENT INFORMATION SYSTEM MODULE

NAME: Voice Mail System

DESCRIPTION/BENEFITS:

DESCRIPTION:

The voice mail system will perform the following functions:

Registration:
- information module with e.g., schedule of classes data
- for student with high GPA, registration process and grade information
- messaging center to leave messages with members of the staff

Other Services: e.g., transcript requests

BENEFITS:

- Reduced lines on campus
- Motivation for students to acquire "privileged" status
- Staff reduction
- Faster registration and inquiry process
- 24 hour access

HARDWARE:

- Voice Mail System

SOFTWARE:

- DBMS with info on services, registration, staff members, student information
- Linker to Voice Mail

TEAM: P

A PROPOSAL FOR A STUDENT INFORMATION SYSTEM MODULE

NAME: Student On-line Support (S.O.S.) System

DESCRIPTION/BENEFITS:

DESCRIPTION:

System to provide students with pertinent information regarding:
- transcript
- calendar dates & deadlines
- financial aid info.
- on-line directory of departments and professors
- current semester schedule of classes

Whenever required, printouts will be provided of the info.

BENEFITS:

- Easier access to student info.
- Decrease in personnel
- More accurate, up-to-date information

HARDWARE:

- 45 serial terminals
- 18 printers
- scanners

SOFTWARE:

- Student database
- Financial Aid database
- Professor database
- Registration database
- custom-made, intelligent front-end software

TEAM: R

A PROPOSAL FOR A STUDENT INFORMATION SYSTEM MODULE

NAME: Registration Plus(+)

DESCRIPTION/BENEFITS:

DESCRIPTION:

The system will:

- allow students to use their PC's at home or terminals on campus to register
- provide a help menu for selection of classes
- advise student on what courses are required, based on major, status, etc.
- provide listing of courses available in other CUNY schools
- preview Summer courses
- provide description of a particular course, when requested
- provide student evaluation rating on a particular professor

BENEFITS:

Time saving:

- can register from home - diminished registration lines
- foreign students and students on vacation will be able to register regardless of their where about
- rapid counselling through the pc instead of making appointments to see a counsellor.

More information available:

- obtain wider selection of options from other CUNY schools
- can find out if the professor received a good rating

Saving transportation money for those that can register at home

HARDWARE:

- Improvement of the current mainframe system
- Introduction of telephone registration system
- PC computers and terminals with slots to input id card
- Modems
- Printers
- LAN with a file server

SOFTWARE:

- Customized, window-based, menu driven program for the counseling/help of class selection/student info retrieval with help screens
- Elaborate database with classes and their descriptions
- Communications software

TEAM: S

A PROPOSAL FOR A STUDENT INFORMATION SYSTEM MODULE

NAME: The Student Access System

DESCRIPTION/BENEFITS:

DESCRIPTION:

-Registration module with access from home or terminal located at Baruch
- to register
- to get grade information
- to get schedule of classes information
- The system will automatically assign IDs at registration

- On-line module with access from home or terminal located at Baruch
- to request books from the library to be put on hold
- to get lecture notes/information
- to get access to advisors
- to get coursework evaluation performed
- to print reports
- to E-mail

BENEFITS:

-Registration module:
- easier process
- more flexibility
- more cost effectiveness
- more efficient
- more secure

- On-line module:
- easier and broader access to information
- better informed students
- more up-to date information disseminated
- better professor/student interaction

HARDWARE:
- PCs
- dumb terminals
- CD-ROMs
- Scanners

SOFTWARE:
- Student database
- E-mail/bulletin board software

TEAM: U

A PROPOSAL FOR A STUDENT INFORMATION SYSTEM MODULE

NAME: RegisterMe

DESCRIPTION/BENEFITS:

DESCRIPTION:

- This system will preform registration on a user friendly bases. Users will be given 5-10 minutes to register. A menu will appear asking for the classes you would like to register for. Then it will inform you which classes will fulfill all of your requirements in major, in electives, and in minor. The system will also:
- make the student aware that he/she is registering for not needed classes - provide a listing of courses still needed for each student
- give a listing of alternative, open classes when the requested class is closed.
- show the listing of electives a student have to choose from, as well as the availability of required courses, professors, professors' evaluations
- provide required courses according to major, as well as overall time span to achieve the major and the overall instructions for registration.

BENEFITS:

- Graduation on time - students will not be taking courses they don't need. - Cut down on registration staff
- Cut down on the amount of paper used on the day of registration
- Quick access to the open and closed courses.
- College will be more prestigious by providing the greatest services to students

HARDWARE:

- Update the existing hardware, plus add some high-end (486 and 586 machines)
- 20-25 on-line terminals so that students have easy access to system
- Scanners to speed the process and avoid any key punching
- ID scanners to process ss# and to gain quickly access to student record
- 5-6 printers to print out bursar's receipts and to allow student output

SOFTWARE:

- An extensive DBMS, to store info., such as teacher evaluation, major courses along with the usual info. such as course section, time
- Customizing the Boss system with added features such as the guidance of classes, a pop-up screen of available sections if 1st selection is closed, Windows showing the requirement satisfied if any, after selection is made, a listing of the courses which are still needed to Graduate, reach Junior status etc..

APPENDIX F

EVALUATOR MATERIALS

APPENDIX F1. Judges' Instructions

The instructions were sent to the judges along with the copy of the task and the results of the group idea generation.

APPENDIX F2. Creativity Assessment Questionnaires

The three different versions of the questionnaire were used by the expert judges to evaluate the information system project proposals generated by the student groups. Each version of the questionnaire had the evaluation criteria randomly ordered.

APPENDIX F3. Expert Judge Questionnaire

The additional questionnaire, filled out after the evaluations were completed, required judges to comment on the meaning of creativity in Information Systems and on the strengths and weaknesses of the reviewed proposals.

APPENDIX F4. Judges' Ratings

The judges' ratings represent the overall creativity scores assigned by the judges to the team project proposals using the Creativity Assessment Questionnaire.

APPENDIX F1 **MEMORANDUM**

TO: Bill Ferns, Michael Palley, Mort Norman

FROM: Beata M. Lobert

RE: Evaluation of Proposals for a Baruch Information System

DATE: May 5, 1993

Enclosed you will find proposals for an Information System at Baruch College. Please take some time to review the proposals first, so you will be able to evaluate them relative to one another. Then, for each project proposal fill out the Creativity Assessment Questionnaire. When you finish the evaluations, please take a minute to answer two questions on the additional enclosed questionnaire.

The Creativity Assessment Questionnaire and How to Fill it ...

The enclosed form is a revised version of the CPSS product development tool. The original CPSS is used to analyze existing products. The revised version is designed to assist IS professionals in evaluating information system project proposals in their initial investigation stage.

It can be also used as a tool for clarifying your own view of the project idea that you are considering. Be assured that all answers are "right" answers, since you are simply evaluating the project idea as you imagine it. You may have confidence that whatever you do, if you follow these simple guidelines, you are "doing it right."

Carefully consider each project proposal in relation to the scales printed on the enclosed form. For each scale, select and **circle an appropriate point between the two alternatives**. While not belaboring your selection, give careful thought to how each word relates to the project proposal. Circle the point on each scale that shows both direction and proximity in meaning to the word that better describes the project.

Don't be concerned if the words do not seem to be complete opposites. Some pairs are but some are related in other ways. Simply ask yourself, "Will the project, if accepted, be more like one term or more like the other?" If you find that the project will be equally like one term and equally like the other, select a point near the middle of the continuum. Do not worry if you realize that people may define words differently, or that others may not agree with your

APPENDIX F1 continued

definitions. Studies of reliability suggest that these differences do not cause much real difference in project evaluations.

The Proposals and How they were Generated...

Be aware of the fact that the enclosed proposals were generated during short, 70-90 minutes, sessions. The students were instructed to engage in an initial investigation phase of the System Development Life Cycle and to develop a brief proposal for an **innovative** information system for Baruch College. They were told to think of the problems that they have experienced during their tenure at Baruch and to come up with information system solutions.

The Deadline...

I would appreciate it if you could **return the proposals to me as soon as possible.** If you have any questions, please call me at home any time of day or night. **Thanks a lot!**

APPENDIX F2 **Creativity Assessment Questionnaire**

(used for evaluation of information system projects in the initial investigation phase)

TEAM:____

Overall, the proposed system is:

SCU	creative	* * * | * * *	uncreative

The project idea presented is:

ICA	clear	* * * | * * *	ambiguous
IMS	meticulous	* * * | * * *	sloppy
IAC	astonishing	* * * | * * *	commonplace
IUO	unique	* * * | * * *	ordinary
IAI	appropriate	* * * | * * *	inappropriate
IAU	attractive	* * * | * * *	unattractive
IOD	organized	* * * | * * *	disorganized
ICE	coarse	* * * | * * *	elegant
IUU	usual	* * * | * * *	unusual
ICW	crude	* * * | * * *	well-crafted

From the organizational point of view, the proposed system, if implemented, will be:

OIE	inessential	* * * | * * *	essential
ORA	revolutionary	* * * | * * *	average
OOI	operable	* * * | * * *	inoperable
OCS	complex	* * * | * * *	simple
OAC	astounding	* * * | * * *	common
OIC	inexpensive	* * * | * * *	costly
OUU	useful	* * * | * * *	useless

From the technical point of view, the proposed system, if implemented, will be:

TAC	astounding	* * * | * * *	common
TPU	pioneering	* * * | * * *	unprogressive
TWU	workable	* * * | * * *	unworkable
TCS	complex	* * * | * * *	simple
TMS	sensible	* * * | * * *	senseless

APPENDIX F2 cont. **Creativity Assessment Questionnaire**
(used for evaluation of information system projects in the initial investigation phase)
TEAM:____

The project idea presented is:

ICW	crude	* * * * * * *	well-crafted
IAI	appropriate	* * * * * * *	inappropriate
ICA	clear	* * * * * * *	ambiguous
IUO	unique	* * * * * * *	ordinary
ICE	coarse	* * * * * * *	elegant
IUU	usual	* * * * * * *	unusual
IAU	attractive	* * * * * * *	unattractive
IOD	organized	* * * * * * *	disorganized
IAC	astonishing	* * * * * * *	commonplace
IMS	meticulous	* * * * * * *	sloppy

From the technical point of view, the proposed system, if implemented, will be:

TCS	complex	* * * * * * *	simple
TWU	workable	* * * * * * *	unworkable
TMS	sensible	* * * * * * *	senseless
TPU	pioneering	* * * * * * *	unprogressive
TAC	astounding	* * * * * * *	common

From the organizational point of view, the proposed system, if implemented, will be:

ORA	revolutionary	* * * * * * *	average
OIE	inessential	* * * * * * *	essential
OUU	useful	* * * * * * *	useless
OIC	inexpensive	* * * * * * *	costly
OOI	operable	* * * * * * *	inoperable
OAC	astounding	* * * * * * *	common
OCS	complex	* * * * * * *	simple

Overall, the proposed system is:

SCU	creative	* * * * * * *	uncreative

APPENDIX F2 cont. **Creativity Assessment Questionnaire**
(used for evaluation of information system projects in the initial investigation phase)
TEAM:____

Overall, the proposed system is:

SCU	creative	* * * | * * *	uncreative

From the technical point of view, the proposed system, if implemented, will be:

TMS	sensible	* * * | * * *	senseless
TPU	pioneering	* * * | * * *	unprogressive
TAC	astounding	* * * | * * *	common
TCS	complex	* * * | * * *	simple
TWU	workable	* * * | * * *	unworkable

From the organizational point of view, the proposed system, if implemented, will be:

OUU	useful	* * * | * * *	useless
OIC	inexpensive	* * * | * * *	costly
OAC	astounding	* * * | * * *	common
OOI	operable	* * * | * * *	inoperable
OCS	complex	* * * | * * *	simple
ORA	revolutionary	* * * | * * *	average
OIE	inessential	* * * | * * *	essential

The project idea presented is:

IAU	attractive	* * * | * * *	unattractive
IOD	organized	* * * | * * *	disorganized
ICE	coarse	* * * | * * *	elegant
IUU	usual	* * * | * * *	unusual
IAC	astonishing	* * * | * * *	commonplace
IMS	meticulous	* * * | * * *	sloppy
ICW	crude	* * * | * * *	well-crafted
IAI	appropriate	* * * | * * *	inappropriate
ICA	clear	* * * | * * *	ambiguous
IUO	unique	* * * | * * *	ordinary

APPENDIX F3

EXPERT JUDGE QUESTIONNAIRE

NAME:_____

Describe briefly a highly creative information system. What features/ characteristics does it need to possess?

Please comment briefly on the information system proposals that you have reviewed. What were their strengths and /or weaknesses as far as creativity is concerned?

APPENDIX F4

JUDGES' RATING

The following are the overall creativity scores (SCU) assigned by the judges using the Creativity Assessment Questionnaire.

Judge▸ Proposal▾	1	2	3
B	5	6	3
C	3	5	2
D	5	5	3
E	5	6	3
F	5	6	2
G	5	5	2
J	6	6	3
K	5	5	3
L	4	5	2
M	5	3	5
N	5	4	5
O	5	5	1
P	5	6	2
R	4	6	2
S	5	5	3
U	6	5	4

APPENDIX G. **SAMPLE SIZE CALCULATIONS**

a = # of levels of Factor A (technology vs no technology) = 2

b = # of levels of factor B (incubation vs no incubation) = 2

D = difference in any 2 row means to be detected = 2

n = # of replicates of the experiment = to be determined
(replicate of an experiment - contains all a x b treatments)

σ = estimate of the standard deviation = .8

n	$\Phi^2 = nD^2/2\sigma^2[(a-1)(b-1)+1]$	$\Phi = \sqrt{\Phi^2}$	numerator degrees of freedom: (a-1)(b-1)	error degrees of freedom: ab(n-1)	Type II error β* (α=.05)	Power of the test 1-β
4	6.25	2.5	1	12	.09	.91
5	7.8125	2.795	1	16	.04	.96
6	9.375	3.061	1	20	.02	.98

* from the Operating Characteristics Curves for the Fixed Effects Model Analysis of Variance (Montgomery, 1984; p. 607); based on Φ and the degrees of freedom.

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