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The Effects of Information Technology on Creativity

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Abstract


All innovation begins with creative ideas. Thus, the quality of new products and services is dependent on the creative performance of individuals working alone or in groups. Deriving from research, it is assumed that creativity and information technology (IT) play important roles in service development. Given the increased importance of IT used as a means of communication in organizations, the present thesis aims to examine the effects information technology will have on creative performance. More specifically, the focus of the study was how the creative performance of small groups and individuals, operationalized in terms of process and product, was affected when provided IT tools for communicating ideas. The consensual assessment technique was employed along with independent judges to obtain objective measures. Additionally, participants subjective perceptions were also collected. Two experimental studies were conducted, both with IT as an independent variable. In Study I, the importance of internal beliefs, such as the perceived usefulness of IT, was also considered. Only with small effects detected. As for the IT variable, the possibility of interaction appeared as important, especially regarding the creative process. In study II, the effects of group versus individual creativity were also investigated. The results indicated that IT can decrease relevant creative abilities for both individuals and groups considering its quantitative aspects, with small groups having a better process, and to some extent, also product. Concerning the IT variable, the face-to-face group produced significantly more incubations and overall, also had a better flow in the creative process. Finally, of interest for validity, participants' self-reported perceptions of product and process showed agreement with objective measures. In conclusion, the results suggest that IT affects the creative process somewhat negatively, leaving the creative product more or less unaffected.

Key words: Creativity, Information Technology, Small groups, Computer-mediated communication, Service development.

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Preface

This thesis takes a psychological approach, focusing on creativity, to human-computer interaction and service development. The reason for this is the fact that computer usage have wide implications for human beings. In order to use information technology in a successful way, knowledge is needed about its positive and negative effects. With such knowledge, it will be easier to perceive how information technology can be used in order to accelerate and enhance the development of, for example, new services.

First of all, I would like to thank my committee, consisting of associate professor Torsten Norlander and associate professor Karl W Sandberg, for sharing their scientific knowledge and giving encouragement.

For inspiration and stimulation, I would like to express my gratitude to my colleagues at the Service Research Center and the Department of Psychology at Karlstad University. Working with you truly provides an ambience that is both intellectual and creative.

I would also like to thank my colleagues participating in the project Service Development with IT-support: Professor Per Norling and ekon. lic. Markus Fellesson. For the help with making the computer system work at the user lab, I thank our systems engineer Nicklas Lundqvist. Finally, also thanks to the B.A. students participating in the project: Jenny Christensson, Anna From, Nina Hedlund, Matilda Jensen, Pernille K-Andersson, Anna Nilsson, Linda Svensson and Susanne Wallin.

According to research, creativity is stimulated by intrinsic motivation and also closely related to humour. Indeed, motivation and entertainment are two phenomena’s that have most certainly been present in all fun experiences that I have shared with several of my doctoral friends. You know who you are – and you know what we’ve done!

Important theoretical and empirical background for the project is constituted by Per Norling’s progress report from Telia [Tjänsteutveckling med IT-stöd. Lägesrapport]. The case studies presented in his report composes the starting point for this project. For more information about the current research status and future directions of the project, the research at Service Research Center at Karlstad University, or about me, you are welcome to visit our homepage at: www.ctf.kau.se/

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Introduction

“Everything in the world remains to be done or done over. The greatest picture hasn’t been painted. The ideal labor contract is yet unwritten. [...] The best way to train salesmen, an easy way to keep slim, a better way to pin diapers — all of these problems are unsolved. Not one product has ever been manufactured, distributed or advertised or sold as efficiently as it should be or someday must be...”. (Osborn, 1963; p. ix).

As Osborn (1963) puts it forward in the quotation above there is always a need for creativity. Creativity — the mental capacity to visualize, foresee and generate ideas is a capacity much sought for by people engaged in service and product development.

All innovation begins with creative ideas (Amabile, Conti, Coon, Lazenby, & Herron, 1996). Successful services, implementations of new programs, new products or their introduction all depends on a person or a team having a good idea — and developing that idea beyond its initial state.

The present investigation considers the problem of providing tools for groups and individuals dealing with creative work — the seed of innovation — using information technology to communicate ideas. There are several reasons why this topic is important, one concerns the development of new services, with the support of information and communication technology.

Creativity

For purposes of scientific inference the term creativity was first coined by Guilford in 1950. The concept was then an uniting of the two words “create” and “activity” (Guilford, 1950). The concept received great attention since it captured the essence in activities as producing, inventing, designing, contriving, composing and planning, to name a few. Because all these abilities are much sought for, and given great importance, by businesses, Taylor (1959) already 1959 was able to find more than one hundred definitions.

Guilford (1967) did not seek to provide a formal definition of creativity because he found that the diverse ramifications of such a concept “cannot be boiled down into one simple statement” (p. 420). He did, however, point out a few distinctions (Norlander, 1997):

1 Creative thinking culminates in novel ideas which may or may not emerge in the form of tangible products.
2 Novelty need apply only within the frame of reference of the thinking person himself/herself.
3 Creative productivity means quantity of output, namely number of responses of certain kinds, e. g. number of words, ideas, products and so forth.
On the basis of Guilford’s three distinctions Ekvall (1983) has formulated the following definition of creativity: “Creative thinking is characterized by the content of something new – new to the thinking individual himself. The level of creativity is linked to the level of novelty” (p. 11). Ekvall has also provided a definition which puts larger emphasis on the person and the product: “Creativity can be defined as an individual’s ability to come up with new and original products and ideas. A creative individual is a person who comes up with a lot of them” (p. 9). Norlander (1997) claims that: “creativity should be understood within the context of Guilford’s three distinctions, i.e. novelty, within-person novelty and quantity of output.” (p. 5). This means that the greater innovative power or newsworthiness of an idea for the thinking person in question, the more creative effort may be considered. By extension, this notion also implies that the greater number of ideas a person can generate the more creative they may be considered. Therefore, according to Norlander (1997), the level of creativity is related to both the degree of innovative power and the number of responses of certain kind, i.e. quality and quantity of idea generation.

The problem of defining creativity reminds of the difficulties the discipline of psychology also have had with defining and explaining the scientific concept of intelligence. Focusing on the mental ability to cognitively perform some activity, creativity have also been compared to intelligence. Nevertheless, creativity differs from intelligence by way of divergent thinking, which can be compared to convergent thinking, commonly associated with general intelligence (Runco, 1997).

- **Divergent thinking** is the intellectual ability to think of many original, diverse, and elaborate ideas.
- **Convergent thinking** is the intellectual ability to logically evaluate, critique and choose the best idea from a selection of ideas. Also, to infer from given and existing information, synthesizing it and drawing conclusions.

According to Guilford (1967) divergent thinking constitutes the core characteristic of creativity. However, some criticism has been raised towards the assumption that only divergent thinking would represent creativity, meaning that also convergent thinking is required for creative performance (Norlander, 1997). Divergent thinking is essential to the novelty of creative products whereas convergent thinking is fundamental to the appropriateness. Thus, any general definition of creativity must account for the process of recognition or discovery of novel ideas and solutions.

Guilford’s (1950, 1959, 1967) suggestions on the definition of creativity has been employed by Torrance (1965, 1966). Developing tests that measured divergent thinking (i.e., creativity), Torrance used the dimensions suggested by Guilford; Fluency, Flexibility, Originality and Elaboration. These dimensions does not only serve as a definition for what creative output could be, but also makes the concept of creativity operational for research situations. Fluency concerns the quantity of ideational responses given to a certain problem. Flexibility is the number of separate categories to which a response belong and originality is the number of novel responses. Originality concerns the novelty and remoteness of the responses and Elaboration the
amount of detail in responses. Given the problem of how to develop improved administrative services at the university the following examples of answers: “improve administration through giving students e-mail addresses”, “introduce uniform rules for administration” and “electronic information for students at busses to university”, would yield three points for Fluency (total number of responses), two for Flexibility (one point for the category e-mail [although two responses they both concern electronically sending out information], and one for the category uniform rules), but only one point for Originality (e-mail addresses for students and uniformity are commonplace, only electronic information for students at the regular buss traffic to university is novel) (Cropley, 1997). Originality and Elaboration represents more qualitative aspects of divergent thinking whereas Fluency and Flexibility accounts for quantity.

- Qualitative aspects of creativity          Originality
                                         Elaboration
- Quantitative aspects of creativity       Fluency
                                         Flexibility

In present investigation, an additional dimension has been added. The reason behind this idea is the field of product and service development. The dimension included is Innovativeness. Innovativeness concerns the ease of feasibility of an idea. Deriving from research it is presumed that Innovativeness play an important role for the success of new products and services since a proposed solution can be very original without being the slightest feasible (i.e., Innovative). Other researchers, as Norlander (1997), has also attempted to suggest additional dimensions.

It is worth noting that the mentioned dimensions used for assessing and defining creativity, shows some correspondance with the criteria’s for patent registration, as they are expressed by the Swedish patent bureau (Ekvall, 1983).

The dimensions described above involves a definition that uses the product as the distinguishing sign of creativity. Such definition is based on the conception that creativity results in the production of some novel outcome that is useful, tenable, or satisfying, and represents a real leap away from what has previously existed (Stein, 1974). From a product and service development point of view, the product definition approach to creativity appears very appropriate. Overall, the product definition approach captures the link between creativity and innovation, where innovation is viewed as the concrete application and implementation of a creative product. Or, as Amabile (1996) has described it: “creativity is the seed of all innovation” (p. 1155).

Another approach to the definition of creativity stems from the very process of creative activity. This approach is based on the assumption that anything that results from a creative process is creative. The creative process focuses on how the connection of at least two previously unrelated matrices of thought creates insight and invention. Newell and Simon (1972) has poetically described the dynamics of the creative process as the: “network of possible wanderings” (p. 82). Thus, focus on the process means focus on the core creating activity when and how it takes place. Because the development of a new service involves an iterative process, much like the creative
one, it appears appropriate to investigate the process of creativity from a product and service development point of view.

The product and process approaches are applied in present investigation. However, there are two other approaches (to the question of defining creativity), besides product and process, that have guided the research on creativity, namely person and press (Amabile, 1996; Norlander, 1997). The person definition approach concerns the notion that creativity is dependent on certain unique patterns of traits connected to an individual's personality. The press definition approach concerns the assumption that environmental and situational conditions are responsible for certain high quality creative activity (MacKinnon, 1971).

The creative product

Creativity can be a quality within individuals or within thought processes, or within the very result of the thought processes (Ekvall, 1988). As stated above the most explicit definitions of creativity have put emphasis on the last mentioned of these, the outcome (product) of the creating activity (Amabile, 1996). Most product definitions of creativity include the characteristics of novelty and appropriateness (Amabile, 1966; Ekvall, 1988). The four dimensions; fluency, flexibility, originality and elaboration, derived mainly from Guilford's theory (1967) captures these characteristics and makes them and divergent thinking operational.

A problem concerning the scientific assessment of creativity involves the question of how to measure them. Amabile (1996) has presented a solution to this problem, and with this also a solution to the problem of defining creativity. Amabile's definition derives from a social psychological-oriented research where she empirically has investigated how different work environment correlates with creativity. In order to assess creative production she has developed a consensual definition. The rationale of the consensual definition is that two or more persons, with presumed expertise within the given area, is to judge the creative value and merit of a certain contribution. Judges should make their assessment on their own, independently of each other. Afterwards the judges assessments are compared, if there is consensus about the creative merit of a product, the judges estimation appears to be a reliable and valid verdict, this assumption being based on the fact that the judges had expertise within the domain. The consensual definition is: "... closely aligned with most of the product definitions [...] in its inclusion of novelty and appropriateness as two hallmark characteristics of creativity" (1996, p. 35). Norlander (1997, 1999) has employed Amabile's consensual definition and suggests 'the Amabile approach' in empirical situations because of the difficulties of establishing a concrete and operational definition of creativity. In Norlander and Gustafson (1996) and Norlander (1997, 1998) Amabile's consensual definition has been used in the way that raters independently of each other rates creativity on a scale ranging from 1 to 10. After the rating a Pearson product-moment correlation is executed along with interviews in order to assess the inter-judge reliability. The Norlander procedure diverges from Amabile in one aspect. Amabile (1996) has described the essence of the consensual technique as follows:
"The essence of the consensual definition is that experts in a domain can recognize creativity when they see it, and that they can agree with one another in this assessment. If experts say (reliably) that something is highly creative, we must accept it as such. The integrity of the assessment technique depends on agreement being achieved without attempts by the experimenter to assert particular criteria or attempts by the judges to influence each other. Thus, the judges should not be trained by the experimenter to agree with one another, they should not be given specific criteria for judging creativity, and they should not have the opportunity to confer while making their assessments" (p. 42).

The Norlander procedure differs from Amabile’s proposals in the aspect that judges are given the suggested dimensions of creativity from Guilford as a guiding principle when making their estimation. Amabile’s consensual definition implies, which is clear from the citation above, that no specific criteria should be given. In present investigation, the Norlander procedure is employed. Put more concretely this means that independent raters have judged final solutions (the product) from, for an example, an originality point of view.

The creative process

The scientific concept incubation stands for the unconscious and involuntary mental activity that takes place during an act of complex problem-solving. The concept can be traced back to Wallas of 1926, who outlined a model for the creative act. Considering that Wallas presented his model for nearly three-fourths of a decade ago, it is astonishing that the different stages of his model is still, by researchers in the field, described in his terms (Koski-Jännes, 1995; Norlander, 1997) or regarded as consistent with more recent models (Runco, 1994).

In Wallas (1926) work, the creative process is viewed as a sequential process. He describes the background of his work as follows: “... take a single achievement of thought – the making of a new generalization or invention, or the poetical expression of a new idea – and ask how it was brought about. We can the roughly dissect out a continuous process, with at beginning and a middle and an end of its own” (p. 79). Wallas model of the creative process contains four phases: preparation, incubation, illumination and verification.

The first stage of the creative process involves preparation. The preparation phase contains, interpreted by Guilford (1971), the motivation and energy to overcome obstacles and problems, in order to start gathering of information and reach competence. It seems reasonable that the more intensively one prepares to solve a problem, the better the chances are of achieving good results. According to Guilford (Norlander, 1997), convergent thinking is an important ingredient in this phase. The next step involves incubation. As previously mentioned, incubation occurs under to a large extent unconscious forms. During the incubation phase the individual does not
center on any specific problems. Instead Wallas (1926) describes this phase as a maturing one where the individual dwell, simmer and ripen upon series of different unconscious and involuntary mental activities. According to Wallas the individual can pursue completely different activities, other than the present, during incubation. Thus, the incubation phase does not imply any explicit thought efforts, notwithstanding it appears as the engine in the creative thought process. During the third phase, the one of illumination, the result of the incubations takes place in form of a "instantaneous flash" (p. 95). Thus, Wallas illuminates illumination by describing it with the well-known metaphor of creativity – the sudden flash, or click – as the culmination of a successful train of thought associations. In sum, when the unconscious processes during incubation has matured, solutions emerge in the illumination phase. The final phase, verification, resembles the first one, preparation, in the way that they both are fully conscious and it is possible to work according to logic rules (convergent thinking) in order to take control of it (Norlander, 1997). The verification phase implies that there should be an creative solution that are tested and elaborated in some way (Guilford, 1971).

Patrick (1935, 1937, 1938) offers the first systematic attempt to confirm Wallas's suggestions about distinct and definable stages in the creative process. Asking persons involved in creative writing, drawing, and scientific problem-solving to describe their thoughts while working, she sought to observe the creative process as directly as possible. Her works thus represent a landmark attempt to carry out psychological experiments on the creative process (Rothenberg & Hausman, 1976). In an elegant manner, the scientific work of Patrick makes it possible to investigate the creative process in individuals and/or groups. The preparation phase is indicated by assertions and thought changes. An example of an assertion could be a statement like: “this was a difficult task”, or: “we seem to be trapped here”. An example of a thought change, the first addressing of an idea, could be as follows: “now that we have defined what the problem really concerns, the idea of expanding the university library seems to be a successful way to deal with it.”. Incubations are indicated when the person (-s) returns to an earlier presented idea with more or less modification. In order to count as an incubation the idea must have recurred in some way, this means that the subject (-s) have been discussing another topic, or been silent, before the recurrence of the idea. An example of this could be a statement like: “I’d like to add, to my previous idea of carrying out information, electronic blackboards in the center...”. When a final plan has been formulated this is an indication of the third phase of Wallas, illumination. The formulation of the plan should be distinctly, separating it from incubations (Norlander, 1997). The seminal work by Patrick has later been used empirically by, for example, Norlander (c.f., 1997, 1999), and her approach is also employed in the present investigation.

As for the assessment of the creative product, and in accordance with the consensual definition, independent judges have been used for the assessment of the creative process as well.
The research situation

Osborn (1963), recognized as the father of group brainstorming, has captured the all-importance of creativity in a simple model of human mental capacities (p. 1):

1. Absorptive – the ability to observe, and to apply attention.
2. Retentive – the ability to memorize and to recall
3. Reasoning – the ability to analyze and to judge
4. Creative – the ability to visualize, to foresee, and to generate ideas.

By artificial intelligence it has been possible, at least to some extent, to perform those first three functions. It seems certain that no machine ever will be capable of the generation of ideas. Considering the great increase of utilization of information technology – however – it seems almost certain that it will have some effects on the creative work performed by individuals and groups using it. Present research aims to investigate the effects information technology will have on creativity for individuals or small groups.

Connolly, Jessup and Valacich (1990) has proposed a conceptual framework for the study of creative processes within a computer supported collaborative work perspective. Their framework makes it possible to study how information technology communication affects idea generation in groups. Connolly et al. postulate that idea generation in a group interaction could either be enhanced or reduced with respect to quality and quantity. Building on Osborn (1963), Connolly et al. (1990) infers that the group, on the positive side, can provide encouragement, stimulation or reward inspiring creative contributions. This assumption, of course, being made under the condition that the group is given a task of sufficient relevance and interest. On the negative side, working in a group might inhibit contributors expecting embarrassment, hostile evaluation, conformity pressures or other negative events for proposing an unusual idea. Not enough, research has identified more obstacles possible when working in groups. Connolly et al. (1990) states:

"Combining individual efforts into a group output opens the possibility of free riding or social loafing. And the mechanics of the combining process itself might provide obstacles to contribution [...] as in ideas which are forgotten or edited while their originator waits for an opportunity to speak." (p. 690).

In summary, Connolly et al. concludes that the group’s overall creative effectiveness depends on the balance it achieves between the positive and negative forces just described. Consequent with the analysis, Connolly et al. present a ‘balance of forces model’ making it possible to predict, evaluate and design experiments investigating the effects of information technology upon creativity (see Figure 1).
Connolly et al.'s model is employed in present investigation. The effects of the creativity enhancing and stifling forces are, to a large extent, influenced by interpersonal, face-to-face, communication. This means that the enhancing and stifling forces present in Connolly et al.'s model can vary with effects on creativity as a consequence if the communication arena changes.

The creativity enhancing forces concerns encouragement, stimulation and reward. Osborn (1963) postulated these processes as important when he launched his brainstorming technique (1993). Amabile (1996, 1989) have, using the critical-incident technique, empirically found evidence for their importance in high-creativity projects. At the organizational level research demonstrates that people are more likely to produce original and fruitful ideas if they are given encouragement to do so. Also, experimental laboratory studies has revealed that threatening, highly critical evaluation undermines creativity. From a supervisory perspective encouragement has shown to be important especially in the areas of goal clarity and the supporting interaction between supervisor and team members work and ideas. At the work-group level creativity was, among other things, enhanced by mutual openness to ideas, constructive challenging of ideas, and shared commitment to the project. Finally,
Amabile (1996) has also showed that the motivation to pursue creative production for internal reasons, such as satisfaction, rather than for external reasons, are one of the more important processes when it comes to enhancement of creativity.

Diehl and Strobe (1987; 1991) has extensively discussed the details of negative forces in group ideation (Connolly et al., 1990). Evaluation apprehension is a concept describing how expectations of negative (and positive) outcome will cause poor performance. For an example, if an plausible idea contributor anticipates embarrassment, hostile evaluation or anything similar, the contributor is likely to keep silent about his/her thoughts. Thus, the mere presence of some group members may intimidate others. Social loafing is an old concept in the field of psychology. It was first coined by the French researcher Ringelmann already in 1913 (Kravitz & Martin, 1986). Ringelmann conducted experiments and discovered that the more people participating in a task, the lesser the individual effort was. The force exerted per individual decrease as a function of increased group size — sometimes referred to as “the Ringelmann effect”. Production blocking is a question of reduction in individual creativity and productivity due to interruptions and turn-taking (Stroebe & Diehl, 1994). This means that some kind of interference effect arises when a person has to contend with others generating ideas at the same time as one is attempting to generate one’s own ideas. Stroebe and Diehl concludes that production blocking is the main obstacle to unlocking the creative potential of brainstorming groups.

Given the information about the enhancing and stifling forces of creativity, the question whether groups are more creative than individuals needs to be addressed. In fact, research indicates (Diehl & Strobe, 1987) that there is no evidence that groups are more creative than individuals when it comes to brainstorming. On the contrary, in a study by Paulus, Dzindolet, Poletes and Camacho (1993) nominal groups (i.e. groups in which individuals create ideas on their own without interacting) were shown twice as creative as true interactive groups. Study one in the present investigation takes its starting-point from the question being addressed. Stroebe and Diehl (1994) has reviewed evidence for the stifling group forces above and mentions some possible remedies of which especially one is worth mentioning: Electronic brainstorming. Electronic brainstorming reduces the extent to which the production of new ideas is blocked by such things as listening to others or waiting for a turn to speak. Groups which brainstorm electronically via computer can produce more ideas than non-electronic groups and more ideas than nominal electronic groups (Dennis & Valacich, 1993). Also, in line with this, it has been suggested that people communicating via computers tends to be more task-focused than face-to-face groups (Straus, 1997). An plausible explanation of this is that communication is perceived more difficult why social conversation takes place less often. Thus, previous theory and research implies that information technology communication can have both positive and negative effects on creative performance.

The research context

Current research about new product and service development indicates that creativity plays an important role within the development process in general, and in
the early phases in particular (Scheuing & Johnson, 1989; Brown & Eisenhardt, 1995; Clark & Wheelwright, 1994; Jönsson, 1995). This counts for information technology as well. Consequently, applying the research about creativity, and how it is influenced by information technology communication, will generate knowledge that contributes to the context of new product and service development.

Research has shown that prosperous companies have a successful product development process (i.e., Cooper, 1993; Zirger & Madique, 1990). Cooper has also shown that the product development process is a critical factor concerning the success for a new product. In short, the product development process seems to be the key to success for business companies. Cooper (1993) asserts with emphasis that this process could be made more efficient, with larger profits as a consequence:

"Getting high-quality new products to market on time is one of the most crucial aspects of succeeding in business. It’s also the most difficult to achieve." (cover page).

There ought to be no exception for service development regarding the significance of this.

Research into the development of new products and services has resulted in several, quite similar, models of the development process (Johne & Storey, 1998). A well known and often referred model is presented by Scheuing and Johnson (1989) (e.g., Johne & Storey, 1998; Martin & Horne, 1995; de Brentani, 1995; Edvardsson, Haglund & Mattsson, 1995) and shown in Figure 2.
As evident from the model, development of new services, and products also for that matter, begins with an idea. A broad overview of theories describing product and service development also validates this conclusion (e.g., Wilhelmsson & Edvardsson, 1994; Edvardsson, 1996).

Research has shown that the number one new product development success factor is product uniqueness (Cooper & Kleinschmidt, 1987). Another way of saying the same is that a company can not do better than its products allow. In conclusion, it is difficult to make a living selling something people don’t want to buy (Stevens, Burley & Divine, 1999). Findings like these calls for creative ideas concerning new products and services. In a recent article Stevens et al. (1999) review research on new product development. They found that the most significant differences between successful and unsuccessful products lie in the quality of execution of the first few stages of new product development. Or, as Stevens et al. puts it forward: “the first few

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**Figure 2: A normative model of the service development process (Scheuing & John-son, 1989, p. 30).**

| Marketing objectives → 1. Formulation of new service objectives and strategy | ← Environmental analysis |
| Internal sources → 2. Idea generation | ← External sources |
| 3. Idea screening | |
| Customer contact → 4. Concept development | ← Prospects |
| 5. Concept testing | |
| Budget development → 6. Business analysis | ← Market assessment |
| 7. Project authorization | |
| Operations personnel → 8. Service design and testing | ← Users |
| Operations personnel → 9. Process and systems design and testing | |
| 10. Marketing and program design and testing | ← Users |
| 11. Personnel training | |
| All personnel → 12. Service testing & pilot run | ← Users |
| 13. Test marketing | ← Users |
| 14. Full-scale launch | |
| 15. Post-launch | |
stages of the game seem to decide the outcome!” (p. 458). Thus, the early stages of development cycle appears to be the most important for success.

de Brentani (1994) has studied new service development within the financial market and stresses the importance of a creative and communicative climate for success. She states:

"In sum, a primary key to developing winners lies in creating an innovative and open new service development culture within the firm where top management supports new ideas, and encourages communication and involvement from among its diverse resources” (p. 21).

As shown earlier, creativity is the starting point of any new development process. However, research suggests that creativity is virtually more essential in the new service development process than in the new product one (Edvardsson, Haglund & Mattsson, 1995). It is the uniqueness of services that brings these consequences. Edvardsson et al. (1995) has identified three service characteristics that make idea generation particularly important. Firstly, they point out that the development of new services often has a lesser need for large capital compared to product development. The reason for this is that service development does not need that large investments in production facilities. Secondly, because that services are often immaterial the speed of imitation is fast, much faster than in product development since they have to produce the product in a very physical and concrete way. Services, on the other hand, are often produced, consumed and delivered at the same time (Zeithaml & Bitner, 2000; Zeithaml, Parasuraman & Berry, 1990; Grönroos, 1990). Finally, because of the special characteristic of services there is a larger threat of new competitors. Altogether these characteristics make idea generation in service development more crucial than in product development. Thus, there is a large need to continuously generate new ideas for service companies if they are to stay in business. In conclusion, all estimates seem to indicate a substantial need for creative performance in the early phases of service development.

The information technology being studied

According to Cairncross (1998), a significant impact that information technology will have - except for reducing the importance of distance - is the proliferation of ideas and the communication of the same: “Innovation has become a global game everyone can play”. (p. ix). The fate of location and the reduced importance of distance will make it much easier for small- and medium sized companies to offer services that, in the past, only giant corporations had the scale and scope to provide. Individuals with valuable ideas, initiative, and strong business plans can attract people worldwide, conveying the ideas into viable business. As a consequence, small- and medium sized companies will have the possibility to, via improved networks, have a more customized approach. An opportunity earlier possessed only by very large companies (Cairncross, 1998).
Most work today is performed by people working together in groups of some kind (McGrath, 1984). Information systems that supports group work is generally referred to as Group Support Systems (GSS). GSSs are a set of techniques, software and technologies designed to focus and enhance the communication, deliberations and decision making of groups (Nunamaker, 1997). A GSS eases the cognitive load of teams working in concert toward a mutual goal. According to Nunamaker, GSS will continue to thrive and develop primarily because organizations need to do more than share information to succeed in the global marketplace.

In present investigation, two forms of information technology that enable communication are being studied. The information technology software that were used are available at the Internet and aims to support group work when individuals are separated geographically. Digital conference arenas like these strives to enhance the internal communication of an organization. It is doing so by offering continuously updated, systematic and visual information that provides an overview of, for example a development process, establishing what is done and what is to be done next. Both information technologies that are studied carry the characteristics of GSS described above (Nunamaker, 1997). The first form of such information technology that is used in the studies is a text-based chat where only written information can be transmitted (referred to as Chat in the studies). On this kind of conference arena individuals participate under more or less anonymous forms. Another kind of Internet-based software was used to represent the second form of information technology. This conference arena, referred to in the study as Videoconference, allowed interacting individuals to see each other while communicating. The two kinds of information technology are, in the studies, compared with groups interacting face-to-face (FtF).

**Summary and conclusions**

Previous theory and research for creativity have been reviewed. The starting point for the theoretical foundation of creativity is provided by Guilford (1950). Guilford (1967) views fluency, flexibility, originality and elaboration as essential dimensions of the creative product. The creative process is also important for the creative performance. The process of creativity is described sequentially containing preparation, incubation, illumination and verification (Wallas, 1926). Patrick (1935, 1937, 1938) has contributed with an operationalized model for Wallas (1926) creative process. Investigating how creativity is affected in some way, for example by information technology, the creative product and process needs to be considered.

According to psychological research, creative performance is the preceding of innovation. Norlander (1997) claims that it is the creative problem-solving that undergoes application and evolves into innovation. This opinion is also shared by Amabile (1996) who views creativity as the seed of innovation. Therefore, creativity appears as an important object of study if one is to contribute to areas such as product and service development. In line with this, empirical findings emphasizes a creative and communicative climate as an important prerequisite when developing new products or services (de Brentani, 1994). Along with this, information technology pro-
vides a tool for communication (the spread of information). With the globalization of market information technology will be an essential tool facilitating communication both internally and externally within organizations. External communication, as when a company generate ideas together with customers or from customer information, has been emphasized among several researchers (i.e., Edvardsson & Gustafsson, 1999; Edvardsson, 1996; Zeithaml et al., 1990). Subsequent research implies that internal communication are equally important (Lievens et al., 1999; Edvardsson & Gustafsson, 1999). According to Cairncross (1998), information technology is a instrument that enhances and facilitates connection, networking and communication.

Connolly et al. (1990) provides a conceptual framework for studying the effects of information technology on creativity. The ‘Balance of Forces Model’ postulates that creativity in a group interaction can be either enhanced or reduced with respect to the dimensions of creativity suggested by Guilford (1967) and the process by Patrick (1935, 1937, 1938). The advantage with the framework provided by Connolly et al. (1990) is that it provides the possibility to carefully assess how critical variables effects creative performance.

The present investigation

Although the use of information technology is proliferating in organizations today, inconclusive gains are made about how communicating electronically affects many aspects of work (e.g., Straus & McGrath, 1994). Because information technology constitute an important communication vehicle in service development, the question of how different information technology tools supports group work needs to be addressed. Therefore, with the intention to contribute to the context of new service development, the effects of information technology on creativity is examined in this thesis.

The aim of the present study was to identify how different information technologies, in the form of Internet based group support systems, would influence the creative performance in groups and further to investigate the relation between these results to individual performance and the importance of user beliefs.

Most prior research has focused on how theoretically interesting aspects, such as anonymity and parallel communication, influence group creativity. However, this investigation builds on recent calls (Nunamaker, 1997) maintaining the need for research that harness the potential of information technology (Sosik & Avolio, 1998).

Employing the ‘Balance of Forces Model’ from Connolly et al. (1990) provides the possibility of assessing the creative performance of groups using different kinds of information technology. An underlying assumption permeating this investigation, influenced by the seminal works of Chapanis (e.g., 1972), is that the transmittance of social cues will influence the performance of a group working with a complex task. That means that being able to receive information from more modalities than one (i.e. both auditory and visually) is assumed to effect the coordination of work within a group. Thus, different sorts of information technology based communication arenas might influence idea generation differently, depending on the amount of verbal and
non-verbal communication cues a certain information technology arena allows being transmitted. Thus, the study aims to shed light to whether the amount of instant visual communication exerts influence on the creative performance on a group working with a complex task with high need of coordination. In accordance with this assumption, and the Balance of Forces Model, three different ways of communicating constitutes the independent variables being studied.

An Internet-based software (Microsoft NetMeeting 4.0) was used to represent a text-based chat form of communication. In a text-based chat only written information can be transmitted. Thus, there was no possibility of face-to-face interaction in this computer-mediated communication form (furthermore referred to as Chat). Another sort of Internet-based software (Whitepine Cu-SeeMe pro), allowing interacting individuals to see each other while communicating, was used to represent a second form of computer-mediated communication (Videoconference). Finally, in the spirit of experimental research, the two kinds of information technology above was compared with groups interacting face-to-face (FtF). Thus, the three experimental groups allowed a gradually increasing amount of interaction between participants.

Altogether 222 persons participated in the two studies. Each participant had to solve a problem that aimed to resemble a situation close to service development. Also, each participant received a fee for participating. The problem was heuristic to its nature, meaning it was only possible to give more or less well elaborated answers since the task did not have a clear and readily identifiable path to solution (Amabile, 1996). In this way, the experiment resembled the situation of developing a new service.


According to research, there ought to be a relation between user beliefs about the potentials of information technology and the level of success by which these users manages them (Davis, 1989; 1993). The objective of this study was to examine the relationship between creative performance in groups and their perceived usefulness of information technology as a communication tool. Deriving from research emphasizing the importance of idea generation in new service development (Scheuing & Johnson, 1989), study I was designed to examine the effects of information technology on creativity in relation to the participants acceptance of information technology.

The experimental designed was modeled after Connolly et al.'s (1990) Balance of Forces Model (see Figure 3).
A 3 X 2 between groups design was used in study I. Independent variables was, to begin with, communication form where two GSSs conditions were compared to each other and to a Face-to-face condition; secondly, participants positive or negative perceived usefulness of IT as a means for communication.

The study was conducted in a user laboratory situated outside the university campus area. 126 men and women were randomly assigned into any of the three communication conditions. The participants were also evenly and randomly assigned into a group (consisting of three participants) with positive or negative acceptance across these conditions.

The experimental session was composed of three phases consisting of two meetings, an original and final meeting, with a thought period in between (c.f., Norlander, 1996). On arrival at the laboratory on the original meeting participants were instructed to fill out a questionnaire concerning background information, a test measuring life orientation (Scheier & Carver, 1985). Each participant then received a complex problem to work with. All participants had a 48 hour intermission between the original and final meeting. Participants were during this time instructed to report in a
notebook notions of concern for the problem. In this second phase, all participants worked individually. At the final meeting the participants was instructed to outline in detail a plan considered optimal to solve the problem given at the original meeting. Also, at the final meeting, data concerning participant satisfaction were collected. The aim of the experimental procedure was to try to emulate a typical project sequence in product or service development. In order to make the experimental setting more realistic, all participants were informed that the three best ideas would be rewarded with a cash price of SEK 1 000.

Overall, the experiment produced three main results:

1. The face-to-face group generally evoked more creative results indicating the importance of face-to-face interaction when there is a need to produce many ideas.
2. The completed solutions of the face-to-face group were assessed as being more productive than the two computer-mediated groups. The Videoconference group showed higher results than the Chat group, indicating that the more real life like conditions are, the better fluency of ideas.
3. Concerning the IT variable the face-to-face group perceived their both their process and their product as significantly better than the computer-mediated groups.

Taken together, the results indicate that the more face-to-face interaction that is permitted, either through personal meetings or by some information system, it will have beneficial consequences for the creative performance of groups.


In his influential book, Osborn (1993) claimed that if the principles behind brainstorming was followed: “the average person can think of twice as many ideas when working in a group than when working alone” (p. 229). There is still a common belief among academic scholars as well as business leaders that groups are viewed as an asset and valuable resource useful when generating innovative and creative ideas (Ilgen, Major, Hollenbeck & Sego, 1993). However, according to recent research (Dennis & Valacich, 1993) many of the benefits claimed by Osborn (1993), the father of group brainstorming, have remained illusory. Deriving from research emphasizing the importance of idea generation in new service development (Scheuing & Johnson, 1989), study II was designed to examine the effects of information technology upon creativity comparing small groups with individuals.

The experimental designed was modeled after Connolly et al.’s (1990) Balance of Forces Model (see Figure 4):
A 3 X 2 between groups design was used in study II. Independent variables was to begin with communication form, where two GSSs conditions were compared to each other and to a Face-to-face condition and secondly, group versus individual creative performance within these communication conditions.

The study was conducted in a user laboratory situated outside the university campus area. 96 men and women were randomly assigned into any of the three communication conditions. The participants were also evenly and randomly assigned into a group (consisting of three participants) or individual across these conditions.

The experimental session was composed of three phases consisting of two meetings, an original and final meeting, with a thought period in between (c.f., Norlander, 1996). On arrival at the laboratory on the original meeting participants were instructed to fill out a questionnaire concerning background information, a test measuring life orientation (Scheier & Carver, 1985), and a test measuring the attitude to creativity with respect to change and stability, the FS-test (Holmqvist, 1986). Each participant, group or individual, then received a complex problem to work with. No matter working individual or group-wise all participants had a 48 hour intermission
between the original and final meeting. Participants were instructed to report in a notebook notions of concern for the problem. Thus, in the second phase all participants worked individually. At the final meeting the participants, group-wise or individually, were instructed to outline in detail a plan considered optimal to solve the problem given at the original Meeting. Also, at the final meeting, data concerning participant satisfaction were collected. The aim of the experimental procedure was to try to emulate a typical project sequence in product or service development. In accordance with this, all participants received notice that the three best ideas would be rewarded with 1 000 Swedish crowns.

Overall, the experiment produced the following results:

1. Regarding the creative product small groups showed a higher flexibility, implying that groups are able to produce a larger variety of ideas than individuals. Although no differences were found regarding fluency for the Assemblage variable a comparison revealed that individuals produce more ideas being on their own than individuals working in a group.

2. Regarding the creative process the face-to-face group showed significantly better results in respect to incubation. This pattern was shown both at the Original and Final meeting. The small groups also produced significantly more incubations than individuals.

3. Subjective measures regarding participant satisfaction showed participants communicating face-to-face perceived their process more satisfying than both computer-mediated groups.

Taken together, the results indicates that although their were no differences found regarding the product, the Face-to-face condition had a better creative process. In accordance with what Osborn (1953) would suggest groups proved to generate more flexible solutions. Although no significant differences were found regarding fluency, a paired-samples t-test showed that the individuals not participating in a group produced significantly more ideas. This is in line with more recent research (Stroebe and Diehl, 1994).

Conclusions

Overall, the primary aim was to investigate how different kinds of information technologies, in the form of Internet based group support systems, would influence the creative performance in groups. Inferring from the empirical data in present research, a pattern was found indicating that face-to-face groups generally appeared to be more creative than the computer-mediated communication groups. Although the findings provides some support for face-to-face interactions, particularly concerning the creative process, the studies suggests that the dimensions of the creative product are affected differently. For example this concerns the more qualitative dimensions, elaboration and originality, who were unaffected by IT variable in both studies.

Study I also aimed to investigate how the perceived usefulness of information technology as a means for communication affected the creative performance. Al-
though the results regarding the creative process gave some support for the notion that a positive attitude conveyed a better creative performance, the overall tendency was rather uncertain. For example, no effects were found regarding the creative product and differences concerning the creative process were found only in the preparation phase.

In study II it was also investigated how groups differentiated from individuals concerning the creative performance using computers. The results indicated that the Face-to-face group had a better creative process however this did not have any significant implications for the creative product. Also, groups produced more flexible solutions than individuals.

A contribution with the present investigation is that it uses the same kind of independent variables in both studies (the IT condition). The empirical data also reveals a certain pattern in both studies. Overall, the only inconsistency discovered concerns Assertions at the Original meeting where the face-to-face group is significantly superior in study I but has significantly fewer (than the computer-mediated groups) in study II. These results and others that in the first hand seem to concern methodological aspects of studying creativity is of interest, but it is clear that more research lies ahead.

An interesting pattern that also were present in both studies concerned the fact that the differences between computer-mediated groups and face-to-face groups was declining at the Final meeting. A plausible explanation that accounts for this is that participants had learned to use some implicit rules of how to interact during the Original meeting. It therefore appears important, from a managerial perspective as well as from a scientific, to investigate and establish interaction protocols that explicates and regulates the computer-mediated communication process.

As concluded the studies give some support to the interaction of people in face-to-face meetings when generating ideas. However, these findings, along with additional research (cf., Carey & Kacmar, 1997), emphasizes not only the importance of face-to-face interaction but also that the usage of advanced computerized group support systems has narrowed the gap to interacting face-to-face, at least concerning some aspects of creativity. The fact that new Internet based group support systems surmounted older and more conservative suchlike was confirmed in study I regarding fluency. These results indicated a pyramidal effect where creative performance increased with the amount of face-to-face contact being permitted.

The present studies have assumed that the amount of face-to-face contact that a certain information technology system allows have a positive relation to creative performance. However, since some results appear contrasting it seems important to further investigate the components of creativity in computer-mediated environments. To reach relevant and managerial knowledge about this, research should consider to enlarge the small-scale experimental approach that have been used here. With the present findings as the point of departure, it seems interesting to investigate if any combinations of face-to-face and computer-mediated meetings would affect the more qualitative dimensions of the creative product. Presumably, each dimensions involves unique information-processing patterns, where computer-mediated communication does not seem to affect the patterns of the qualitative ones. It is also possible that the
qualitative dimensions were left unaffected because of the individual time-period that was used in the experimental setting.

Furthermore, it also seems natural to study if the present findings can be ecologically validated outside the laboratory setting. This question calls for a more naturalistic study, maybe with the usage of the critical incident technique (e.g., Amabile & Gryskiewicz, 1987). Despite the limitations noted, this study is valuable because it represents a step toward understanding how different communication arenas might not affect all dimensions of creativity, and also because it took care of the fact that creative work appears intra-personal as well as inter-personal with the use of Patrick’s design (1935, 1937, 1938).

Taken together, creating new services may become increasingly dependent on the ability to use information technology as a medium for innovation. It should therefore be possible to formulate several hypotheses aiming to gain knowledge about how information technology can be used to facilitate the early phases of service development. Furthermore, from an service development point of view, an important question that needs to be addressed concerns how creativity can play an essential role sparking breakthrough thinking. Whereas evolutionary product or service improvements often follow predictable paths, breakthrough innovation involve unexpected leaps of creativity and insight. Although such original thinking may manifest itself in a variety of ways, its source is always the same: the creative power of the human mind (Mas-citelli, 2000). This last question calls upon additional experimental studies, utilizing customers’ creativity to lead the development process of new services.
References


The Effects of Information Technology and Perceived Usefulness on the Creative Performance in Small Groups

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Abstract: The effects of information technology on the creative performance in small groups was examined. An experimental 3 x 2 design was used in order to assess the effects of information technology and perceived usefulness on the creative product and process. The consensual technique was used to obtain measures of creativity. Results of analysis of variance indicated the face-to-face group evoked more creative results. The more real life like conditions were, the better fluency of ideas. Regarding the creative process most occurrences appeared in the preparation phase. The computer-mediated groups showed more activity in the preparation phase. Small effects were found due to participants perceived usefulness, indicating that groups with negative attitudes asserted more. Participants in the face-to-face group were more satisfied with their process than was the case in the computer-mediated groups. It was suggested that social context cues can contribute to group communication by stimulating task motivation among participants.

Keywords: Creativity, Information Technology, Small groups, Computer-mediated communication, Product, Process.

Introduction

The quality of new products and services is greatly dependent on the creative performance of individuals working in groups. Both normative and empirical research suggests that project teams should be assigned to work with the development of a new good or service, from idea generation to market launch (e.g., Brown & Eisenhardt, 1995; Clark & Wheelwright, 1994; Edvardsson, 1996). However, on the contrary to what one might expect, creativity research over the past decades has indicated that creative efforts made by groups are not always as successful as suggested or imagined (e.g., Diehl & Stroebe, 1987, 1991; Stroebe & Diehl, 1994; Paulus, Dzindolet, Poletes & Camacho, 1993). Psychological processes as evaluation apprehension, free riding and production blocking accounts for a great deal of explanation of this. Interestingly, research indicates that these weaknesses might be surmounted by the use of information technology (Dennis & Valacich, 1993). Although the use of information technology is proliferating in organizations today, little advance has been made concerning how communicating electronically affects various aspects of work (Straus & McGrath, 1994), this concerns creativity in particular. Because information technology constitute an important communication tool in many development projects, the question of how
information technology influences the creative performance in groups is addressed. Therefore, with the intention to contribute to the new product and service development context, the effects of information technology on creativity is studied in this paper.

**Previous theory and research on creativity and information technology**

For purposes of scientific inference the term creativity was first coined by Guilford in 1950. The concept was then an unifying of the two words “create” and “activity” (Guilford, 1950). The concept received great attention since it captured the essence in activities as inventing, designing, composing and producing, to name a few. Because all these abilities are much sought for, and given great importance by business, Taylor (1959) already 1959 was able to find more than one hundred definitions.

In present paper creativity is defined from a product and process perspective. The product is assessed through Guilford’s (1967) four dimensions of creativity; fluency, flexibility, originality and elaboration. The process is assessed through Wallas (1926) four phases; preparation, incubation, illumination and verification.

Connolly, Jessup and Valacich (1990) has proposed a conceptual framework for the study of creative processes within a computer supported collaborative work perspective. Their framework makes it possible to study how information and communication technology affects idea generation in groups. Connolly et al. postulate that idea generation in a group interaction could be either enhanced or reduced with respect to quality and quantity. Building on Osborn (1993), Connolly et al. (1990) infers that the group, on the positive side, can provide encouragement, stimulation or reward inspiring creative contributions. This assumption, of course, being made under the condition that the group is given a task of sufficient relevance and interest. On the negative side, working in a group might inhibit contributors expecting embarrassment, hostile evaluation, conformity pressures or other negative events for proposing an unusual idea. Not enough, Connolly et al. also mentions the mechanics of the combining communication process as an obstacle for a group, referred to as production blocking. This can occur for example when: “ideas [...] are forgotten or edited while their originator waits for an opportunity to speak.” (p. 690). Diehl and Strobe (1987) has more extensively discussed the details of negative forces in group ideation. In summary, Connolly et al. (1990) concludes that the group’s overall creative effectiveness depends on the balance it achieves between the positive and negative forces just described. Consequent with this analysis, Connolly et al. presents a ‘balance of forces model’ that makes it possible to predict, evaluate and design experiments investigating the effects of information technology on creativity. Their model is, with some adaptation, employed in present investigation (see Figure 1).
Amabile has found that encouragement is of utmost significance enhancing creativity (Amabile, Conti, Coon, Lazenby & Herron, 1996). Furthermore, she has also noticed that creativity gets killed much more often than it gets supported (1998). Her notions on how to ‘kill creativity’ is well in line with the stifling forces mentioned by Connolly et al. (1990). Stroebe and Diehl (1994) has reviewed evidence for the stifling group forces mentioned above and suggests some possible remedies of which especially one is worth mentioning; namely computer-mediated communication. Computer-mediated communication reduces the extent to which the production of new ideas is blocked by such things as listening to others or waiting for a turn to speak. Groups that brainstorm electronically via computer can produce more ideas than non-electronic groups and more ideas than nominal electronic groups (Dennis & Valacich, 1993). Also, in line with this, it has been suggested that people communicating via computers tend to be more task-focused than face-to-face groups (Straus, 1997). A plausible explanation of this is that communication is perceived more difficult why social conversation takes place less often. In conclusion, previous theory and research implies that information technology can have both positive and negative effects on creative performance. The benefit of the conceptual framework set out by Connolly et al.

Figure 1. The Balance of Forces Model (Connolly et al., 1990) adapted and employed in the study.
(1990) is that it enables the study of how different critical variables affects creativity. In the present investigation it will be studied how information technology effects creative performance in a group of people collaborating on a heuristic task.

Creativity in Product and Service Development

The development process of new products and services is a complex and iterative process often performed by groups of people. This makes the communication between the parties involved crucial for success. However, product development is not just any organizational work process, it is a process highly dependent on creativity (Clark & Wheelwright, 1994). Creativity is a unique and complex human capability that, on the group level, is tightly interwoven with communication. In order to make communication of a concurrent product development project work more efficiently the usage of information technology have been proposed (e.g., Brown & Eisenhardt, 1995; Clark & Wheelwright, 1994). However, before altering the modes of communication in product and service development projects, there is a need to consider what effects computer-mediated-communication might have on the creative performance in a work group.

Amabile (1996) and Amabile et al. (1996) has shown the importance of the social environment for individual creativity. It is likely that the social dimension will be possibly even more profound when it comes to joint creativity tasks like the performance of a product development team. In such cases, the psychological processes of creativity are not only affected by the external social environment but also by the nature and quality of the communication and mutual interaction within the group. This builds on an important psychological assumption, influenced by the seminal work of Chapanis (e.g., Chapanis, Ochsman, Parish & Weed, 1972), that the transmittance of social cues will influence the performance of a group working with a complex task. That is, being able to receive information from more modalities than one (e.g., auditory and visually) is assumed to effect the coordination of work within a group. The use of different information technology based communication tools might therefore influence the creative performance of a product development team differently; depending on the amount of various verbal and non-verbal communication cues a certain information technology arena allows being transmitted.

Although intuitively tempting, one should not automatically assume that access to more social cues is always desirable. In fact, one of the advantages of different group support systems is that they can ease the cognitive load and hence improve performance of teams working towards a mutual goal by its very design, structuring and limiting the amount of information transferred (Nunamaker, 1997). Additionally, members can communicate by typing or drawing spontaneous ideas into a network of computer workstations simultaneously. This has proven an effective way of enhancing creativity among individuals working together in groups, since it the stifling forces previously mentioned (Diehl & Stroebbe, 1991). Also, such arrangements seem to reduce the problems of evaluation apprehension (Dennis & Valacich, 1993).
In addition to the unanswered question about the effects of information technology on creative performance in groups, the question of how user beliefs - towards the possibilities of using information technology as a means of communication - would affect the performance of groups is addressed. Research has shown that lack of user acceptance is an impediment to success for new information systems (Davis, 1993; 1989). All the same, as it seems fairly reasonable that lack of user acceptance will lead to rejection of usage, one might ask what implications such distrust will have on performance. Will confidence in the possibilities of information technology enhance the performance? The question stems from classical research within the field of social psychology which states that attitudes influences behavior (Eagly & Chaiken, 1992; Ajzen, 1991). The extent to which an individual believes or not that using a particular system will enhance his or her performance is referred to as ‘perceived usefulness’ (Davis, 1993). The perceived usefulness is hypothesized to have an overall impact on performance process and outcome.

Most prior research has focused on how theoretically interesting aspects, such as anonymity and parallel communication, influence group creativity. However, this investigation builds on recent calls (Nunamaker, 1997) maintaining the need for research that harness the potential of information technology (Sosik & Avolio, 1998). The present studies derives from this need and extends prior work in several ways. Firstly, because work in organizations today tends to be non-anonymous, participants in both studies are working under identified conditions. Secondly, creative work, such as developing new services, tends to occur during a longer period of time. Therefore, unlike a majority of studies conducted (c.f., Sosik, 1997, for a review of studies) studying how a shorter period of electronic brainstorming influences creative performance, this study examines the effects of information technology during a longer period of time (three days). Also, in line with this, present study does not only examine the mere outcome of group creativity, the creative product, but also the creative process, which is an extension of earlier research. Finally, in this study three experimental conditions (compared to usually only two) have been used, allowing a gradually increasing amount of verbal and non-verbal communication cues. This has been done to facilitate causal inference about the effectiveness and satisfaction of face-to-face interaction when communicating electronically.
Method

Participants

The experiment was conducted at the Cyber/IT Research Laboratory of Karlstad University (Sweden). One hundred and twenty-six individuals, 62 men and 64 women, participated. All were students and they were recruited on the campus and efforts were taken in order to secure about equal representation from both sexes in order to control for possible gender effects. Participants were randomly assigned into each of six experimental groups which together constituted two independent variables (see “Design”). The mean age for the entire population was 23.5 years ($SD = 3.53$, $range = 19$ to $46$). There were no (three-way ANOVA) significant differences between groups or between sexes with regard to age, number of academic terms spent at Karlstad University, computer and Internet usage, and e-mail experience ($ps > 0.05$).

One test was administered to all participants in order to provide further background information. The test measured dispositional optimism, namely the Life Orientation Test - LOT (Scheier & Carver, 1985). The mean value for LOT by the students was 21.42 points ($SD = 4.14$, $range = 8$ to $32$), which is directly comparable with values in other studies concerning students (e.g., Norlander & Archer, submitted; Norlander, Erixon & Archer, 2000). A three-way ANOVA showed no differences between groups and no difference between sexes and there were no interactions ($ps > 0.4$).

Design

Participants were randomly assigned in equal numbers (three participants) to each of six experimental groups, namely a Chat/Negative group, a Chat/Positive group, a Videoconference/Negative group, a Videoconference/Positive group, a Face-to-face/Negative group, and a Face-to-face/Positive group. In this way two independent variables were obtained: an IT variable (Chat, Videoconference, and Face-to-face) and an Attitude variable concerning perceived usefulness (Negative and Positive).

An Internet-based software (Microsoft NetMeeting) was used to represent a text-based chat form of communication. In a text-based chat only written information can be transmitted (here referred to as Chat). Another sort of Internet-based software (Whitepine Cu-SeeMe), allowing interacting individuals to see each other while communicating, was used to represent a second form of computer-mediated communication (Videoconference). Finally, the two kinds of information technology above were compared with groups interacting face-to-face (FtF). The Attitude variable was constituted by the participants perceptions toward using information technology as a means of communication and was collected though a VAS-scale.
The outcome of the dependent variable was collected through tape recordings from two meetings, one Original meeting and one Final meeting, together with a notebook all participants were instructed to use.

**Instruments**

**Background information.** Background data was collected by means of a questionnaire. The questionnaire contained information about participants’ experience and usage of computers, the Internet and also how often they used e-mail for purposes of communication.

**Attitude towards IT.** In order to control for consistency of attitudes, participants received a short note containing supposedly scientific information about either the disadvantages or the advantages of communicating via IT. Then, participants were instructed to fill out a questionnaire containing filler items and a question regarding how they viewed the perceived usefulness of information technology when it comes to purposes of communication. The question used a VAS scale ranging from 1 to 10, where 1 indicates a “negative perceived usefulness of IT” and 10 a “positive perceived usefulness of IT”. An one-way ANOVA with type of note (negative or positive) as independent variable and attitude towards IT as dependent variable showed no significant difference ($p = 0.395$), those indicating that the attitude held was dispositional. Participants were divided (cut point = 50%) into either a Negative Attitude group ($M = 1.95, SD = 0.78, n = 21$) or a Positive Attitude group ($M = 4.05, SD = 0.66, n = 21$).

**LOT- Life Orientation Test.** The test (Scheier & Carver, 1985) consists of eight items, plus four filler items. The task of each participant is to take up a standpoint to the extent of whether or not one is in agreement with each of the items described, on a scale of 0 – 4, where 0 indicates “strongly disagree” and 4 indicates “strongly agree”. The test measures dispositional optimism, defined in terms of generalized outcome expectancies. There was no time limit for the LOT test.

**Panels.** Five panels of scorers were constituted: panel A, B, C, D judged the creative product from Guilford’s dimensions of creativity (i.e., fluency, flexibility, originality, elaboration). The judges in these panels were doctoral candidates in psychology at the university with exception for the panel who judged fluency (A) who were students holding a bachelor degree in psychology. Panel E was given the task of identifying indicators of the stages of creative thought (i.e., preparation, incubation, illumination) at the original meeting, in the diary and at the final meeting. Panel E were consisted of students holding a bachelors degree in psychology. All ten judges performed all scoring completely independently of each other.

**Subjective measures.** Beside the measures of creativity, subjective measures was collected regarding how participants perceived the process and the product. The participants was asked to fill out a short questionnaire about their perceptions of the communication process and the outcome of the group. A VAS scale was used for this objective and the individual scores were combined into a group total.
(ranging from 0 to 30 for Process; from 0 to 60 regarding Outcome). Concerning Outcome two scales was combined due to their high correlation ($r = .80, p > .0001$). A reason for the subjective measures is the likeliness that subjective perceptions of the process and product of electronic communication will affect future usage, no matter how good objective results of the creative performance proves to be.

**Procedure**

The experimental session was composed of three phases consisting of two meetings, an original and final meeting, with a thought period in between (c.f., Norlander & Gustafson, 1996). The laboratory consisted of three separate rooms, each named after major cities in order to create a feeling and understanding of being geographically dispersed. In the FtF condition the group used a circular table.

**The Original meeting.** On arrival at the laboratory on the Original meeting participants were instructed to fill out a questionnaire concerning background information, and the LOT. Thereafter procedures for securing the dispositional attitudes were taken (see “Instruments” section). Each participant then received a complex problem and was instructed to work with this in the group in one of the three conditions. The Original meeting lasted for 7 minutes. The aim of the whole experimental procedure was to try to emulate a typical project sequence in an early product or service development phase. Consequently, the problem concerned how the university better could give better service to students, enabling higher quality in their studies. During the Original meeting participants also were instructed to sign a contract not revealing any of the characteristics of the experiment, this way attempts were made not to give participants knowledge of any of the other conditions in the experiment.

**The Diary.** When the Original meeting had been terminated every individual was presented with a small pocket-size notebook (specially made for the occasion). For a description of the instructions enclosed with the diary, see Norlander (1997). The diary phase was motivated through real-life settings, where members of a product development team are expected to elaborate upon problems and their solutions in different situations over a period of time.

**The Final meeting.** At the final meeting the participants was instructed to outline in detail a plan considered optimal to solve the problem given at the original meeting. The Final meeting lasted for 10 minutes. Also, at the final meeting, data concerning participant satisfaction were collected. The aim of the experimental procedure was to try to emulate a typical project sequence in product or service development. In order to make the experimental setting more realistic, all participants were informed that the three best solutions would be rewarded with a cash price of $100.
Scoring

The merit of the creative product. The judges of panel A, B, C, D were told to rate every participant in accordance with a selected dimension of creativity (Guilford, 1967). The dimensions measure divergent thinking and were Fluency (number of ideational responses), Flexibility (number of ideational responses within separate categories), Originality (the cleverness of an idea) and Elaboration (the amount of details in ideational responses). There were two judges for every dimension. Every judge was being instructed to rate the finished solutions from the Final meeting on a scale measuring from 1 to 10. The rationale for this procedure has been called “consensual definition” and has been forwarded by Amabile (1996). Amabile has described the technique as follows: “agreement being achieved without attempts by the experimenter to assert particular criteria or attempts by the judges to influence each other. Thus, the judges should not be trained by the experimenter to agree with one another, they should not be given specific criteria for judging creativity, and they should not have the opportunity to confer while making their assessments” (p. 42). Furthermore, Amabile claims that “the essence of the consensual definition is that experts in a domain can recognize creativity when they see it, and they can agree with one another in this assessment” (p. 42).

The creative process. The three reports (original meeting, diary and final meeting) were each typed on a separate slip of paper designated merely by number. The papers from the three Chat, Videoconferencing and FtF group were, of course, shuffled. The scoring was carried out by trained judges according to a written instruction, to a large extent adapted from Patrick (1935, 1937, 1938), Norlander and Gustafson (1996) and Norlander (1997, 1998, 1999). The panel reported the frequency and localization of assertions (AS), thought changes (TC), incubations (IC) and illuminations (IL). AS and TC are connected with, and represents, the preparation phase, IC the incubation phase and IL with the illumination phase. The four categories/indicators were defined in the following way:

AS  the assertion that the group had no ideas (i.e., “this is difficult”, “we seem to be trapped in a corner here”).
TC  any modification of thought which was sufficient to cause formation of a new sentence (i.e., “e-mail information to students could perhaps be something...”)
IC  the spontaneous recurrence of a notion with more or less continual modification while other topics were under consideration.
IL  This was the period when the plan is distinctly formulated by the group.

The three reports were regarded as descriptions of one process. That means that an incubation (IC) which was noticed in the Diary could have its origins in the Original meeting and so forth.
Results

Interjudge Reliabilities

Panel A, B, C, D. The correlation statistics (Pearson’s r) showed a significant correlation regarding Fluency ($r = .92, p < .001$) and Flexibility ($r = .65, p < .001$) between judges. It was considered relevant to average the scoring for Fluency and for Flexibility for further statistical analysis. The correlation statistics (Pearson’s r) showed no significant correlation between judges in regard to Originality ($r = .30, p = .054$) or Elaboration ($r = .26, p = .096$). Consequently, it was not considered relevant to average the judges scoring on Elegance and Elaboration for further statistical analysis.

Panel E. The two meetings and diary of each group were also analyzed separately by two independent judges for the number of assertions (AS), thought changes (TC), incubations (IC) and illuminations (IL). The correlation statistics between the two judges showed significant correlation for all variables, with the highest correlation for the number of thought changes in the Diary ($r = .84, p < .001$) and incubations also in the Diary ($r = .83, p < .001$). Most difficult to judge was the number incubations at the Original meeting ($r = .45$) however significant ($p < .003$). Of great interest for the investigation was the correlation of incubations at the Final meeting, which showed an adequate agreement between judges ($r = .47, p < .002$). It was considered relevant to average the judges scoring for AS, TC, IC and IL.

Dependent Variables

1. The merit of the creative product. ANOVAs (3 x 2 factorial design) were computed with IT group and Attitude group as independent variables and Fluency and Flexibility as dependent variables. The analysis showed no significant interaction effects ($ps > .5$) and no significant differences in regard to Attitude group ($ps > .4$) and there was no significant difference in regard to IT group for Flexibility ($p = .166$) but a significant difference for Fluency [$F(2,36) = 7.25, p = .002$]. For means and standard deviations see Table 2.
Table 2. Means (and standard deviations) in regard to IT group (Chat, Videoconference, and Face-to-face) and Assemblage group (Group, Individual) for Fluency and Flexibility.

<table>
<thead>
<tr>
<th></th>
<th>Chat</th>
<th>Videoconference</th>
<th>Face-to-face</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fluency</td>
<td>9.79 (2.49)</td>
<td>11.79 (3.97)</td>
<td>15.71 (5.42)</td>
</tr>
<tr>
<td>Flexibility</td>
<td>2.29 (0.73)</td>
<td>2.00 (0.92)</td>
<td>2.68 (1.08)</td>
</tr>
</tbody>
</table>

*Fluency.* Univariate F-test showed a significant difference between IT groups [$F(2,41) = 7.45, p = .002$]. A post hoc test (Tukey-HSD, 5% level) indicated that the Face-to-face group had higher fluency as compared to both the Videoconference group and the Chat group. There was no significant difference between the two Chat groups. A trend test (Jonckheere) showed a significant trend ($J = 397, J^* = 2.38, p = .009$) indicating that the more real life like the conditions are, the higher the fluency will be.

*Flexibility.* Univariate F-test showed no significant difference between IT groups ($p = 0.173$). The distribution did not indicate a possible trend.

2. The creative thought process. The AS and TC served as indicators for the preparation stage and were combined. IC served as indicator for the incubation stage and IL for the illumination stage. According to the judges there were all participants illuminated.

It is of interest to see the distribution of the four indicators of the creative thought process in regard to the Original meeting, the diary and the Final meeting. The preparation stage (AS + TC) clearly seems to be most frequent in the Original and Diary sessions, while the most incubations and almost three-fourths of the illuminations were noted at the Final meeting (See Table 3). These findings are well in accordance with earlier research (Norlander and Gustafson, 1996; Patrick, 1938).
Table 3. The distribution in per cent of AS+TC, IC and IL, at the Original meeting, Diary, and Final meeting.

<table>
<thead>
<tr>
<th>Content</th>
<th>Original meeting</th>
<th>Diary</th>
<th>Final meeting</th>
</tr>
</thead>
<tbody>
<tr>
<td>AS+TC</td>
<td>46.55</td>
<td>15.28</td>
<td>38.18</td>
</tr>
<tr>
<td>IC</td>
<td>29.81</td>
<td>19.73</td>
<td>50.45</td>
</tr>
<tr>
<td>IL</td>
<td>6.52</td>
<td>23.91</td>
<td>69.57</td>
</tr>
</tbody>
</table>

Note: AS+TC = the per cent assertions and thought changes, representing the preparation stage, that the group had, IC = incubations, IL = illuminations.

A Pillais’ MANOVA (3 x 2 factorial design) was used with IT group and Attitude group as independent variables and with the indicators of stages of creative thought at the Original meeting, Diary and Final meeting as dependent variables. The analysis showed a significant interaction effect ($p = 0.047$, power = 0.93) and a significant difference in regard to Attitude group ($p = 0.038$, power = 0.84), and finally there was a significant difference in regard to IT group ($p = 0.001$, power = 0.99). Described below are only significant results from the univariate F-tests.

**Interactions.** Univariate F-tests showed significant interactions for Assertions at the Final meeting [$F(2,36) = 3.73$, $p = 0.034$] and for Illuminations at the Final meeting [$F(2,36) = 4.62$, $p = 0.016$]. Interaction analysis (one-way ANOVAs and Tukey-HSD) indicated that in the Videoconference group those with Negative attitude had more assertions ($M = 1.21$, $SD = 1.04$) as compared to those with Positive attitude ($M = 0.00$, $SD = 0.00$). Further the analysis indicated that the Positive attitude group belonging to the Videoconference condition had more Illuminations ($M = 0.57$, $SD = 0.45$) as compared to the Negative attitude group in the same condition ($M = 0.00$, $SD = 0.00$).

**Attitude groups.** Univariate F-tests showed significant effects for Thought Changes at the Original meeting [$F(1,36) = 4.90$, $p = 0.035$] and in the Diary [$F(1,36) = 5.42$, $p = 0.026$], and Assertions at the Final meeting [$F(1,36) = 4.34$, $p = 0.044$]. Described analysis indicated that in regard to Thought changes at the Original meeting the Positive attitude ($M = 7.26$, $SD = 3.02$) were superior as compared to the Negative attitude group ($M = 6.62$, $SD = 2.50$) and likewise the Positive attitude group ($M = 2.85$, $SD = 1.58$) had more thought changes in the Diary as compared to the Negative attitude group ($M = 2.08$, $SD = 1.65$). Finally it was indicated that participants in the Negative attitude group ($M = 0.62$, $SD = 0.86$) had more assertions at the Final meeting as compared to participants in the Positive attitude group ($M = 0.29$, $SD = 0.60$).

**IT groups.** Univariate F-test showed a significant difference between IT groups in regard to Assertions at the Original meeting [$F(2,36) = 6.19$, $p = .005$].
A post hoc test (Tukey-HSD, 5% level) indicated that the Videoconference group ($M = 1.32, SD = 1.48$) had more assertions as compared to both the Chat group ($M = 0.21, SD = 0.32$) and the Face-to-face group ($M = 0.29, SD = 0.43$). Univariate F-test also showed a significant difference in regard to Thought changes in the Diary between IT groups [$F(2,36) = 3.31, p < .0481$. A post hoc test (Tukey-HSD, 5% level) indicated that the Videoconference group ($M = 5.55, SD = 2.33$) had fewer thought changes as compared to the Chat group ($M = 8.07, SD = 2.90$). The FtF group scored at an intermediate level ($M = 7.21, SD = 2.55$). A trend test (Jonckheere) showed a significant trend ($J = 2136, J* = 5.00, p = .001$) indicating that less interaction permitted at the Original and Final meeting, the more Thought changes in the Diary.

3. Participants self-reported perception and satisfaction of process and product. A univariate F-test showed a significant difference between IT groups [$F(2,41) = 22.93, p < .001$] regarding participants perceptions of the Process. A post hoc test (Tukey-HSD, 5% level) indicated that the Face-to-face group were more satisfied with their process as compared to both the Videoconference group and the Chat group. There was no significant difference between the two Chat groups. A trend test (Jonckheere) showed a significant trend ($J = 471, J* = 4.08, p < .001$) indicating that the more real life like the conditions are, the better the process is regarded.

These findings were reiterated regarding participants perceptions of the Product. A univariate F-test showed a significant difference between IT groups [$F(2,41) = 12.26, p < .001$]. A post hoc test (Tukey-HSD, 5% level) indicated that the Face-to-face group were more satisfied with their outcome as compared to both the Chat group and the Videoconference group. There was no significant difference between the two Chat groups. Neither did the distribution indicate a possible trend.
Discussion

This study used an experimental design in order to investigate the effects of information technology and perceived usefulness on the creative performance in small groups. Overall, the experiment produced three main results:

1. The FtF group generally evoked more creative results indicating the importance of interaction possibilities when there is a need to produce many ideas. The more real life like conditions were, the better fluency of ideas.

2. Regarding the creative process most occurrences appeared in the preparation phase. Computer-mediated groups showed more activity regarding assertions at the meetings and more thought changes in the Diary. Groups with a positive perceived usefulness also showed more thought changes while negative groups needed more assertions at the Final meeting.

3. Participants in the FtF group were more satisfied with their process than was the case in the computer-mediated groups.

The results from the study suggests, although only to a certain extent, that social context cues can contribute to group communication in the way that it can regulate interaction, add meaning to information and monitor feedback between participants involved. According to Straus and McGrath (1994) a reduction in cues such as eye contact, emotional expressiveness, and voice conveys disruption in the communication process, which makes the discussion among members more difficult to comprehend. Also, there are some indications that individuals feel their ideas are less understood when using information-poor media as a means of communication (Straus & McGrath, 1994).

With support of Amabile’s (1996) componential framework of creative performance and the importance of intrinsic motivation, it is suggested that face-to-face interaction can contribute with task motivation for individuals in creative work. The proposition on task motivation rests on the conceptualization that a person is said to be intrinsically motivated to engage in an activity if that person views the engagement as an end in itself, and not as a means to some extrinsic goal. Several studies (e.g., Sosik, Kahai & Avolio, 1998; Dennis & Gallupe, 1993; Connolly et al., 1990) has described the advantageous aspects of the increased anonymity in computer-mediated communication arenas because it reduces the effects of phenomena such as evaluation apprehension and conformity. However, the increased level of anonymity may also reduce group members’ motivation to contribute because they are unable to receive personal recognition and stimulation for their contributions (Nunamaker, Dennis, Valacich & Vogel, 1991). With this suggestion at hand, it would be interesting to compare individuals to groups. If intrinsic motivation is stimulated by possibilities of identifying ones contribution, there should be no differences between individuals communicating computer-mediated or face-to-face.
However, as there are some facts in the experiment speaking for the advantages of face-to-face interaction is should be noted that none of the more qualitative variables was affected by the type of communication. In this way the study results suggest that the different four dimensions of the creative product represents different information-processing patterns that are not affected varying by the external environment, as the communication arena, in the first place. Future research should concentrate on examining what kind of processes that influences the more qualitative aspects of creativity as originality and elaboration. Involvement of a leader could be one such suggested process. For example, Sosik, Kahai and Avolio (1998) found significant effects, despite small samples, on originality and elaboration investigating leadership style under conditions of computer-mediated conditions. Interestingly, they found no effect for anonymity on the same variables using the same sample.

One extension with present study was that it used data from three sessions. This was a necessity in order to examine the creative process. Overall, the results on the creative process reveals the same pattern as the findings for the merit of the creative product. However, it is interesting to see that the effects of electronic communication seem to fade away during the interaction. The significant differences between the groups concern assertions at the Original meeting and thought changes in the Diary. The fact that the computer-mediated groups showed more assertions in the Original meeting could plausibly be attributed to startup procedures. Consequently, at the Final meeting participants were more familiar with the media due to practice at the Original meeting. An indication that accounts for this is the fact that the Videoconference condition proved to be the weakest group. Most likely this is the type of communication arena that people are most unfamiliar with, and therefore needs more practice. Finally, concerning the creative process, it is also worth noting that the thought process followed the same pattern that the early studies of Patrick (1938) and Norlander and Gustafson (1996) showed. This indicates that the model of Patrick owns generalizability since this study has used quite different independent variables from Patrick (1935, 1937, 1938) and Norlander and Gustafson (1996).

Because of the increasing use of information technology in today’s society individuals attitude towards the technological advances appears important. In order to examine whether expectations and beliefs, the perceived usefulness of information technology, would affect creative performance such attitudes was also included in the experimental design. During the last years several research models have been developed that measure and assess peoples attitudes towards information technology (Davis, 1993; Parasuraman, 2000; Mick & Fournier, 1998; Eason, 1988). The underlying rationale for these models is that they maintain that successful implementation of information technology is dependent on users’ perceptions and attitudes towards it (Davis, 1993; Eason, 1988). Although the results for the Attitude variable gives some support for this assumption regarding the creative process the overall tendency seems rather uncertain. For example, no effects were found regarding the creative product and differences concerning the creative process were found only in the preparation phase. Therefore, to get more conclusive and stronger indications of the relationship between these variables further
research is required. Such research should more explicitly take the socialpsychological research about attitudes as its starting-point. For example, according to the theory of planned behavior (Ajzen, 1991), our intention to engage in a certain behavior is strongest when we have a positive attitude toward that behavior. In other words, because of voluntary participation the subjects who participated in this study might all have shared somewhat more positive perceptions of the usefulness of, and have interest of usage, information technology. Consequently, in order to investigate the role of positive or negative perceptions of the usefulness of information technology, one should need to carefully select participants that has acquired their attitudes on earlier experiences and behavior, i.e., when they are easily accessible (Fazio, 1989).

Despite the above mentioned limitations the present study is still valuable because it represents an important contribution to understanding not only how the creative product is affected by the usage of information technology, but also how it affects the creative process. Examining the process appears important not only for purposes of validation, but also because of the rather extensive biographic approach, where creative persons have described their creative products from a process perspective (e.g., Amabile, 1996; Sternberg, 1999). Additionally, the present study has taken advantage of not only objective measures of the creative product and process (from judges), but also subjective measures. Clearly, no matter how good the product or the process is estimated by trained judges outside, participants subjectively dissatisfied will, if given the choice, abandon that kind interaction. A further analysis of the data also showed significant correlation between objective and subjective measures concerning product ($p < .05$), but not for process.

Concerning development of new services, a managerial implication of this study would be that computer-mediated communication has a potential that lies in using the new technology not as a surrogate for the physical meeting but as a substitute for no meeting at all. Instead of having members of a project team being prevented from work by time or distance restraints, information technology can provide a common platform for interactive communication and joint work efforts given the sufficient practice of using it.
References


The Effects of Information Technology on the Creative Performance of Groups versus Individuals

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Karlstad University

Abstract: The effects of information technology on the creative performance in groups and individuals was examined. An experimental 3 x 2 design was used in order to assess the effects of computer-mediated and face-to-face interaction on creative performance. 48 groups, divided into individuals or small three-person groups, worked on a heuristic task during three sessions. Creativity was operationalized in terms of product and process. The consensual assessment technique was used together with independent judges to obtain objective measures, and additionally, participants subjective perceptions was also collected. The results regarding the creative product showed that small groups had a higher flexibility than individuals. The small groups also proved to have significantly more incubations. Regarding the creative process, the face-to-face group showed a better flow, and especially this is valid with respect to incubations. This pattern was shown both at the Original and Final meeting. Finally, of interest from a validity point of view, subjective measures revealed that participants communicating face-to-face perceived their process more satisfying than both computer-mediated groups. It was suggested that face-to-face interaction strengthens the creative process and that practice and interaction schemes could improve performance of computer-mediated groups.

Key words: Creativity, Information Technology, Small groups, Computer-mediated communication, Product, Process

Introduction

The quality of new products and services is heavily dependent on the creative performance of individuals working alone or in teams. Both normative and empirical research suggests that teams of individuals should be assigned to work with the development of a new good or service, from idea generation to market launch (Clark & Wheelwright, 1994; Zeithaml & Bitner, 2000). However, on the contrary to what one might expect, creativity research over the past decades has indicated that creative efforts made by groups are not always as successful as suggested or imagined (e.g., Diehl & Stroebe, 1987, 1991; Stroebe & Diehl, 1994; Paulus, Dzindolet, Poletes & Camacho, 1993). Some studies has as a matter of fact revealed that groups can be outperformed by an equal number of non-interacting individuals, often referred to as a nominal group (e.g., Dennis & Valacich, 1993; Connolly, Routhieaux & Schneider, 1993). Psychological processes as
evaluation apprehension, free riding and production blocking accounts for a great deal of explanation for these intuitively rather peculiar facts. Interestingly, research indicates that the weaknesses of groups might be surmounted by the use of information technology (Dennis & Valacich, 1993). Today, the use of information technology is proliferating in organizations. Nevertheless, only inconclusive gains has been made concerning how communicating electronically affects aspects of work, such as creativity. Because information technology constitute an important communication tool in many development projects, the question of how information technology influences this question needs to be addressed. Consequently, with the intention to contribute to the new product and service development context, the effects of information technology on creativity is examined in this paper.

Previous theory and research on creativity and information technology

For purposes of scientific inference the term creativity was first coined by Guilford in 1950. The concept was then an uniting of the two words “create” and “activity” (Guilford, 1950). The concept received great attention since it captured the essence in activities as inventing, designing, composing and producing, to name a few. Because all these abilities are much sought for, and given great importance by business, Taylor (1959) already 1959 was able to find more than one hundred definitions.

In present paper creativity is defined from a product and process perspective. The product is assessed through Guilford’s (1967) four dimensions of creativity; fluency, flexibility, originality and elaboration. The process is assessed through Wallas (1926) four phases; preparation, incubation, illumination and verification.

Connolly, Jessup and Valacich (1990) has proposed a conceptual framework for the study of creative processes within a computer supported collaborative work perspective. Their framework makes it possible to study how information technology affects idea generation in groups. Connolly et al. postulate that idea generation in a group interaction could be either enhanced or reduced with respect to quality and quantity. Building on Osborn (1963), Connolly et al. (1990) infers that the group, on the positive side, can provide encouragement, stimulation or reward inspiring creative contributions. This assumption, of course, being made under the condition that the group is given a task of sufficient relevance and interest. On the negative side, working in a group might inhibit contributors expecting embarrassment, hostile evaluation, conformity pressures or other negative events for proposing an unusual idea. Not enough, Connolly et al. also mentions the mechanics of the combining communication process as an obstacle for a group, referred to as production blocking. This can occur for example when: “ideas [...] are forgotten or edited while their originator waits for an opportunity to speak.” (p. 690). Diehl and Strobe (1987) has more extensively discussed the details of negative forces in group ideation. In summary, Connolly et al. (1990) concludes that the group’s overall creative effectiveness depends on the balance it achieves between the positive and negative forces just described. Consequent with this
analysis, Connolly et al. presents a 'balance of forces model' that makes it possible to predict, evaluate and design experiments investigating the effects of information technology on creativity. Their model is, with some adaptation, employed in present investigation (see Figure 1).

Figure 1. The Balance of Forces Model (Connolly et al., 1990) adapted and employed in the study.

Social psychological research by Amabile (e.g., 1996) confirms the stimulating positive forces enhancing creativity mentioned in the model by Connolly et al. (1990). Stroebe and Diehl (1994) has reviewed evidence for the stifling group forces and suggests some possible remedies of which especially one is worth mentioning; namely electronic brainstorming. Electronic brainstorming reduces the extent to which the production of new ideas is blocked by such things as listening to others or waiting for turn to speak. Groups that brainstorm electronically via computer can produce more ideas than non-electronic groups and more ideas than nominal electronic groups (Dennis & Valacich, 1993). Also, in line with this, it has been suggested that people communicating via computers tends to be more task-focused than face-to-face groups (Straus, 1997). A plausible explanation of this is that communication is perceived more difficult why social conversation
takes place less often. Thus, previous theory and research implies that information and communication technology can have both positive and negative effects on creative performance. The benefit of the conceptual framework set out by Connolly et al. (1990) is that it enables the study of how different critical variables affect creativity.

The usage of information technology and groups versus individuals in service development

The development process of new products and services is a complex and iterative process often performed by groups of people. This makes the communication between the parties involved crucial for success. However, product development is not just any organizational work process, it is a process highly dependent on creativity (Brown & Eisenhardt, 1995; Clark & Wheelwright, 1994; Edwardsson, 1996). Creativity is a unique and complex human capability that, on the group level, is tightly interwoven with communication. In order to make communication of concurrent product development processes work more efficiently the usage of information technology are now increasingly being implemented. However, before altering the modes of communication in product and service development projects, there is a need to consider what effects computer-mediated-communication might have on the creative performance for groups and individuals.

Amabile (1996) has shown the importance of the social environment for creativity. It is likely that the social dimension will be possibly even more profound when it comes to joint creativity tasks like the performance of a product development team. In such cases, the psychological processes of creativity are not only affected by the external social environment but also by the nature and quality of the communication and mutual interaction within the group. This builds on an important psychological assumption, influenced by the seminal work of Chapanis (e.g., Chapanis, Ochsman, Parish & Weed, 1972), that the transmittance of social cues will influence the performance of a group working with a complex task. That is, being able to receive information from more modalities than one (e.g., auditory and visually) is assumed to effect the coordination of work within a group. The use of different information technology based communication tools might therefore influence the creative performance of a product development team differently; depending on the amount of various verbal and non-verbal communication cues a certain information technology arena allows being transmitted.

Although intuitively tempting, one should not automatically assume that access to more social cues is always desirable. In fact, one of the advantages of different group support systems is that they can ease the cognitive load and hence improve performance of teams working towards a mutual goal by its very design, structuring and limiting the amount of information transferred (Nunamaker, 1997). Additionally, members can communicate by typing or drawing spontaneous ideas into a network of computer workstations simultaneously. This has proven an effective way of enhancing creativity among individuals working to-
gether in groups, since it limits production blocking (Diehl & Stroebe, 1991). Also, such arrangements seem to reduce the problems of evaluation apprehension that are often apparent in groups, since participants tend to evaluate ideas based on its merits, rather than on the basis of the contributor (Dennis & Valacich, 1993).

In addition to the unanswered question about the effects of information technology on creative performance in groups, the question of how groups differentiate from individuals regarding creativity is addressed. The research question dates back to the days of Osborn who suggested that communication among members in a group could provide process gains, often referred to as synergy effects, from their stimulating collaboration. However, taking a closer look on what experimentally designed research conveys about how groups perform compared to individuals regarding problem-solving capacity, one gets two answers. One that says groups are more creative, and one that claims the opposite (Ekvall, 1988). When scrutinizing these experiments certain features appear that can explain the contradictory results. In the experiments were individuals appeared as superior the results from groups have been compared to individuals that afterwards have been ‘grouped’ into a group result. Results like these, together with common psychological discoveries like “group think” (Janis, 1972) shows that there are many pitfalls and possible risks combined with creative work in groups. Furthermore, a common feature for the studies that have been conducted comparing groups with individuals is that the tasks given have been of a very general kind. All participants have had enough knowledge and experience to contribute and understand the problem and thus have been able to contribute to a final solution. Yet, this is a reality and premise that does not often exist outside the research laboratory. The reason for group and team work in organizations is that many problems is of such complicated nature, and comprises such time limitations, that it requires a group of people with complementary expert knowledge to be able to bring it in to a successful close. Also, there are many democratic aspects which motivates group work. Claiming that groups are superior, on the other side, Osborn stated that if the principles of brainstorming was followed: “the average person can think of twice as many ideas when working in a group than when working alone” (p. 229).

Still, there is a common belief among academic scholars and business leaders that groups are viewed as a superior resource when generating innovative and creative ideas. Taking these considerations together, it appears precipitated to generally take side for groups or individuals as being the best creative problem solvers. Instead, reflecting on the discussion above, it appears important to examine how groups are performing in comparison to individuals who are individuals, and not combined into groups. Because research (Dennis & Valacich, 1993) has highlighted that group work can be enhanced in electronic computer environments, this study examines how individuals perform in comparison with groups in both face-to-face situations and two computer-mediated environments.

Most prior research has focused on how theoretically interesting aspects, such as anonymity and parallel communication, influence group and individual creativity. However, this investigation builds on recent calls (Nunamaker, 1997) maintaining the need for research that harness the potential of information tech-
nology. The present studies derives from this need and extends prior work in several ways. Firstly, because work in organizations today tends to be non-anonymous, participants are working under more identified conditions. Secondly, creative work, such as developing new services, tends to occur during a longer period of time. Therefore, unlike a majority of studies conducted (c.f., Sosik, 1997, for a review of studies) studying how a shorter period of electronic brainstorming influences the creative product, this study examines the effects of information technology during a longer period of time (three days). Furthermore, in line with this present study does not only examine the mere outcome of group creativity, the creative product, but also the creative process, which is an extension of earlier research. Finally, in this study three experimental conditions (compared to usually only two) have been used, allowing a gradually increasing amount of verbal and non-verbal communication cues. This has been done to facilitate causal inference about the effectiveness and satisfaction of possibilities of interaction when communicating electronically.
Method

Participants

The experiment was conducted at the Cyber/IT Research Laboratory of Karlstad University (Sweden). Ninety-six individuals, 48 men and 48 women, participated. All were students recruited on the campus and efforts were taken in order to secure about equal representation from both sexes in order to control for possible gender factors. Participants were randomly assigned into each of six experimental groups which together constituted two independent variables (see “Design”). The mean age for the entire population was 24.51 years ($SD = 4.64$, $range = 19$ to $39$). There were no (three-way ANOVA) significant differences between groups or between sexes with regard to age and number of academic terms spent at Karlstad University ($ps > 0.05$).

Two personality inventories were administered to all participants in order to provide further background information. One test, the FS (Change and Stability) test, measured attitude-to-creativity with respect to change and stability (Holmquist, 1986). A three-way ANOVA showed no differences between the groups and no difference between the sexes and there was no ($ps > 0.05$). The other test, the Life Orientation Test (LOT), measured dispositional optimism (Scheier & Carver, 1985). A three-way ANOVA showed no differences between the groups or between the sexes and there was no interactions ($ps > 0.05$).

Design

Participants were randomly assigned to six different experimental groups, namely Chat/Individual, Chat/Group, Videoconference/Individual, Videoconference/Group, Face-to-face/Individual, and Face-to-face/Group. In this way two independent variables were obtained: IT group (Chat, Videoconference or Face-to-face) and Assemblage (Individual or Group).

An Internet-based software (Microsoft NetMeeting) was used to represent a text-based chat form of communication. In a text-based chat only written information can be transmitted (here referred to as Chat). Another sort of Internet-based software (Whitepine Cu-SeeMe), allowing interacting individuals to see each other while communicating, was used to represent a second form of computer-mediated communication (Videoconference). Finally, the two kinds of information technology above were compared with groups interacting face-to-face (FtF). The Assemblage variable was created by means of randomization. There were three persons in each group and, of course, only one in the individual condition.

The outcome of the dependent variable was collected through tape recordings from two meetings, one Original meeting and one Final Meeting, together with a notebook all participants were instructed to use.
Instruments

Background data. FS – Change and Stability. An attitude to change and stability test (Holmquist, 1986) which correlates highly with several creativity tests was applied. The test consists of 20 items of the type: “Risk-taking is necessary for success”, and each participant was asked to respond on a 4-point scale, ranging from agree to disagree. There was no time limit for the FS test. LOT- Life Orientation Test. The test (Scheier & Carver, 1985) consists of eight items, plus four filler items. The task of each participant is to indicate whether or not one is in agreement with each of the items described, on a scale of 0 – 4, where 0 indicates “strongly disagree” and 4 indicates “strongly agree”. The test measures dispositional optimism, defined in terms of generalized outcome expectancies. There was no time limit for the LOT test.

Panels. Five panels of scorers were constituted: panel A, B, C, D, E judged the creative product from Guilford’s dimensions of creativity (i.e., fluency, flexibility, originality, elaboration). The judges in all panels were doctoral candidates in psychology at the university with exception for the panel C who judged Originality who were professional journalists as a newspaper. Panel F was given the task of identifying indicators of the stages of creative thought (i.e., preparation, incubation, illumination) at the Original meeting, in the diary and at the Final meeting. All twelve judges performed all scoring completely independently of each other.

Subjective measures. Beside the measures of creativity, subjective measures was collected regarding how participants perceived the process and the product. The participants was asked to fill out a short questionnaire about their perceptions of the communication process and the outcome of the group. A VAS scale was used for this objective and the individual scores were combined into a group total (ranging from 0 to 30 for Process; from 0 to 60 regarding Outcome). Concerning Outcome two scales was combined due to acceptable correlation (r = .65, p > .0001). A reason for the subjective measures is the likeliness that subjective perceptions of the process and product of electronic communication will affect future usage, no matter how good objective results of the creative performance proves to be.

Procedure

The experimental session was composed of three phases consisting of two meetings, an original and final meeting, with a thought period in between (c.f., Norlander & Gustafson 1996). The laboratory consisted of three separate rooms, each named after major cities in order to create a feeling and understanding of being geographically dispersed. In the FtF condition the group used a circular table.

The Original Meeting. On arrival at the laboratory on the Original meeting participants were instructed to fill out a questionnaire concerning background in-
formation, FS and LOT. Each participant then received a complex problem and was instructed to work with this in the group in one of the three conditions. The Original meeting lasted for 7 minutes. The aim of the whole experimental procedure was to try to emulate a typical project sequence in a early product or service development phase. Consequently, the problem concerned how the university better could give better service to students, enabling higher quality in their studies. During the Original meeting participants also were instructed to sign a contract not revealing any of the characteristics in the experiment, this way attempts were made not to give participants knowledge of any of the other conditions in the experiment.

The Diary. When the Original meeting was terminated, all participants were presented with a small pocket-size notebook (specially made for the occasion). In the notebook the problem was presented along with the following instructions: 

We want you to think of this problem from now on and until after the experiment is over. Write down in this notebook every idea, notion and thought to solution of the problem that occurs for you. Carry this notebook with you wherever you go, and whenever you get an idea concerning this problem, just make a note of it, no matter how irrelevant it may seem. It is not necessary to write much, only a few sentences at a time. We would rather have more frequent and shorter memoranda than a single long report. Also, write down what origin you estimate triggered you idea (for example, was it your group discussion that stimulated you, or was it maybe an association you did when you saw or heard something?). Don’t concern yourself with the absurdity of what you make a note of or read anything peculiar to the subject or discuss it with others. We just want your own ideas. (Adapted from Patrick, 1938; Norlander & Gustafson 1996; Norlander, 1997).

The diary phase was motivated because of real-life settings, where members of a product development team are expected to elaborate upon problems and their solutions in different situations over a period of time.

The Final Meeting. At the final meeting the participants was instructed to outline in detail a plan considered optimal to solve the problem given at the Original meeting. The Final meeting lasted for 10 minutes. Also, at the final meeting, data concerning participant satisfaction were collected. The aim of the experimental procedure was to try to emulate a typical project sequence in product or service development. In order to make the experimental setting more realistic, all participants were informed that the three best solutions would be rewarded with a cash price of $ 100.

Scoring

The creative product (Panel A, B, C, D and E). The judges of panel A, B, C, D and E were told to rate every participant in accordance with a selected dimension of creativity. The dimensions were scientifically derived from Guilford
(1967. The dimensions measures divergent thinking and were Fluency (number of ideational responses), Flexibility (number of ideational responses within separate categories), Originality (the cleverness of an idea) and Elaboration (the amount of details in ideational responses). Additionally, a dimension measuring the feasibility of an idea was added, Innovativeness. There were two judges for every dimension, altogether 10 different judges were used. Every judge was being instructed to rate the finished solutions from the Final meeting on a scale measuring from 1 to 10. The rationale for this procedure has been called “consensual definition” and has been forwarded by Amabile (1996, 1983). Amabile (1983) has described the technique as follows: “agreement being achieved without attempts by the experimenter to assert particular criteria or attempts by the judges to influence each other. Thus, the judges should not be trained by the experimenter to agree with one another, they should not be given specific criteria for judging creativity, and they should not have the opportunity to confer while making their assessments” (p. 38).

The creative process (Panel F). The three reports (original meeting, diary and final meeting) were each typed on a separate slip of paper designated merely by number. The papers from the three Chat, Videoconferencing and FtF group were, of course, shuffled. The scoring was carried out by trained judges according to a written instruction, to a large extent adapted from Patrick (1935, 1937, 1938) and Norlander (1996, 1997, 1998). The panel reported the frequency and localization of assertions (AS), thought changes (TC), incubations (IC) and illuminations (IL). AS and TC are connected with, and represents, the preparation phase, IC the incubation phase and IL with the illumination phase. The four categories/indicators were defined in the following way:

- **AS** the assertion that the group had no ideas (i.e., “this is difficult”, “we seem to be trapped in a corner here”).
- **TC** any modification of thought which was sufficient to cause formation of a new sentence (i.e., “e-mail information to students could perhaps be something…”).
- **IC** the spontaneous recurrence of a notion with more or less continual modification while other topics were under consideration.
- **IL** This was the period when the plan is distinctly formulated by the group.

The three reports were regarded as descriptions of one process. That means that an IC which was noticed in the Diary could have its origins in the Original meeting and so forth.
Results

Interjudge Reliabilities

Panel A, B, C, D, E. The correlation statistics (Pearson’s $r$) showed a significant correlation regarding Fluency ($r = .97, p < .001$), Flexibility ($r = .65, p < .001$), Originality ($r = .63, p < .001$) and Elaboration ($r = .74, p < .001$) between judges. It was considered relevant to average the scoring for these variables for further statistical analysis. There was however no significant difference in regard to Innovativeness ($r = .22, p = .125$) and consequently it was no considered relevant to average the scoring for further statistical analysis.

Panel F. The two meetings and diary of each group were also analyzed separately by two independent judges for the number of assertions (AS), thought changes (TC), incubations (IC) and illuminations (IL). The correlation statistics between the two judges showed significant correlation for all variables, with the highest correlation for the number of thought changes in the diary ($r = .91, p < .001$) and assertions at the Original meeting ($r = .86, p < .001$). Most difficult to judge was the number of thought changes at the Final meeting ($r = .51$) however also significant ($p < .001$). Of great interest for the investigation was the correlation of incubations at the Final meeting, which showed good agreement from both judges ($r = .81, p < .001$).

Dependent Variables

1. The creative product. A Pillais’ MANOVA (3 x 2 factorial design) was used with IT group and Assemblage group as independent variables and Fluency, Flexibility, Originality and Elaboration as dependent variables. The analysis showed no significant interaction effect ($p = 0.481$), no significant difference in regard to Assemblage group ($p = 0.087$) and no significant difference in regard to IT group ($p = 0.635$). Univariate F-tests did however indicate a significant result for Flexibility in regard to Assemblage [$F(1,42) = 6.82, p = 0.012$] where the participants in the group condition scored higher on flexibility as compared to participants in the individual condition. For means and standard deviations see Table 2.
Table 2. Means (and standard deviations) for the creative product concerning the IT group.

<table>
<thead>
<tr>
<th></th>
<th>Chat</th>
<th>Video-Conference</th>
<th>Face-to-face</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ind</td>
<td>Group</td>
<td>Ind</td>
</tr>
<tr>
<td>Fluency</td>
<td>9.00 (4.54)</td>
<td>7.06 (3.34)</td>
<td>4.31 (4.24)</td>
</tr>
<tr>
<td>Flexibility</td>
<td>1.44 (1.32)</td>
<td>2.62 (1.30)</td>
<td>1.88 (0.83)</td>
</tr>
<tr>
<td>Originality</td>
<td>4.38 (2.86)</td>
<td>5.88 (2.84)</td>
<td>5.00 (3.21)</td>
</tr>
<tr>
<td>Elaboration</td>
<td>4.56 (2.77)</td>
<td>5.88 (2.47)</td>
<td>4.88 (2.34)</td>
</tr>
</tbody>
</table>

It was also considered of interest to compare individuals and groups in respect of fluency capacity. The 24 groups produced together 174.48 ideas and the 24 individuals produced together 149.52 ideas. As already shown this difference was not significant. But a comparison only between individuals showed that an individual in the Group condition averaged 2.42 ideas (SD = 1.46) which may be compared to the mean result in the Individual condition, i.e., 6.23 ideas (SD = 5.09), a difference which proved to be significant on a paired-samples t-test \[ t(23) = -3.54, p = 0.002 \].

2. The creative process. The AS and TC served as indicators for the preparation stage and were combined. According to the judges there were no participants with no illumination at all.

It is of interest to see the distribution of the four indicators of the creative thought process in regard to the Original meeting, the diary and the Final meeting. The preparation stage (AS + TC) clearly are most frequent in the Original and Diary sessions, while the most incubations and 94 per cent of the illuminations were noted at the Final meeting, see Table 3. These findings are well in accordance with earlier research (Norlander and Gustafson, 1996).
Table 4. The distribution in per cent of AS+TC, IC and IL, at the Original meeting, Diary, and Final meeting.

<table>
<thead>
<tr>
<th>Content</th>
<th>Original meeting</th>
<th>Diary</th>
<th>Final meeting</th>
</tr>
</thead>
<tbody>
<tr>
<td>AS+TC</td>
<td>58.44</td>
<td>19.13</td>
<td>22.43</td>
</tr>
<tr>
<td>IC</td>
<td>35.15</td>
<td>12.12</td>
<td>52.73</td>
</tr>
<tr>
<td>IL</td>
<td>5.21</td>
<td>1.04</td>
<td>93.75</td>
</tr>
</tbody>
</table>

Note: AS+TC = the per cent assertions and thought changes, representing the preparation stage, that the group had, IC = incubations, IL = illuminations.

A Pillais’ MANOVA (3 x 2 factorial design) was used with IT group and Assemblage group as independent variables and with the indicators of stages of creative process at the Original meeting, Diary and Final meeting as dependent variables. The analysis showed a significant interaction effect \(p = .022, \text{power} = .96\) and a significant difference in regard to Assemblage group \(p < .001, \text{power} = .99\), and finally there was a significant difference in regard to IT group \(p < .004, \text{power} = .99\). Described below are only significant results form the univariate F-tests.

**Interactions.** Univariate F-tests showed significant interactions for Thought changes at the Original meeting \(F(1,42) = 3.43, p = 0.042\) and in the Diary \(F(1,42) = 3.92, p = 0.027\). There were also a significant interaction concerning Incubations in the Diary \(F(1,42) = 5.77, p = 0.006\). Interaction analysis (one-way ANOVAs and Tukey-HSD) indicated that in the Videoconference group those in the Group condition had more thought changes and more incubations as compared to the Individual condition. Likewise, in the Chat group the Group condition had more thought changes as compared to Individuals. Further, the Group condition using Videoconference had more incubations as compared to the Group condition in the Chat group. Finally, Individuals in the Face-to-face group had more thought changes at the original meeting as compared to individuals at the original meeting in the Videoconference and Chat groups.

**Assemblage groups.** Univariate F-tests showed significant effects for Thought changes at the Original meeting \(F(1,42) = 17.02, p < 0.001\), the Incubations at the Original \(F(1,42) = 76.36, p < 0.001\) and the Final meeting \(F(1,42) = 17.89, p < 0.001\), and finally for the Assertions at the Final meeting \(F(1,42) = 6.33, p = 0.016\). Described analysis indicated that in regard to Thought changes at the Original meeting the small groups \((M = 6.52, SD = 2.03)\) were superior as compared to the individuals \((M = 4.29, SD = 2.65)\). Likewise, the small groups had more incubations at both the Original \((M = 4.92, SD = 2.05\) compared to \(M = 1.00, SD = 1.16)\) and the Final meeting \((M = 5.92, SD = 2.73\) compared to \(M = 2.96, SD = 2.42)\). Finally, it was indicated that the small groups \((M = 1.31, SD = 2.17)\) also had more Assertions than individuals \((M = 0.23, SD = 0.36)\).
IT groups. Univariate F-tests showed a significant difference between IT groups in regard to Assertions \([F(2,42) = 5.28, p = 0.009]\), Thought changes \([F(2,42) = 12.06, p < 0.001]\) and Incubations \([F(2,42) = 5.45, p = 0.008]\) at the Original meeting. There were also a significant difference in regard to Incubations at the Final meeting \([F(2,42) = 4.60, p < 0.016]\). A post hoc test (Tukey-HSD, 5% level) indicated that the FtF group had more Assertions \((M = 2.03, SD = 2.28)\) than the Videoconference group \((M = 0.94, SD = 1.44)\) and the Chat group \((M = 0.19, SD = 0.44)\). Regarding Though changes and Incubations at the Original meeting the pattern that the FtF group \((M = 7.28, SD = 1.91, M = 3.97, SD = 2.63)\) was superior to the Videoconference group \((M = 4.41, SD = 2.28, M = 2.69, SD = 2.72)\) and the Chat group \((M = 4.53, SD = 2.18, M = 2.22, SD = 2.18)\) was repeated. Finally, the FtF group were also superior concerning Incubations at the Final meeting \((M = 5.91, SD = 3.61)\) in comparison to the Videoconference group \((M = 3.44, SD = 2.46)\) and the Chat group \((M = 3.97, SD = 2.18)\).

3. Participants self-reported perceptions of product and process. One-way ANOVA revealed significant differences for the IT condition regarding the process \([F(2,47) = 5.26, p = 0.009]\). A post hoc comparison (Scheffe) indicated that the FtF group had a better process \((M = 7.19, SD = 3.05)\) as compared to both the Videoconference group \((M = 4.47, SD = 2.34)\) and the Chat group \((M = 4.67, SD = 2.48)\). There were no significant difference between the two computer-mediated groups. Regarding the Assemblage variable there were no significant difference \((p < 0.06)\). Neither were any differences found regarding how participants perceived their product.
Discussion

This study used an experimental design in order to investigate the effects of information technology and groups versus individuals on the creative performance in small groups. Overall, the experiment produced three main results:

1. Regarding the creative product small groups showed a higher flexibility, implying that groups are able to produce a larger variety of ideas than individuals. Although no differences were found regarding fluency for the Assemblage variable a comparison revealed that individuals produce more ideas being on their own than individuals working in a group.

2. Regarding the creative process the face-to-face group showed significantly better results in respect to incubation. This pattern was shown both at the Original and Final meeting. The small groups also produced significantly more incubations than individuals.

3. Subjective measures regarding participant satisfaction showed that participants communicating face-to-face perceived their process more satisfying than both computer-mediated groups.

There is a discrepancy between everyday beliefs and scientific knowledge regarding the creative performance of groups versus individuals (Stroebe & Diehl, 1994). The overall findings from this study gives somewhat dissimilar indications concerning this question compared to previous research (Guilford, 1967; Osborn, 1963; Stroebe & Diehl, 1994; Dennis & Valacich, 1993).

In accordance with what Guilford (1967) and Osborn (1963) would suggest, groups proved to generate more flexible solutions. This finding indicates that if production of a wider span of ideas are sought for, groups of people should be employed. On the contrary to these findings, more recent research has indicated that groups are less effective than previously hypothesized (Stroebe & Diehl, 1994). The explanation to this inconsistency concerns the question of how to measure and operationalize creativity. The research of Stroebe and Diehl (1994) derives very explicitly from Osborn (1963) and thus focuses on the idea generation aspect only, a conceptualization that in this investigation is equivalent to the dimension of fluency. For example, Strove and Diehl (1994) states that: "... the number of good ideas is the best measure of quality" (p. 273) when investigating creative performance. Considering this, the results concerning flexibility does not appear incongruent anymore. Regarding idea generation in this study, there were no significant differences for fluency between the small groups and individuals. Although no significant differences were found, a paired-samples t-test showed that the individuals not participating in a group produced significantly more ideas. Interpreted in the terms of Stroebe and Diehl (1994), social-psychological processes as evaluation apprehension and production blocking accounts for this.

Dennis and Valacich (1993) have proposed computer-mediated communication as means for bridging the stifling forces elicited in group situations. By
communicating via a computer network, processes as evaluation apprehension and production blocking is reduced and thus, groups should outproduce individuals regarding fluency. The empirical data of this study reveals such a pattern for the Videoconference group only. Again, it is assumed that the design of the study has contributed to the deviation between previous theory and present empirical findings. Accordingly, the participants in this experiment were not explicitly told to generate as many ideas as possible, but to create a well merited solution. Consequently, subjects seem to have put more emphasize on more qualitative aspects of creative performance, such as originality and elaboration. Concerning the dimension elaboration for example, according to theory (Guilford, 1967) groups should more easily reach a higher level of detail and depth in their responses on account of composing and improvement of different members ideas. Although not significant ($p < 0.17$) the empirical trend supports this line of argument. A plausible and interesting hypothesis for the circumstance that the small groups not were significantly superior to individuals is that the computer-mediated groups had difficulties combining their process. On account of this, it is suggested that with the existence of practice, and implementation of routines, the efficiency of the computer-mediated interaction would increase.

Present study constitutes a contribution to creativity research by way of extending the view of creative performance. Besides using four dimensions for assessing the creative product, the creative process was also examined. The creative process however, is typically not addressed (Kay, 1994). A review of research examining the effects of different types information technology has almost exclusively studied the creative product in terms of number of ideas generated (cf. Sosik, 1997). Nevertheless, the process whereby an individual or group actively attempts to find, discover or synthesize, i.e. creating -- an idea or problem should be at least equally important as the final product.

The results from the creative process follows and validates some of the patterns found regarding the creative product. Evident is that the both computer-mediated small group conditions has had a more easily flowing process than individuals with significantly more thought changes and incubations at the Original meeting, continuing in the Diary. At the Final meeting the differences diminish, most likely as a consequence of problems with the combining process at the illumination stage. Again, this can plausibly be attributed to the fact that in the Final meeting participants were explicitly told to come up with a final solution. In the face-to-face condition there was no such pattern, most likely since people have practice from deliberations and composing activities through earlier life experience. In the transition stage of incubation to illumination the ability to retain and recycle information is needed. Then, when a final solution is outlined in a group of people it requires close access to information as the resolution of reference, the assurance of mutual knowledge and management of consensus in order have the interaction working out as good as possible. Because human beings are not experienced to communicate via computers the efficiency of handling such interactions will decrease. It appears likely that the task of communicating ideas and problem-solve will be especially fragile for disturbances in the communication-intensive combing process of the illumination phase.
As an answer to the question of how to facilitate interaction Novick and Walpole (1990) have suggested, in the same way as formal face-to-face meetings function, the establishment of social protocols that enable participants in computer-mediated environments to cooperate more efficiently. The fact that groups did not discriminate from individuals regarding the creative product, and that the differences decreased at the Final meeting concerning the creative process, suggests that participants have started using some implicit rules of how to interact. Therefore, it seems natural that if preset agendas, i.e. interaction protocols, would be used, complexity should decrease and steadiness increase, with beneficial consequences for regulation of process as a result. Future studies, aiming to understand the potential of information technology communication, should consider this question as a possible direction of research. The need for research that focuses on the facilitation of computer supported cooperative work have also been addressed by Nunamaker (1997).

The experiment has several limitations. First of all it is necessary to consider the question of external validity as in all laboratory research. The question of task motivation, for example, could well be reasoned to have differed across participants, thus threatening internal validity. However, such differences are most likely distributed equally across conditions. What perhaps should differentiate then, is the level of task motivation of students compared to product and service developers who, in contrast to the former, is daily is dependent on creative performance. Recognizing this nevertheless, it is judged that the level of motivation was at least satisfactorily since it concerned a matter that is often debated by university students. If participants did have any lack of interest, this ought to have been most manifest in the Diary, which was outside experimental control. Consequently, if any data should be interpreted extra careful, it should be data from the Diary session. The question of task motivation is of special interest because of Amabile’s (1996) research on the importance of intrinsic motivation for creative performance. A second limitation concerns the lack of control of gender aspects. Phenomena as communication and computer usage and knowledge is most likely to differentiate among sexes, and it is therefore unsatisfactory that this variable is left outside control in the present study. Future research should address these shortcomings.

Despite these limitations, this study is valuable because it involves an advance toward a more fully understanding of the effects of electronic communication arenas on creativity. Especially, the complexity of the notion of creativity has emerged as central in our study. We have shown that there are aspects of creativity that are affected by the use of computer-mediated communication and that there are other aspects that are not. An important contribution with this study is that we have not only focused on how computer-mediated communication and other kinds of computer support affect the creative product, but also the creative work process in itself. Furthermore, for purposes of validation subjective measures was collected and compared with objective measures (from judges) with substantial agreement as result.

As noted in the introduction, creating new services may become increasingly dependent on the ability to use information technology as a medium for in-
novation. A managerial implication of this study is that information technology may well serve as an important arena for exchanging and developing ideas, especially under circumstances where these abilities have been carefully practiced, and when regular face-to-face meetings are made impossible by time and geographical obstacles.
References


The Effects of Information Technology on Creativity

Per Kristensson

All innovation begins with creative ideas. Thus, the quality of new products and services is dependent on the creative performance of individuals working alone or in groups. Deriving from research, it is assumed that creativity and information technology (IT) play important roles in service development. Given the increased importance of IT used as a means of communication in organizations, the present thesis aims to examine the effects information technology will have on creative performance. More specifically, the focus of the study was how the creative performance of small groups and individuals, operationalized in terms of process and product, was affected when provided IT tools for communicating ideas. The consensual assessment technique was employed along with independent judges to obtain objective measures. Additionally, participants subjective perceptions were also collected. Two experimental studies were conducted, both with IT as an independent variable. In Study I, the importance of internal beliefs, such as the perceived usefulness of IT, was also considered. Only with small effects detected. As for the IT variable, the possibility of interaction appeared as important, especially regarding the creative process. In study II, the effects of group versus individual creativity were also investigated. The results indicated that IT can decrease relevant creative abilities for both individuals and groups considering its quantitative aspects, with small groups having a better ....(cont.)