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Creative Idea Generation

Aybuke Aurum and Adrian Gardiner

Imagination is more important than knowledge.
Albert Einstein

Organisations acknowledge the fact that competitive advantage depends heavily on their ability to capitalise on their employees' ideas as well as to support and maintain creativity within their working environments. Thus, the importance of creativity has long been recognised in management. This chapter reviews the current literature on creativity and discusses various views, which provide a theoretical framework for understanding the thought process involved. It also identifies characteristics of creative support systems based on empirical research and suggests directions for practice and research to contribute to organisational creativity.

Introduction

Organisations operating within the 21st century will have to cope with accelerating rates of change in technology and increased levels of competition on a global scale. More than ever, organisations will need to rely upon enhanced professional and managerial capabilities to meet these new challenges.

Within this changing business environment, companies in order to stay competitive will be forced to constantly pursue new strategies to differentiate themselves from their competition,

such as by offering a stream of new products and new services (Satzinger et al., 1999). Furthermore, there is a growing recognition that an organisation's capability to deal with change improve services and quality, cut costs, develop new products, and compete in a global market, will depend upon the level of creative and innovative thinking of its workforce (Covey, 1989). In short, organisational success in a new age is defined by continuous profitable growth, and creativity has been recognised as a key factor to growth or survival (Tomas, 1999). Recently, Beaver (2001) went as far to declare that creativity should be the new focus of management, rather than knowledge.

The Concept of Creativity

There are many aspects to creativity. Tomas (1999), for example, defines creativity in terms of an original idea. Steinberger (1999) argues that everyone has some creativity, but society and managers discourage creativity. Steinberger points out the six essential elements of creativity in terms of intelligence, knowledge, thinking styles, personality, motivation and environmental context.

Shalley and Perry-Smith (2001) argue that it is not enough to only be original. Also, appropriateness is vital in order to distinguish creative ideas from surreal ideas that may be unique, but have unlawful or highly unrealistic implications. Therefore, the concept of appropriateness is linked with the selection or filtering of 'creative products'. As Poincare (1913, 28; quoted in Sawyer, 1999, 449) points out, "It is not merely a question of applying rules, of making the most combinations possible according to certain fixed laws. The combinations obtained would be exceedingly numerous, useless and cumbersome. The true work of the inventor consists in choosing among these combinations so as to eliminate the useless ones."

There are also differences among researchers with respect to the way in which creative ideas are generated (Handzic and Cule, 2002). Three major perspectives offered by Shneiderman (2000) include: inspirationalist, structuralist and situationalist views. The inspirationalist approach emphasises dramatic

breakthrough and intuitive aspects of creative idea generation. The structuralist perspective emphasises the importance of previous work and methodological techniques to explore possible solutions. The situationalist view focuses on the social context as a key part of the creative idea generation process.

Another classification of various theories recognises psychoanalytical, behavioural, and process-orientated perspectives on creative thinking (Marakas, 1999). The psychoanalytical perspective maintains that creative idea generation is a preconscious mental activity; whereas the behavioural perspective argues that it is a natural response to stimuli. In contrast, the process-oriented view sees it as a thought process that can be improved through instruction and practice.

Moreover, some researchers view creativity (and innovativeness) as individual attributes or traits that remain stable over time and are resistant to manipulation (Gallivan, 2002). Recently, Vandenbosch et al. (2001) took a broader view of the cognitive style perspective and characterised a number of systemic approaches to idea generation (inquiry styles) that may be exhibited by individual managers. These approaches include: Incrementalist (takes small steps; ideas are usually modest changes); Consensus builder (focuses on agreements among stakeholders rather than ideas per se); Searcher (combines information from diverse places; ideas result from unusual associations); Debater (argues with him or herself to develop ideas); and Renaissance person (seems to be infinitely objective and flexible).

Measuring Creativity

Another fundamental issue is how to measure the level of creativity. Measurement of creativity requires a clear definition and identification of a creative act or product. Furthermore, what is considered 'creative' may change over time as new insights and innovations are added to what is 'known'. As Shneiderman (2000, 115) puts it: "computing logarithms by John Napier was a great breakthrough in 1614, but is now seen

as merely a mechanical operation that is embedded in calculators.” It is clear that creativity assessments are domain specific, requiring subjective assessments from qualified judges within the domain field (Ford and Gioia, in press). A typical example is a study of creativity in design by Dorst and Cross (2001), where five design teachers – all of whom were also practising designers – were used to assess the level of creativity of students’ designs for a ‘litter disposal system’ for a new Netherlands’ train. Inter-rater reliability was then examined to determine whether the ratings could be relied upon.

Idea Generation

Central to creativity is the ability to generate ideas. Some psychologists and philosophers (going back to Aristotle and Plato) have argued that idea formation can be explained by way of association. Moreover, many of these scientists have claimed that thinking involves moving from one idea to another via a chain of association and thought, which is impossible without imagination. The development of thinking was thus believed to be a process of accumulating associations. It can therefore be suggested that an individual's capacity for solving a problem is explained by their capacity for generating associations (Garnham and Oakhill, 1994; Gilhooly, 1988). This theory suggests that association occurs when two stimuli occur together (contiguity), when two stimuli are similar to each other (similarity), or when two stimuli are different from each other (contrast) (Gilhooly, 1988; Stein, 1975).

Associations may be stimulated by environmental factors, by previous associations, or may be mediated by ideas related to other associates. Therefore, it is possible to have many combinations and permutations. Associations can vary in strength, depending on how often associated ideas occur together or separately. This theory assumes that the individual comes up with useful combinations of ideas that are already in their tacit knowledge, but which have not been previously brought together. In other words, according to *associationism*, the human mind has the power of creating its own associations,

but not a simple new (innovative) idea (Garnham and Oakhill, 1994).

In the 1960s, Mednick and Mednick (1964) suggested three ways *association* may be applied in the formation of ideas:

- i) Serendipity - association of ideas can be done accidentally e.g. discovery of penicillin,
- ii) Similarity - ideas are associated by similarity in one dimension,
- iii) Mediation - ideas are evoked through the mediation of associates that they have in common.

Later, Koestler (1981) proposed 'bisociative theory'. In this theory, ideas are connected by fixed rules in given associative contexts, and problem solving involves using the established rules within one context. In other words, 'associative' thinking occurs according to a set of given rules, on a single plane. In contrast, bisociative thinking is combining two different sets of rules, which exist on several planes at once.

Creativity Techniques

Consistent with the view that creative thinking can be learnt by appropriate stimulation and instruction, a variety of formal techniques have been developed to assist the production of novel ideas. Some of these techniques are limited to the idea generation aspect of the creative process, while ignoring previous work, consulting with others, or disseminating solutions. Other techniques primarily aim to increase the production of novel ideas by enhancing the creative environment as well as the interaction within a group. In all, many techniques for idea generation have been proposed. For instance, in his classification of creativity tools, Van Gundy (1988) identifies sixty-one tools for group idea generation; and Higgins (1994) offers 101 creative problem-solving techniques that can be used to increase the level of corporate innovation.

Most techniques are based on the notion that one may lose many creative ideas by evaluating them prematurely. Therefore, separation of the creation of ideas from their evaluation is an

important aspect. De Bono takes the view that “Unless we can imagine something, we cannot undertake to achieve it” (De Bono, 1985). The fundamental rules of creative thinking are: “Have a positive outlook; Build upon group ideas; Think of as many ideas as possible; and don’t stop to review your ideas” (Morais, 2001). Tomas (1993) also asserts that in order to be creative, individuals must not constrain themselves by rules when generating ideas. A popular expression that highlights this scenario is the need to ‘think out of the box’. In general, it is believed that idea generation methods are an important source of encouragement for people (Satzinger et al., 1999). There are many idea-generation techniques available. However, they can be classified into three basic categories: free association, structured relationships and group techniques (Marakas, 1999). In the category of structured relationship techniques, the focus is on the generation of new ideas via forced combinations of diverse ideas or concepts to produce new ideas. However, the most widely used techniques involve groups and applying variations of the brainstorming theme.

Brainstorming

One of the most popular free association techniques is brainstorming, which adheres to the fundamental rules of creative thinking, as introduced above. Brainstorming sessions can be conducted electronically, or verbally. Brainstorming was originally proposed by Alex Osborn (1957) as a means of generating as many ideas as possible from group work. He claimed that a group can generate twice as many ideas as individuals working alone, provided that the group follows a systematic approach and adopts four rules. Osborn's purpose in suggesting these rules was to overcome social and motivational difficulties that might inhibit the generation of ideas in groups.

The four rules are:

1. No criticism is allowed,
2. Freewheeling is welcome,
3. Quantity wanted,
4. Combination and improvement are sought.

For a brainstorming session, a group is formed and is encouraged to think freely and propose ideas. The objective of brainstorming is to encourage associations. The basic assumption is that it is possible to generate many ideas, provided that the individual is exposed to stimuli and has experience, knowledge, the personal flexibility to develop various permutations and combinations, and the capacity to make correct selections. The best ideas are listed and this forms the basis on which the group develops its solution strategy. This method initially emphasises the quantity of ideas generated, leaving the assessment of quality to a later stage. This method is used to uncover ideas without being constrained, as the outcome is not permanent. Brainstorming also allows individuals or groups to capture all of their thoughts.

According to Nutt (1984), the reason for forbidding criticism comes from the distinction between the critical and creative mind. Nutt explained that the critical mind analyses and compares the ideas to make a choice. On the other hand, the creative mind makes forecasts to visualise new ideas. The author suggested that these two different mental processes are not compatible. This is to say that making a judgement is not compatible with thinking freely to make free associations and be creative, because the critical mind tends to dominate the creative mind (Nutt, 1984).

Nominal Group Technique

Nominal Group Technique (NGT) is a variation of the 'brainstorming' process developed in late 1960s. NGT is described as a means of generating alternative solutions to problem in-group sessions (Aurum, 1997). NGT was originally developed for face-to-face group meetings. The technique has two main parts: generating ideas first, and discussing ideas later. In the meeting, group members sit around a table in full view of each other. A leader then introduces the problem to members.

In the first part, each member writes their own ideas on a card or a pad. The members do not communicate with each

other while writing their ideas. Later, each group member presents their idea (one idea at a time, in rotation). The leader writes the ideas on a board that can be seen easily by everybody. In the second part, the discussion starts and the leader asks members' comments, opinions on each idea. More ideas can be added at this stage. When the commenting stage is finished, each group member writes their own favourite ideas on a card in ranking order.

In this technique, the writing process is time consuming. Members may become bored after they finish presenting their ideas and lose interest in the topic. The advantage of this technique is that it incorporates a ranking procedure in the selection of ideas. However, the ranking process has been found to be time consuming in large groups or where there is a large number of ideas (Huber, 1982). NGT is a useful technique when there is a need to overcome the adverse effects of social pressure in the group.

Delphi Technique

The Delphi Technique (DT) was introduced in the 1950s by the RAND Corporation. DT uses a survey of experts' opinion in which experts review one another's ideas. In this technique, a group of experts is first chosen to participate, and a small team is set up to prepare a set of questionnaires on the topic. This team then sends the questionnaires, together with some supporting information on the topic, to the experts (geographically dispersed groups), or gives the material to the experts during face-to-face meetings. Each member responds to the questionnaires anonymously. Later, the team collects the responses and statistically summarises them. The team prepares another set of questionnaires based on the experts' responses (or the same questionnaires that are used previously), and again distributes these questionnaires alongside the summarised data to experts. This process continues until the group reaches a consensus.

DT emphasises agreement (consensus) between experts. It has been found to be useful where statistical information is

important such as forecasting. It is also used as a method where controlled anonymous group interaction is necessary.

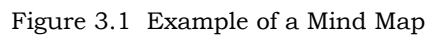
KJ Method

The KJ Method (also known as affinity diagrams) is another brainstorming tool, and was originally developed in the 1960s by Jiro Kawakita of Japan. This method was used originally for anthropological fieldwork to generate ideas from gathered and stored data. However, it has also been widely used within Japanese business (Ohiwa et al., 1990).

The original method involved having group members write their ideas onto cards. However, in later years, Ohiwa et al. (1990) developed the system for computer-supported environments by using HyperCard. The application of the method has two major components: First, a diagram (named 'A-type diagram') is produced to assist in the generation of ideas and to also illustrate the relationships between ideas (participants write down their ideas on cards and then the cards are grouped, based on similarity). Second, generated ideas are recorded on a document – which is called 'B-type writing'. Relationships between the card groups (such as opposition, equality, causality) are then outlined by drawing arrows.

Mind Mapping

Another free association technique is mind mapping. This method involves starting with writing down a main idea in the centre of the page, and then working outward in all directions (which visually appears to be like wheel spokes), producing a growing and organised structure composed of key words and key images. Mind mapping therefore relies on association (and clustering) of concepts/ issues. The association process underlying construction of the mind map, actually facilitates making connections between concepts, and hence tending to generate new ideas and associations that have not been thought of before. An example of a mind map is shown in Figure 3.1.



An individual creativity technique is Solo Brainstorming (SBS), originally proposed by Aurum (1997). This technique is especially suited to environments where sentential analysis is appropriate, or information sources are document-based (e.g., reports, abstracts, testimonies, interview transcripts, web publications). The SBS technique (as shown in Figure 3.2) requires the individual to adhere to a formal protocol (procedure), where a series of documents are examined ('reading' stage), and then edited. The 'editing' stage consists of the following activities: typing a summary of each document; making lateral comments/links (e.g. making connections between documents; noting ideas as they occur); and nominating issues to be followed up. The ultimate aim in a SBS session is to determine a sufficient set of issues. As

applications of the SBS protocol have been computer-based, all issues are automatically available in electronic form for further analysis.

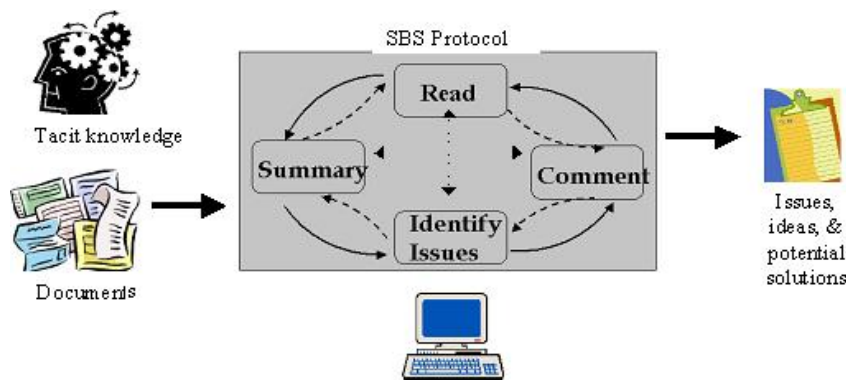


Figure 3.2 Overview of the SBS Technique

The SBS protocol – as a technique to facilitate creativity – touches upon an important research issue in the area of knowledge management: whether an increase in an individual's level of domain knowledge will necessarily increase their capacity to be creative within that domain. (For example, does being truly creative require a rich mental model of the domain?; or can only experts within a domain truly provide creative insights or solutions?) In a typical SBS session, participants are given factual-type information. It can therefore be argued that this information may allow participants to learn more about the domain, thereby evolving their mental model of causal connections (e.g., identifying previously unknown variables, parameters, or links; or weakening existing links and associations). In line with this view is Amabile (1983), who identified domain knowledge or expertise as the foundation of creative activity. However, one cannot merely assume that availability of richer information will necessarily lead to the level of mental connections and permutations of cognitive structures required to produce creative insights. For example, proponents

of the view that an individual's level of creativity is an individual trait would argue that any increase in creativity possible from mere provision of a richer level of domain knowledge would be constrained by the individual's intrinsic level of creative ability. Moreover, individuals may need a requisite level of motivation and degree of reflection to integrate new information successfully, and overcome the cognitive load (mental demands) required to integrate and pre-process the incoming information in order to be able to leverage this information within a demanding creative task.

Central to the SBS protocol is to encourage participants to use their cognitive abilities by asking them to make 'lateral comments' (e.g., being instructed to make conceptual connections between issues and between documents). Lateral thinking is a function of knowledge and imagination that may bring out discovery, innovation, imagination and exploration. It is also an aid to creativity when one needs to have diverse ideas. Lateral thinking is a way of thinking that seeks as many alternative options as possible to the extent of one's adventurousness. In other words, it is a mental activity involving making connections between knowledge and ideas that were previously unrelated. In idea generation sessions, it is important to think expansively and to suspend judgment.

In a SBS session, lateral comments involve input from the participant as well as from different 'authors' of the abstracts and views featured within the other documents. The interaction between these two sources of inputs brings forth creativity, acts as a rich source for stimuli that will trigger greater recollection of relevant knowledge (tacit knowledge), and makes it possible for the participant to see relationships between different elements, make analogies, and look at scenery from different points of view. If the participant does not have any 'lateral comments', then essentially they are restricted to only the material in abstracts, or other documents.

There is no universally accepted set of lateral thinking or creative thinking criteria. Aurum (1997) suggests that the level of 'laterality' for any thought for a given problem can only be

assessed with respect to the thoughts generated by others for the same problem. Aurum also found that documents generated from SBS sessions exhibited some unique characteristics. Several analyses of the documents produced by the participants were performed. An original scheme involving linguistic analysis was developed to measure lateral thinking. Linguistic Analysis was useful in capturing the linguistic behavioural patterns of SBS users. The development of the lateral thinking measurement proved to be one of the most interesting aspects of her research. The scheme she applied indicated that there was a significant difference in linguistic patterns between different users. From the linguistic analysis, it was possible to identify those users who were able to think *laterally* in the SBS session. Furthermore, lateral thinkers displayed a more complex linguistic pattern than non-lateral thinkers. The users who generated many ideas and identified many issues were also found to be lateral thinkers. The findings showed that *lateral thinkers* wrote many 'issue loaded' or 'idea loaded' sentences, whereas *non-lateral thinkers*, because they were not as successful as the first group in the SBS session, produced fewer ideas. However, the distinction between these two groups was not clear-cut, but rather a continuum (Aurum, 1999).

The value of SBS also lies in being a 'formal' protocol - one that places specific (yet flexible) demands upon participants to adhere to a set of behaviours designed to enhance the level of an individual's creativity. Adherence to the SBS regime will thus encourage a higher level of intrinsic motivation (discipline), application of a systematic and thorough approach to analysis, as well as reflective and lateral thinking.

Typically, to measure the level of creativity attributable to application of the protocol, before interacting with the document set, users are asked to list issues they are already aware of. Once the individual has completed to their satisfaction the SBS protocol (i.e., all documents have been examined), the issues that were raised can be analysed across various dimensions (e.g., originality, workability and relevance).

Electronic Brainstorming

In recent years, the use of computer-supported group decision making has grown rapidly, and electronic-supported brainstorming sessions have become an essential part of Decision Support Systems (DSS). Many different terms have been used to describe computer-supported group interactions, including Electronic Meeting Systems and Electronic Brainstorming Systems. These systems are generally collections of specific tools that are used to support a large variety of group tasks, such as idea generation, voting/decision making and electronic discussions (Chen et al., 1994; Nunamaker et al., 1991, Petro, 1994).

In a computer-supported group session, group members share their knowledge and ideas by sending their ideas to each other, and by viewing the ideas of other members.

The creative thinking of each member is therefore stimulated as a result of viewing each other's ideas. There are several software systems that support the generation of ideas in groups. For instance, Electronic Brainstorming Systems (EBS) and the KJ Method are widely known and used systems. In EBS, group members generate ideas, which are typed into computers. All group members work in parallel, sending their ideas and comments to other members, with no interruptions by others. Ideas are then circulated randomly among group members, who add ideas and comments. These ideas are screened on a large electronic board, as well as on each individual's workstation. One benefit of this process is that participants receive feedback for their ideas and make comments on other participants' ideas independently and without holding any negative or positive bias about the individuals who contributed the ideas. Ideas generated from a brainstorming session can be recorded and stored in electronic files, making them easily accessible for printing or later reference. An example of this interactive environment is the Electronic Meeting Systems software developed at the University of Arizona (Nunamaker et al., 1991).

The development and use of Electronic Brainstorming has brought a new perspective to brainstorming. Empirical studies have found that EBS is a better way to generate ideas than both individual brainstorming and face-to-face group brainstorming (Nagasundaram and Dennis, 1993; Gallupe and Cooper, 1993). Nagasundaram and Dennis (1993) suggested that EBS combines the benefits of both nominal and real groups by bringing anonymity into the environment. Note that EBS can support face-to-face meetings as well as anonymity. It has been found that anonymity reduces the effects of judgemental comments and psychological stress associated with sharing one's thoughts with others (Dennis et al., 1994; Gallupe and Cooper, 1994; Lamm and Trommsdorff, 1973).

Researchers have also suggested that anonymous voting also reduces problems caused by conformity and group-think (Kleindorfer et al., 1993; Nunamaker et al., 1991). The 'group think' problem may arise when the level of social interaction is strong. According to Janis (1972), in some cases, group members are so loyal that the desire for conformity becomes very high. Accordingly, group members may suspend their own ideas in favour of the group (i.e., cease to realistically appraise alternative courses of action), thus developing 'one-track-thinking'.

Existing idea generation techniques handle the process of issue identification differently. In the Delphi method, the issues are identified by a group of people and then distributed to other participants so that they can generate ideas for those issues. In other techniques, such as the Nominal Group Technique, KJ Method or Electronic Brainstorming Sessions, the participants generate the ideas first and then they organise the ideas by reducing them into a set of issues. However, organising the ideas can be a very tedious task. For instance, Chen et al. (1994) reported that, in electronic sessions, 10-20 users could easily produce 500-1000 lines (which contain ideas) in an hour. On the other hand, reducing the ideas to a sensible set of issues can take more than a couple of hours, and may cause confusion and dissatisfaction between users.

Creativity in Context

This section presents examples of several domains in which researchers and practitioners have acknowledged the important role of creativity.

Disaster Planning

Natural disasters represent a serious threat to the environment, and in recent years, the world has witnessed some major disasters with tragic environmental and economic consequences (e.g., earthquake in Turkey in 1999; bushfires in Australia in 1994 and 2001). Environmental disasters are a particularly serious problem in Australia where bushfires cause a significant amount of damage every year.

Aurum et al. (2002a) investigated whether the application of the SBS protocol could assist to improve the number, relevancy, breadth and uniqueness of issues that were raised by individuals, who participated in a simulated bushfire-planning scenario.

The participants in this study were postgraduate students from the University of New South Wales. They were told to assume the role of a committee member, the committee having been set up to review how a fictitious disaster had been managed, and subsequently make recommendations to improve the disaster planning process. Participants were also instructed to identify issues that could potentially apply to a range of situations in bushfires.

The types of documents used as input for this simulation were abstracts from published articles focusing upon issues relevant to bushfires or forecasting natural disasters (which included the social and psychological impacts of fires, as well as technical issues – e.g., how to protect one's home from fire).

Issues raised during the simulation were analysed to see whether the number of issue categories identified by individual users increased with application of the SBS protocol. In addition, a similar analysis was performed on nominal groups of individuals in order to determine the minimum number of

people required in a group before all issue categories were covered. To determine the issue categories, six judges examined all the issues that were raised by all participants, and then clustered the issues into broader categories of issues.

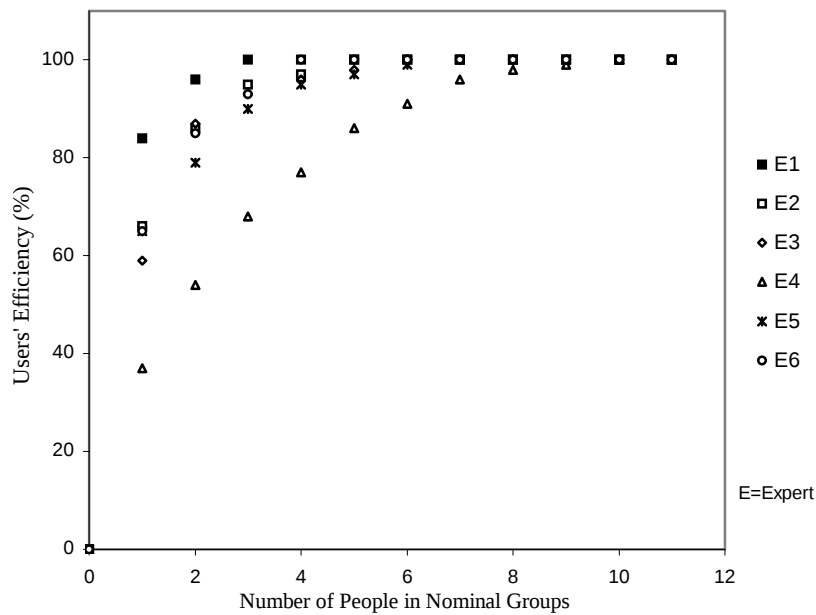


Figure 3.3 Optimum Number of People Needed in Groups
– With the Best Performers

Results of the individual-level analysis indicated participants generated substantially more relevant ideas; and the average number of ideas had tripled (increasing from 5 to 15). In terms of the breadth of categories covered by each individual, the average expanded by 30 per cent (increasing from 17 per cent to 47 per cent). For the analysis of nominal groups (collective-level analysis), nominal groups were formed through selection of various combinations of individuals. Redundant issues (issues being raised by more than one of the individuals in the nominal

group) were eliminated, and therefore counted only once. The goal of this analysis was to determine how many individuals (comparing a nominal group composition comprising the best performing individuals vis-à-vis a nominal group composition comprising the worst performing individuals) were needed before most of the issue categories had been covered. Figures 3.3 and 3.4 show comparisons of the experts' classifications. Figure 3.3 shows the maximum number of issue categories that were identified when the best individuals came together; whilst Figure 3.4 shows the maximum number of issues that can be identified when the worst individuals become members of a group. The plots are based on each individual expert's classification.

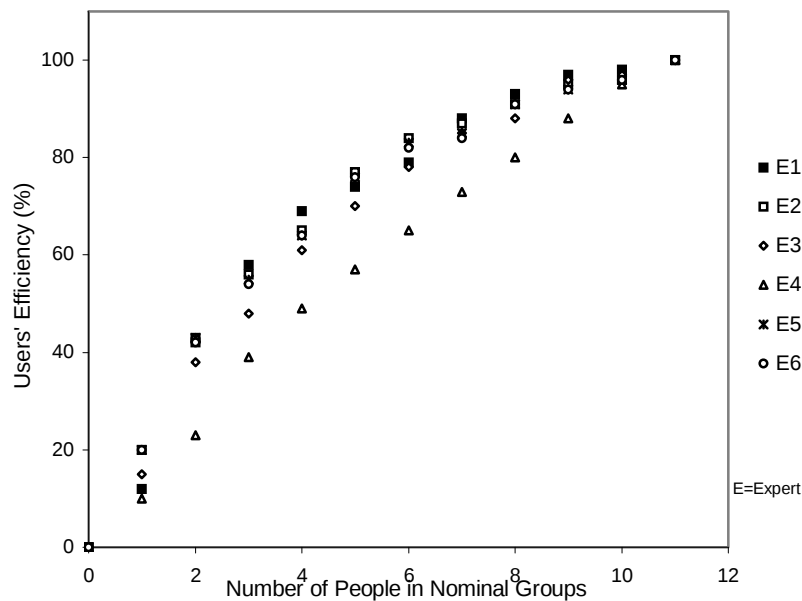


Figure 3.4 Optimum Number of People Needed in Groups
– With the Worst Performers

The curves in Figure 3.3 (the maximum productivity scenario) revealed that four people could cover 95 per cent of the issue categories, and five people could cover 97 per cent of the issue categories. Figure 3.4 (the minimum productivity scenario) suggest that four people were able to cover 63 per cent of the issue categories, and with five of the worst performing people, 69.7 per cent of the issue categories was covered. Clear implications from these findings are that groups of individuals are likely to perform more highly using the SBS protocol. In addition, small groups of individuals – whether they comprise individuals who are either ‘poor’ or ‘good’ in terms of the breadth of issues suggested – are still able to cover the majority of relevant issues.

Software Engineering

Software engineering is another domain in which creativity plays an important role. For example, Hicks et al. (in press) characterises the systems develop life cycle approach to software development as an information-knowledge process. They assert that two forms of creativity are integral to most stages of this process: adaptive creativity, involving the adaptation and extension of existing knowledge to a new situation; and inventive creativity, which is purely original, and may involve radical new fundamental principles or methods in order to achieve an existing or new function.

The value of creativity is also well recognised in the field of system requirements determination. For example, JAD (Joint Application Development) sessions, which are popular for requirements determination, routinely include the use of creativity techniques to increase the quality of participants’ insights into their requirements. Recently, Robertson (2001) referred to requirements determination as ‘requirements discovery’, which suggests that many users may not even be aware of their true requirements (e.g., unconscious requirements) without application of techniques for reflection and creativity.

In an experiment focusing upon requirements elicitation, Aurum et al. (2002b) (see, also, Aurum and Martin, 1999, for related findings) applied the SBS protocol to determine whether application of the protocol would deliver a richer set of requirement statements and insights. An experiment was conducted in which participants were told to adopt the role of a systems analyst retained by a fictitious organisation, the Cultural Heritage Authority (CHA), to write requirements specification for their main information systems. Participants were told that CHA's corporate charter is to coordinate the marketing of Australia's cultural heritage. Participants were sixteen graduate students studying software analysis and design at the University of Canberra.

The types of documents used as input to this study included: fictitious interviews with users and other people holding authoritative positions within both CHA and the wider industry; and abstracts from published articles addressing either heritage or marketing issues.

Before applying the SBS protocol, participants were asked to generate ideas with respect of the anticipated requirements for CHA's information systems. These ideas were then compared with the ideas generated during application of the protocol to determine whether the application of the SBS protocol had indeed led to a richer level of requirement specifications. Specifically, this study focused upon whether application of the protocol would result in identification of more relevant, workable and original requirements issues.

Accordingly, after application of the protocol, several software experts scored the issues raised by participants in terms of their workability, relevance and originality. Overall, the results of the analysis indicated that application of the protocol had a significant ($p < 0.01$) positive impact upon the originality of the ideas, but had no significant impact on their relevance and workability. As shown in Figure 3.5, the overall mean score for originality increased from 1.4. ('very common') to 1.8 ('slightly

novel’). The value of increasing originality of ideas would have been undermined if the ideas were less workable or relevant; however, this was not the case. Therefore, application of the protocol did indeed increase the overall quality of the elicited requirements. The results of this study support the idea that thinking-assisting applications can be developed, learnt, practised and used to generate ideas.

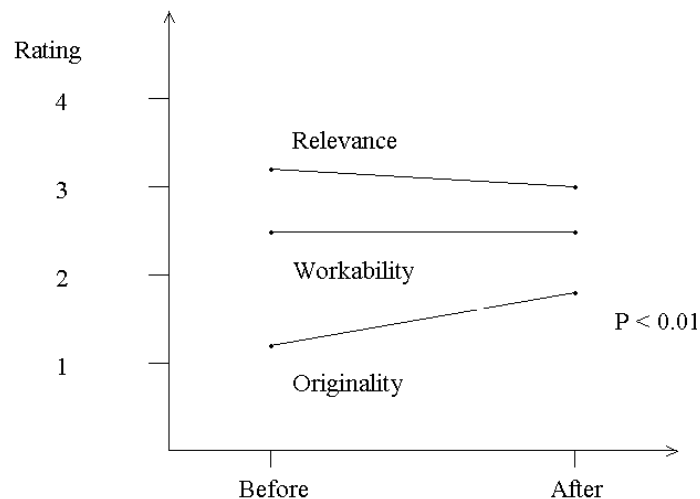


Figure 3.5. Mean Rating Scores for Participants' Creative Performance Before and After Their Interaction with Technology

Factors Affecting Creativity

Most empirical studies investigating the value of creative thinking and idea generation techniques suggest that the creative performance of individuals and groups is highly contingent. A variety of factors has been suggested to influence

creative thinking, and they can be grouped into two broad categories: social and technological (Handzic and Cule, 2002). Social factors cover various initiatives, such as government policies (Herceg and Flattery, 2000), organisational structure and culture (Datta, 2001; Gore and Gore, 1999; Herceg and Flattery, 2000; Muoio, 2000; Sunderland, 2000), and educational programmes (Sangran, 2001; Sunderland, 2000). Social factors are especially relevant to establishing a climate conducive to creative performance. The role of information technology, on the other hand, is seen primarily in terms of facilitating the creative process, including generation, exploration, communication and dissemination of ideas (Shneiderman, 2000; Sridhar, 2001).

Social Factors

Recognising that creation of novel ideas often takes place in social contexts, a number of empirical studies have evaluated various contextual factors that may influence the creative performance of individuals or groups (e.g., evaluation, surveillance and competition). A study by Amabile et al., 1992 (quoted in Nagasundaram and Bostrom, 1995), suggest that freedom (control over one's work), challenge, sufficient resources, organisational encouragement and recognition, and support from work group (including trust and free communication among group members) are factors that stimulate creativity. In contrast, factors that may impede creativity include organisational impediments (including politics, harsh criticism of new ideas, and an atmosphere of risk-avoidance) and extreme workload pressure.

An example of a recent study in this area is Shalley and Perry-Smith (2001), who suggest that the level of an employee's creativity whilst performing a task may be increased if they are more intrinsically motivated to perform that task. With higher levels of motivation, employees will become more focused upon the task, and thus be less concerned with contextual conditions, which may act to decrease their concentration upon the task itself (i.e., not being free of non-essential thoughts). To investigate this issue, Shalley and Perry-Smith (2001) conducted

an experiment to investigate two factors suggested in the literature as impacting employees' level of intrinsic motivation (and therefore the level of creativity): the independent and joint effects of providing positive or negative models (e.g., using a positive prior solution as an exemplar of what can be achieved); and expected job performance evaluation. Their study also distinguishes between two types of job performance evaluation: informational and controlling. Informational evaluation instructs the employee on how to enhance their performance by providing them, for example, with information about task competency, or task support information. In contrast, controlling evaluation examines employees against a regulated benchmark of performance.

The findings of the Shalley and Perry-Smith (2001) study clarify that when an individual is awaiting an informational evaluation, they will have higher creativity and 'intrinsic motivation'. On the other hand, when an individual is expecting a controlling evaluation, their level of creativity and 'intrinsic motivation' is lower. Furthermore, the results of this study indicate that models (exemplars) can assist the progress of creativity. As predicted, individuals presented with a creative exemplar had higher creative performance than those individuals with no such exemplar. Also, individuals expecting an informational evaluation and provided with a creative exemplar had the highest levels of creativity. Conversely, individuals expecting a controlling evaluation and provided with a standard exemplar had the lowest levels of creativity. Finally, the results indicate that there is a direct relationship between 'intrinsic motivation' and evaluation, and that personal perseverance is arbitrating the relationship between 'intrinsic motivation' and evaluation.

In another study, Satzinger et al. (1999) considers in what manner do the contents of group memory – a repository of ideas generated by a GSS (Group Support System) – influence the type of ideas produced by individuals in an idea generation activity. In particular, this study investigated the cases where the repository of ideas contained either 'paradigm preserving', or

'paradigm-modifying' ideas (which is a similar idea to the possible affects that models may have upon creativity – see, Shalley and Perry-Smith, 2001). Satzinger et al. (1999) findings suggest that individuals exposed to 'paradigm modifying' ideas tended to produce 'paradigm-modifying' ideas. Likewise, those exposed to 'paradigm preserving' ideas tended to produce 'paradigm-preserving' ideas. Whether generated ideas were considered paradigm preserving ideas was influenced by how well they retained the current paradigm (framework) presented in the business problem (paradigm preserving) or whether they reflected a fundamental change in the underlying paradigm (framework) of the existing problem (paradigm modifying) – i.e., ideas that break away from the standard way of perceiving the problem at hand.

Recently, Paulus and Yang (2000) analysed the creative process of 'brainwriting' (a version of brainstorming where generated ideas are written down based on a problem statement, and then swapped). An advantage of the brainwriting technique is that it can reduce some of the documented barriers to the production of ideas that may occur in brainstorming groups. For example, production losses may arise from: failure to contribute ideas because one is concerned about being evaluated by other group members; and production blocking, which is when only a single person is allowed to make a contribution at any point in time (i.e., they cannot verbalise their thoughts as they occur). While a person waits for their turn to contribute, the focus of the argument may change, and hence the person's potential contribution is lost. Paulus and Yang (2000) suggest that writing ideas, instead of speaking them in groups, eliminates the problem of production blocking, since individuals do not have to wait their turn to offer ideas. In addition, brainwriting may reduce evaluation apprehension since the written format eliminates the need for public speaking, and is typically more anonymous than brainstorming. It was thus proposed that group brainwriting would produce more ideas than individual brainwriting. Indeed, the results of the study suggest that brainwriting results in a greater number of ideas generated by

interactive groups, compared with the number of ideas generated by individuals. This written procedure might have stimulated each group member's attention to the other suggested ideas. Furthermore, up to four ideas were written on a piece of paper. This allowed group members to easily reflect on the ideas generated and integrate them with their own ideas. As ideas had to be remembered, it might have been made more difficult to generate ideas in the same instance.

Paulus and Yang (2000)'s study also demonstrates – like Aurum's SBS creativity protocol – the value of a formal protocol in creativity tasks, as these procedures encourage participation, increase intrinsic motivation to generate and share ideas, and ensure that potential stimuli/triggers for creativity are properly attended to by all participants.

Paulus et al. (2002) conducted an extensive review and analysis of past literature on brainstorming within groups and identified a series of social and cognitive influences on both individual and group-oriented creative processes. In summary, this analysis revealed that individuals left to their own devices are not likely to be very productive, particularly when involved in a verbal exchange of ideas. However, when processes are structured as to limit the inhibitory processes and facilitate stimulation, high levels of ideas generation can be achieved. Mixture of individual and group processes appeared to be the optimal approach.

Technological Factors

A variety of technologies have been developed to stimulate idea generation. Ideafisher, Serious Creativity, Mindlink, Ideapro and Brainstormers are only a few of the many available software programmes. Each programme usually focuses upon supporting a specific technique. The programmes assist in defining the problem prior to generating ideas and they may provide stimuli that enhance imagination. One of the main advantages of these programmes is the speed at which one can produce ideas. Sometimes, the ideas generated can also be stored in an ideas bank and revisited at a later date.

Most available programmes can be used for individual or group idea generation. When groups are in different locations, they can communicate through computers (Sridhar, 2001). Furthermore, if idea generation was taking place in different countries, the ideas generated could also produce a variety of cultural perspectives. Humphreys et al. (2000) showed how creative knowledge for distributed innovative decision-making could be successfully generated and communicated through the interplay of modes of composing in multimedia (textual, audio-visual) and modes of language (observation, action). In a study involving youngsters from a number of communities, they found that communicating in multimedia empowered local decision-makers to discover new resources and implement new pathways in situations where conventional decision analysis and decision support were constrained.

An extensive analysis of existing tools by Shneiderman (2000) revealed that most available tools provide support only for some parts of the creative process. These activities may include searching and browsing libraries, consulting with peers, visualising data, developing ideas, what-if analysis, composing artifacts, reviewing and replaying histories, or disseminating results. He pointed out that by combining all of them into an integrated creativity support system, a workbench for creative performance could be possible. However, he did warn about potential limitations of such a workbench, as it may restrict imagination to only what is possible within the toolset.

An Integrated Approach to Creativity Support

It is now widely recognised that many organisations rely upon a stream of ideas flowing from management and employees in order to remain competitive. While there is no doubt that most organisations already have creative people (their employees) and a creative press (their working environment), it is unlikely that the majority of organizations have formal creative processes and tools in place. Creative processes have to be learnt, and organisations should seek to incorporate a number of initiatives reflected in the growing body of literature in creativity support.

For example, Paulus and Yang (2000) support an organisational creativity approach using *brainwriting* - a technique that can now be readily implemented on computer networks now found in many organisations (Kiely, 1993).

In terms of what organisations can do to facilitate employee creativity, Kletke et al. (2001, 230) distinguish between efforts at “institutionalising individual creativity”, efforts at increasing “organisational creativity”, and successful “organisation innovation” by organisations. They refer to “institutionalising individual creativity” as ways that organisations “can facilitate the development of its individual members with the intent of gaining synergy as multiple individuals work creatively across the organisation”. On the other hand, “organisational creativity” refers to “the creation of novel and useful products, services, processes”. Finally, “organisation innovation” refers to “the adoption and implementation of these novel products, services and processes.” Kletke et al. (2001) view individual creativity as a precursor of organisational creativity, and organisational creativity as a precursor of successful innovation.

It is important to recognise that creative process is as much about teamwork, hard work and understanding the audience as it is about generating ideas. It is also necessary to evaluate creative performance. Shalley and Perry-Smith (2001) strongly emphasise that people must be given informational evaluation. Additionally, people should be provided with creative exemplars (models) so they can be reviewed and imitated. Ultimately, implementation of these recommendations will help to increase the level of creative performance of employees.

Most of the tools currently available to support creative thinking, focus on supporting the idea generation aspect of the process, while largely ignoring collecting previous work, consulting with others, or disseminating solutions. The fundamental beliefs that new knowledge is built upon previous knowledge, powerful tools can support creative process, refinement is a social process, and that creative work is not completed until it is disseminated, lead us to a conclusion that there is a need for an integrated support of creative

performance. An ambitious task for researchers and designers of creativity support systems is to construct an integrated software tool that supports the creative process. While we recognise that creativity is inherently human, we strongly believe that supportive technology can become the person's 'potter's wheel', which has the potential to open up a new media of expression and enable impressive creative performance.

In addition, the four-phase framework (GENEX – generator of excellence) suggested by Shneiderman (2000) may provide a basis for development of such a tool. The phases of his framework include: collect (learn from previous work), relate (consult with peers and mentors), create (explore, compose and evaluate possible solutions), and donate (disseminate the results). For example, digital libraries with powerful search and visualisation tools can support the collect phase, which involves searching and visualising activities. The relate phase, which requires consultations with peers and mentors, can be supported through asynchronous tools such as email and discussion groups, or synchronous tools like videoconferencing and software sharing. The create phase requires support for free thinking, exploring solutions, composing artifacts and reviewing session histories. Some of the potentially valuable support tools for this phase may include brainwriting, what-if support (commonly found in tools such as spreadsheets), and publishing and simulation software. Finally, email may provide a valuable means for disseminating final ideas to the circle of people who should receive them during the donate phase. The main challenge for researchers remains to determine those tool combinations that have the greatest potential to facilitate creative performance. Overall, it is expected that an integrated creativity support system (architecture) in a nurturing and collaborative social environment, may assist a modern organisation to introduce innovation, to support the company's business strategy, and ensure its survival and success in the new millennium.

Conclusion

Many organisations have come to realise that the creativity of their management and employees is an important source for competitive advantage. However, arguably more can be done within these organisations to promote a creative culture – for example, more organisations should seek to reward management and employees for creative (or divergent) displays, and make more widely available creativity supporting technologies.

A number of techniques have been developed to facilitate creativity, with many techniques based upon some form of *brainstorming*. The techniques outlined in this chapter were: NGT, DT, KJ Method, Mind Mapping, and SoloBrainstorming. Selection amongst these techniques will depend upon a number of factors – for example: whether a group of people, or single individuals, are involved in the creativity session; whether all members of the group are in physical proximity to each other; and the nature of the problem. In terms of the latter factor, DT, for example, is frequently used for gaining consensus amongst a number of experts in tasks such as forecasting; whereas SBS can be used for individual problem definitions in the areas of strategic planning, and requirements determination.

One theme common to some of the more recent studies on creativity we reviewed is the importance of a rich (and varied) source of stimuli to support the creative process; whether the stimuli be: documents, as in Aurum et al. (2001); group memory, as in Satzinger et al. (1999); or models, as discussed in Shalley and Perry-Smith (2001). Other forms of stimuli include: text, audio, graphics, simulations, video, etc. (Kletke et al., 2001). Indeed, the effectiveness of the brainstorming technique relies on participants being stimulated by the ideas contributed by others (i.e., others' ideas becoming one's stimuli). The potential to cascade ideas is referred to as *synergy* (Dennis & Valacich, 1993) – i.e., the ability of an idea from one participant to trigger a new idea in another participant, an idea that would otherwise not have been produced.

Another theme within our review is that formalising the creative process through some 'protocol' (i.e., a structured formal process, or a set of rules) can be an effective strategy in terms of supporting the level of intrinsic motivation and mental effort required by participants undertaking a creativity task (see, e.g., Aurum et al., 2001; Paulus and Yang, 2000). Application of a formal protocol is usually at the heart of a creativity technique, and ensures a more systematic and thorough approach to information analysis, which is essential for many creativity tasks (Aurum et al., 2001).

Finally, there is still a need for the development of creativity supporting tools, as called for by Shneiderman (2000). However, these tools and related creative activities need to be integrated into a process that ensures the 'right' information (stimuli) is available to the creative processes and tools, and that creative products are properly disseminated within the organisation.

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