CREATIVITY

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INNOREGIO: dissemination of innovation and knowledge management techniques

by **Dr Eleni Sefertzi**

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Contents

1 DESCRIPTION

1.1 What is Creativity

There are many definitions of creativity. A number of them suggest that creativity is the generation of imaginative new ideas (Newell and Shaw 1972), involving a radical newness innovation or solution to a problem, and a radical reformulation of problems. Other definitions propose that a creative solution can simply integrate existing knowledge in a different way. A third set of definitions proposes that a creative solution, either new or recombined, must have value (Higgins 1999). A novel idea is not a creative idea unless it is valuable or it implies positive evaluation. Also, according to dt ogilvie (1998), imagination, which involves the generation of ideas not previously available as well as the generation of different ways of seeing events, is important to achieve creative actions.

To combine this variety of definitions, we can say that creativity involves the generation of new ideas or the recombination of known elements into something new, providing valuable solutions to a problem. It also involves motivation and emotion. Creativity "is a fundamental feature of human intelligence in general. It is grounded in everyday capacities such as the association of ideas, reminding, perception, analogical thinking, searching a structured problem-space, and reflecting self-criticism. It involves not only a cognitive dimension (the generation of new ideas) but also motivation and emotion, and is closely linked to cultural context and personality factors." (Boden 1998).

According to Boden (1998), there are three main types of creativity, involving different ways of generating the novel ideas:

a) The "combinational" creativity that involves new combinations of familiar ideas.
b) The "exploratory" creativity that involves the generation of new ideas by the exploration of structured concepts.
c) The "transformational" creativity that involves the transformation of some dimension of the structure, so that new structures can be generated.

Creative thinking in a disciplined manner can play a real role in innovation. "Creativity and innovation are normally complementary activities, since creativity generates the basis of innovation, which, in its development, raises difficulties that must be solved once again, with creativity…It is not possible to conceive innovation without creative ideas, as these are the starting point." (European Commission 1998).

Innovation results when creativity occurs within the right organisational culture. The right organisational culture is one that provides through creativity processes (creative techniques) the possibilities for the development of personal and group creativity skills. We can define creativity IMT as the establishment of skills by implementing creativity generation techniques.

1.2 Objectives of Creativity

Main objectives of a creative thinking process is to think beyond existing boundaries, to awake curiosity, to break away from rational, conventional ideas and formalised procedures, to rely on the imagination, the divergent, the random and to consider multiple solutions and alternatives (Candy 1997, Schlange and Juttner 1997).

The result of the creative thinking process is especially important for businesses. Managers and managerial decisions and actions, confronted with fast-changing and ambiguous environments in business, need to develop creative solutions and creative action-based strategies to solve problems, as they allow to increase understanding of problematic situations, to find multiple problems, to produce new combinations, to generate multiple solutions that are different from the past, to consider possible alternatives in various situations that could occur in the future and "to expand the opportunity horizon and competence base of firms" (dt ogilvie 1998).

1.3 Description / structure of the methodology / alternative solutions

Creativity is not an innate quality of only a few selected people. Creativity is present in everyone. It can be learned, practised and developed by the use of proven techniques which, enhancing and stimulating the creative abilities, ideas and creative results, help people to move out of their normal problem-solving mode, to enable them to consider a wide range of alternatives and to improve productivity and quality of work. "Creativity is thus constructed as a learned ability that enables us to define new relationships between concepts or events, which seemed apparently unconnected before, and which results in a new entity of knowledge" (European Commission 1998). Knowledge and information are the basis for creativity.

The scientific research is recently oriented towards the development of creativity as an educational process. Many studies show that creative abilities can be developed by the implementation of creativity techniques (see Mansfield, Busse and Krepelka 1978, Parnes and Brunelle 1967, Rose and Lin 1984, Taylor 1972). Concrete creativity supporting techniques, including also computer-based support tools (artificial intelligence models, computer software idea processors, information systems, etc.), are developed to promote and generate creativity, to break fixed ideas, to stimulate imagination, as well as to define the conditions in which creativity takes place (the creative environment or climate). Using such techniques, a company aims to "incorporate the employees' potential of creativity into the process of performance creation" (Bullinger 1999).

There are numerous creative techniques, which are also classified in many ways (Higgins 1994). In general, a certain type of question or a certain area of application (such as marketing, product or service development, strategic and decision planning, design, quality management, etc.) often calls for a certain type or a certain group of creativity techniques. The description of some well-known and basic techniques and their implementation procedure is presented in session 3.

A classification for these techniques can be made between analytical techniques and intuitive techniques. Analytical techniques follow a linear pattern of thought or sequence of steps, such as the "5 Ws and H" technique (it asks the questions who, what, when, where, why, and how) and have better application for very specific, analytical questions (Higgins 1999). They stimulate different ways of organising known information and help approach problems from new angles (Miller 1987). Intuitive techniques are less structured techniques. They tend to skip steps in a sequence and tend to provide a whole answer all at once, such as the "wishful thinking" technique (based on ideal possibilities and solutions), and they are more appropriate for ill-defined questions (Higgins 1999).

Another classification can be made between techniques that are more appropriate to generate creativity in individuals, and techniques, which generate creativity in groups undertaken within work groups. “Improving personal creativity for individuals involves enhancing the individual’s use of intuition and reducing mental blocks creativity, such as fear of failure. At the group level it requires team building and other efforts to enhance the use of group dynamics to achieve creativity and innovation” (Higgins 1996). However, this classification is not rigorous, since many group idea generation techniques can also be used by individuals. On the other hand, the individual and the group are two main agents that always interact in the process of creativity in business and industrial innovation. “Creativity is an attribute of the individual, though generally it can only be developed efficiently when it is tackled within a group of team. For this reason, most creative techniques are proposed and undertaken within the framework of specific work groups, within companies or other organisations” (European Commission 1998).

A third classification might be between creative techniques that rely upon divergent thinking and techniques that rely upon convergent thinking. Divergent thinking is the generation and the free flow of ideas and it demands considerable discipline, which is aided by the introduction of rigorous techniques forcing divergence toward many alternatives. Convergent thinking, on the contrast, demands techniques of filtering and focus to identify the ideas that have a truly innovative value, to converge on an acceptable solution (Hall 1996). Divergent and convergent thinking are complementary phases of a procedure, since divergence helps forcing towards many alternatives and possible options before convergence on an appropriate solution.

Fundamental concepts for all creative techniques are:
- The suspension of premature judgement and the lack of filtering of ideas.
- Use the intermediate impossible.
- Create analogies and metaphors, through symbols, etc., by finding similarities between the situation, which we wish to understand and another situation, which we already understand.
- Build imaginative and ideal situations (invent the ideal vision).
- Find ways to make the ideal vision happen.
- Relate things or ideas which were previously unrelated.
- Generate multiple solutions to a problem.

Main points to increase or encourage creativity in a company are:
- to be happy, to have fun
- keep channels of communication open
- trust, failure accepted
- contacts with external sources of information
- independence, initiatives taken
- support participatory decision-making and employees’ contribution
- experiment with new ideas

1.4 Expected results / benefits

Creativity, through the generation of ideas with value, is needed in order to solve concrete problems, ease the adaptation to change, optimise the performance of the organisation and

best practice manufacturing, and change the attitude of the staff of the organisation. Creative thought processes are also important at all stages in the R&D process.

Some expected results of the creativity process are:

- innovation through new product and process ideas
- continuous improvement of products or services
- productivity increase
- efficiency
- rapidity
- flexibility
- quality of products or services
- high performance

1.5 Characteristics of providers

The implementation of creative techniques within work groups, requires the assistance and advise of external consultants. One or two consultants, experts in creative techniques, is normally enough to undertake the implementation process in a company. His/hers job normally consists of presenting the different techniques and their application method, defining the problem to be studied for the participants, initiating and clarifying the rules of the technique, gathering the necessary data and information to approach the problem, stimulating the generation of ideas of participants, and evaluating the ideas before proceeding to put them in practice.

Training of management staff by experts may also be very useful. Management staff must be trained to stimulate creativity in employees, to provide motivation, to facilitate a creative climate and to encourage the use of creative techniques. Managers can also be trained to implement creative techniques by themselves.

2 APPLICATION

2.1 Where Creativity development has been applied

Creativity processes are used regularly by many private and public sector organisations of all sorts in manufacturing, services, banking, or construction companies. Big firms such as Xerox, AT&T, Frito-Lay, as well as car manufacturing firms, software development firms, railroad pharmaceutical firms etc., use creativity techniques to increase efficiency and quality, especially in their research, strategic planning and marketing departments.

Small firms and innovative R&D organisations, such as biotechnology companies (Arlington 1997), are also becoming to implement creative techniques in order to solve problems and to improve the use of skills, techniques and processes.

Creativity techniques may be applied in almost any functional area of the company: strategic planning, corporate business strategy, product development, improvement of services, functional strategy, finance, human resources, marketing, management of collection of information, product design, software design, quality management, etc.

Nearly all innovation management techniques that can be applied in companies (BPR, benchmarking, TQM, MRP II, employee involvement, marketing of innovation, etc.) require also the implementation of creativity techniques. For example, in the Innovation Programme of DG XII of European Commission, besides other innovation management techniques, creativity techniques have been applied in the following IMT projects (see European Commission 1998):
-INVENT (Pro. 006) - Implementation of a Method for Targeted Economic-Oriented Research in SME Invention Management.
- IMPACQT (Pro. 008)
- PARTNERS (Pro 010) - Promotion of Innovation Management Techniques in the field of Sub-Contracting.
- IDEAS (PRO 017 - Integrated Product Development Expertise Applied to SMEs.
- PRIISME (Pro 029) - Promoting of IMTs in ISRAELI SMEs.
- Programme to Create New Activities in SMEs (Pro 045).
- MARKPRO (Pro 050) - Implementation of Market Oriented Product Innovation in Danish SMEs

2.2 Types of firms / organisations concerned

Creativity techniques can be implemented by all firms and public organisations that confront with problem solving and focus on innovation in processes, products or services.

In case where the implementation of creative techniques is focused on the support of personal creativity, such as to support individual designers work for new product development, or to support individual scientists work in the laboratory, very small firms or a person can implement creative techniques for individuals.

In case where the company focus is to increase group creativity and to create environments where a collaborating team work creatively together, the firm must have at least 20 employees, including 3 members as management staff.

2.3 Implementation cost

The application of creativity techniques is a continuum process. Sessions of creativity within work groups normally take place at company facilities during normal hours and working conditions. The implementation of a creative technique includes the following costs:

- The fee of an external consultant for 4-7 days work for undertaking a session of creativity (preparation, application, evaluation).
- The cost of software packages developed for personal computers or workstations (if necessary). Hardware and equipment must permit to deal with network communications.
- Training cost (2-4 days) (if necessary).

Cost: from 3000 to 7000 Euro.

2.4 Conditions for implementation

Concerning the implementation of creative techniques, some of them are easy to apply, while others need some infrastructure, experts, work teams, training, collection of

information, resources, etc. In this case, the assistance of an external consultant is required.

Besides the support of external consultants, the company itself must encourage creative environment. This implies the participation of all workers in the concerns of the company, and an open and flexible attitude on the part of management. According to Higgins (1999) factors to encouraging the creative work climate are:

- A secure environment with minimal administrative interference.
- An organisational culture that makes it attractive and easy for people to discover and solve problems.
- Rewards for employee performance and enhancement of intrinsic motivation.
- Managerial willingness to take risks for creativity and innovation, as well as an open and flexible attitude on the part of management.
- Providing people with formal and informal training to enhance creativity.

Important conditions for implementation of creative techniques within work groups in a company are also the existence of well-trained human resources, a clear strategic definition of the company and to focus on the core competencies of the company (European Commission 1998). For solving complex problems requiring input by many areas, i.e. marketing, engineering, design, the company would preferably be one employing multidisciplinary teams.

3 IMPLEMENTATION PROCEDURE

As mentioned before, there is numerous creativity supporting techniques. The description, in an illustrative manner, of some well-known creative techniques for problem solving will be presented here. See also Annex, Table 1, the use of some stimulus that can extend perspectives to approach a problem.

Brainstorming

This is one of the best known and most used in the business world group based creativity process for problem solving. It is a method of getting a large number of ideas from a group of people in a short time. It can be used for generating a large number of ideas or solutions for well-defined strategic or operational problems, such as for engineering design processes. It forms also a basic framework or constitutes the initial phase for the implementation of many other groups based on creative techniques.

Brainstorming sessions take place in a group of 6-10 people. The presence of a leader is necessary to stimulate the generation of ideas, as well as a preparation phase to gather the necessary data and information to approach the problem. A recorder writes the problem statement and the idea generated by the group on a white board. Several guidelines for brainstorming are available, such as suspend judgement, free wheel, quantity, and cross-fertilise. The whole process takes normally one hour and can be conducted through several stages. The session begins with stating the problem and calling for solutions by the leader. The following stages can be: restate the problem in the form of “How to…”, select a basic restatement and write it down as “In how many ways can we…”, warm-up session, brainstorming, and identify wildest idea. An evaluation method is additionally used for to identify the ideas that have a value for implementation. The four basic rules of

brainstorming are: a) no criticism and no prior judgement of any idea, b) all ideas, even the absurd, are welcome, c) quantity has value, the more ideas the better, if a large quantity of ideas is generated, then the idea pool very likely would contain high-quality ideas, d) sharing and combining ideas, and constructing ideas based on those developed by other members of the group for producing new ideas. See: Osborne (1963), Rawlinson (1981), Chen (1998), Higgins (1996), European Commission (1998). See also Annex, Table 2: Brainstorming phases.

A special type of brainstorming tool is PMI in which the participants are directed to brainstorm the Plus points, then the Minus points and finally the Interesting points (De Bono 1992, 1993).

Related to brainstorming, which is characterised by verbal communication, is also the hand-written communication as a brain-writing technique. The process is that ideas generated by individuals are written down on a piece of paper, and then exchanged and combined with those of the other individuals in the group. Written ideas are circulated and read by the other participants in the group each of whom, in turn, write down new ideas. A variation of this hand-written communication is the 6-3-5 method in which each of the 6 participants in the group generates and writes 3 ideas related to the problem on a piece of paper in 5 minutes. After 5 minutes, each participant passes the piece of paper to the person on the right, who reads it and adds 3 new ideas in 5 minutes. The process continues until each participant gets the original piece of paper back (European Commission 1998).

Electronic brainstorming is also a hand-written communication technique, which employ computerised programs to achieve brainstorming.

Story boarding

It is a creativity technique for strategic and scenario planning based on brainstorming and used mainly by groups. It requires a leader, a secretary and takes place in a group of 8-12 people. The leader arranges the ideas generated by brainstorming in a logical order on a white board creating a story. This technique allows identify the interconnections of ideas and how all the pieces fit together. It can be used to identify issues, problems, solve a complex problem and determine ways to implement solutions.

The story boarding process includes four phases: a) planning, b) ideas, c) organisation and d) communication. Each phase includes a creative session (it takes 45 minutes) and a critical session, in which participants critique their story board.

- The planning phase begins with the problem definition or the issue being examined - the topic header. Purpose header, a miscellaneous column and other, normally 10-12, headers (column titles) are placed and brainstormed in order to give Ideas and then items, which are listed under the headers (the purpose header is listed first).
- The second phase - the ideas board, is to take one column from the planning board, which becomes the topic header and the items of that column become headers of new ideas.
- In the third phase - the organisation board, participants identify who is responsible for implementing chosen solutions, what has to happen, and when.
- In the last phase - the communication board, participants identify who must communicate with for all of the events identified in the organisation board to take place. Through the process, visual graphics to summarise or present relevant points

are presented by the leader. These might be strategic models, places or things (Higgins 1996).

Lotus Blossom

This technique can also be used in scenario planning and is very useful for forecasting strategic scenarios. It is designed for groups and is used to provide a more in-depth look at various solutions to problems. It begins with a central core idea surrounded by eight empty boxes or circles. Using brainstorming, eight additional ideas (solutions or issues) are written in these boxes. In the next step, each of these eight ideas becomes the core of another set of eight surrounding empty boxes, which are filled in by new ideas using brainstorming. The process continues until a satisfactory solution or a sufficient number of ideas have emerged (Higgins 1996). See Annex, Figure 1: Lotus blossom sample.

Checklists

This creative technique is used mainly for product improvement or modification. It involves applying a series of words, verbs, adjectives or phrases contained in checklists or tables to an existing product or service or its attributes. *Osborn's Checklist* is the best known and includes the verbs: put to other uses, adapt, modify, magnify, minify, substitute, rearrange, reverse and combine. Each verb contains also an expanded definition in the form of questions. For example, the description of the verb substitute is: Who else instead? What else instead? Other ingredient? Other material? Other process? Other power? Other place? Other approach? Other tone of voice? (Osborn 1963). The method is to apply each of the verbs and its expanded description to a product or service. See Annex:, Table 3: Osborn's checklist).

Another checklist technique is *Van Gundy's PICL* (product improvement checklist). Used in the same way as Osborn's list, gives many options containing 792 words, both standard and unique, that can be applied to existing products or services, and 102 stimulation questions (Van Gundy 1988, 1993).

Morphological Analysis

This method is another product improvement technique, permitting the in-depth analysis of products or processes. It involves applying a set of words to an item another set of words. Normally, one set of words is verbs and the other set are attributes of the product. Another way is that one set of words would be components of the product (breaking the product down into its parts) and the other set of words would be alternative solutions. The method is to combine each word of one set with each word of the other set. These two sets of words result in a two-dimensional matrix. A three dimensional matrix can be created by adding a third list of factors. The difficulty of this technique is the large number of ideas deriving of the multiple combinations that can be made (Higgins 1996, European Commission 1998).

Mapping Process

The use of maps is particularly useful in strategic management thinking in organisations, helping to organise discontinuities, contradictions or differences, and bring pattern, order and sense to a confusing situation, acting as a spatial representation of a perspective. There are many forms of mapping, including computer-based tools to support mapping:

- *Mind Mapping*

It is an individual brainstorming mapping technique designed by Tony Buzan. It begins with a central focal point, a problem, an object, a name or issue, written in the centre of a piece of paper with a circle around it. Each major facet of the problem or the solution to the problem originating from the central idea is then brainstorming in order to generate new ideas. Each of those ideas are then written on lines drowned outward from the circle. The next step is to brainstorm those ideas in order to identify issues related to the problem, or solutions that are written on smaller lines that are drowned on the prime lines forming a branch. Additional perspectives such as implementation factors or further definition of the solutions could go on those lines. One branch may also be chosen in order to develop a whole new mind map based on that branch. When a mind map is completed, its possible interrelations and possible multiple appearances of issues, and its overall meaning in the context of the problem must be examined (Buzan 1983).

- *Mapping for generate collective creativity*
  The use of maps to support collective creativity is a more complicate process. It is necessary to introduce appropriate maps into a suitable type of organisation that would preferably be one employing multidisciplinary teams. It is also important that the participants find the maps useful for organising and planning their work. The mapping process usually involves three phases:

  1st phase starts with a brainstorming exercise in order to initiate a discussion around the problem or the product. Normally, the participants are asked to mention all aspects they regard as relevant to the problem to be dealt with. During this process a large number of visual references are used to elicit the perspectives of the members with regard to the potential new concept. It is emphasised to the participants that the maps are intended to enrich the conversation, and should not be perceived as representations of the concept itself, but more as the semantic terrain or space, which covers all potential strategies. The knowledge elicited is discussed, and in about 2 hours is organised and structured by the participants into a map that intuitively understand. This map is the initial cognitive map, which describes all the problematic areas in brief outlines.

  In the 2nd phase of the process, which serves to expose the individual participants' perspective both to themselves and to the other members of the group, the participants discuss the values that they associate with a very large range of objects and images. A number of these images are then selected that are considered to metaphorically represent potential aspects of the product strategy.

  In the 3rd phase, these images and appropriate annotations are arranged in a two-dimensional space, positioning the images depending upon how the values of these objects relate to one another. In doing this, the group is mapping out a terrain constituted by the differences between the images, expressing the range of different product strategies open to the group (Fentem, Dumas & McDonnell 1998). For creating maps, many software applications are available (see further down in computer-based creativity techniques).

The Excursion Technique

Is a very useful technique for forcing a group to have new thought patterns to formulate strategies. The process involves five steps (see Higgins 1996):

In the 1st step - the excursion - the consultant asks participants to take an imaginary excursion to a physical location (a museum, a jungle, a city, another planet, etc.), which has nothing to do with the real problem. After the excursion each participant writes down 8-10 images, which he/she saw during the journey (things, people, places or items) in the 1st of 3 columns.

In the 2nd step, the consultant asks participants to draw analogies or express relationships between what they saw on the excursion and the problem as defined, and to write them in the column 2 next to each of the items identified in the first column.

In the 3rd step, participants are asked to determine what solutions to their problems are suggested by the analogies or the relationships in column 2, and write them in column 3 beside the items and analogies identified in the other columns.

In the 4th step, participants share their experiences from the excursion: what they saw, their analogies and their solutions.

In the 5th step, as with brainstorming, participants may discuss on each other's ideas. Eventually the leader helps the group come to a common solution or a set of solutions to the problem.

Computer-based creativity techniques

Computer-based supporting techniques to stimulate the human creative process have an immediate and pragmatic aim, which is the implementation of computational models (computer software) for generate and organise ideas for creative work. They are used more frequently in research planning, product design, knowledge acquisition, decision- making, motivation, etc. We can distinguish groups of computerised creativity techniques, such as AI models, Idea Processors systems and visualisation and graphical systems.

AI (artificial intelligence) models of creativity

AI deals with solving non-quantified, unstructured problems. Its task is about knowledge representation and reasoning and to built intelligent, rational, and autonomous agents. Current AI models of creativity involve different types and appropriate techniques of supporting the generation of new ideas. According to Margaret Boden (1998), in respect to the three types of creativity, there are also three main types of computer models that involve:

a) The stimulation of the combination of ideas, mainly by using analogies in the sense that associated ideas shares some inherent conceptual structure.
b) The exploration of structured concepts, so that novel and unexpected ideas result. It requires considerable domain-expertise and analytical power to define the conceptual space and to specify procedures that enable its potential to be explored.
c) The transformation of a problem, so that new structures can be generated which could not have arisen before. New solutions to a problem can be created with transforming a problem into a new problem, solve the new problem and then adapting the solution back to the original problem.

AI employs symbolic approaches for creative problem solving and includes stimulus such as heuristics, search, weak methods, knowledge representation and reasoning to facilitate

problem structuring and idea generation. The focus of AI creativity techniques in the form of computerised programs, is to help users to take a fresh look at problems by guiding what may be a user's otherwise undisciplined intuition through a series of problem-solving exercises, and to think in non-linear et non-logical ways. The main advantage of computerised, guided problem solving is that the programs prompt a user for ideas in a thorough manner. Recent programs of AI include also knowledge-based approaches, using large-scale databases and narrative systems (Chen 1998). AI researches have also developed efficient search algorithms for problem solving.

Some AI programs of creativity are:
- The *Copycat* program that looks for analogies between alphabetic letter-strings (Hofstadter, FARG 1995, Mitchell 1993).
- The *EURISKO* program a transformational system with also an exploratory process that can be applied to a wide range of domains.
- The *AARON* program for exploring line drawing in particular styles and colouring (McCorduck 1991).
- The *BACON* program of exploratory AI-creativity designed to model scientific discovery (Langley, Simon, Bradshaw and Zytkow 1987).

Idea Processors software

Idea processors have a close relationship with artificial intelligence and use many artificial intelligence techniques. Idea processors are normally software packages developed for personal computers or workstations. They are used for idea generation and organisation in some specific stages of problem solving acting as knowledge-support systems (Chen 1998). In order to assist the human thinking, idea processors usually perform extensive search in large databases, knowledge bases, or text bases.

For many idea processors the electronic brainstorming is the most important technique to generate ideas. The use of computer programs helps to de-structure and then to restructure thinking in a different way. The *Idea Generator Plus* program provide seven components to the user, that permit to go through a step-by-step problem analysis and solution finding process: examine similar situations, examine metaphors, examine other perspectives, focus on goals, reverse the goals, focus on the people involved, and make the most of the ideas (Nirenberg 1985).

In another program, the *IdeaFisher*, using hypertext databases from Fisher Idea Systems Inc., all entries in the database are cross-referenced by concept and association. It uses a giant cross-referenced text base of words and phrases representing concepts and images enhanced by a series of questions (see also spatial hypertext systems). The program also allows to generate new ideas based on combination of words by creating a list of people, animals, verbs, adjectives and phrases that are associated with the combination of two words that a user choose.

Some other programs related to an idea processor are:
- The *Ideatree* system with an exploratory focus, linking laterally or hierarchically concepts that exist into the idea-boxes of the program.
- The *Emergent Media Environment* (EME), an interactive computer system that integrates facilities for supporting the generation, collection, organisation and presentation of ideas and advises about the divergence and convergence of the ideas.

- The *GENI* (GENerating Ideas) experimental system incorporates a variety of techniques to assist in making different types of connections: internal connections (between elements of the focal problem itself) and external connections (between the focal problem and external factors).

There are also many idea processors programmes available on the Internet (most of them are commercial products) including the following:
http:/ideaprocessor.citi.doc.ca
http:/www.maxthink.com
http:/www.ozemail.com.au
http:/www.inspiration.com
http:/www.signet.com.sg/axon2000

Visualisation and graphical systems

Computer support methods, such as visualisation of data and graphical techniques for marking up visual phenomena and expressing knowledge about data in rule form, are also available. Visualisation of data and graphical techniques are very important to support creativity. They involve working with visual data such as images, drawings, sketches, diagrams, charts, graphs, graphical objects, that are specific to the domain, and they take the form of expressing ideas and concepts through sketching, annotation and examining multiple or alternative views of the same data, all of which varies according to the domain of interest.

There are many such systems giving various opportunities to the users. A visualisation system, the *Inspiration* (from Inspiration Inc.) provides a blank canvas in which the user can quickly record and arrange ideas as they occur and allows a visual approach to organising thoughts. The system can also change the relationship between ideas and connect related ideas by dragging kinks between them to create a graphical map of the users thinking.

Another visualisation system *is Axon 200* used for creating complex flowcharts or concept diagrams and describes how different factors or events influence each other. It uses checklists and visual attributes such as colour, shape, size, scale position, depth, link and icon. It also creates relationship diagrams, which allow the user to represent multiple relationships between various visual objects on the screen (Chen 1998).

Visualisation systems are also very important in design such as the *Speech Knowledge Interface* (SKI) system that support rapid graphical interaction with visual images, the *Vehicle Packager Knowledge Support System* (VPKSS) that aids designers at the conceptual stage of the design process (Candy 1997).

Spatial representation tools

In relation with visualisation systems, there are also computer-based tools, such as computer-based information and communication systems, for supporting representations and creating cognitive maps in two-dimensional spaces. Some representations use a specific notation, others use spatial proximity to indicate the relationship between objects (usually words relating to concepts) in the spaces, and others, used in marketing and design

departments called “mood boards”, use collections of images as metaphors that reflect the quality aspects of the product strategy (Fentem, Dumas and Mcdonnell 1998).

- *Kelly Repertory Grid technique* is a knowledge elicitation tool used in the marketing, management and expert systems development. It analyses data using principal components analysis (PCA) software and produces a map by plotting the first two components. The map produces a spatial positioning of text with respect to dimensions that are significant or correspond to the personal constructs that the participant member uses to categorise and evaluate the world (Kelly 1955). An Internet version of this tool is *Webgrid*. Available at http://www.cpsc.ucalgary.ca/

- *Spatial Information Systems*
  These systems have been designed to support creativity by mapping objects (concepts, text objects, design requirements and parameters) into two-dimensional spaces, using various combinations of ‘knowledge processing’ and multivariate statistical analysis techniques. Users can also select an area of this space and to create a new space by reprocessing using principal components analysis (PCA) only the data associated with the objects lying within this subspace (Fentem, Dumas and Mcdonnell 1998). For example, one of these systems searches research papers for the frequency of certain keywords and uses a type of PCA to analyse the results of this search and represent these keywords and the papers within a common two-dimensional space (Sugimoto, Hori, Ohsuga 1996). Another system named *En Passant 2* stores researcher’s notes and triggers to recall and to reconsider. The users can browse their notes and view relations among them interactively (Aihara, Hori 1998).

- *Spatial hypertext systems*
  These systems have been designed for the “exploration of alternative structures for content, and applications in which the domain structure is not well understood at the outset, or changes during the course of a task”. In spatial hypertext, the links between nodes are conveyed implicitly by arranging the nodes in the space. “Nodes appear in different contexts through multiple spatial references to the same underling content” (Marshall and Shipman 1995). The users are presented with a window that acts as a work- space in which they organise their material. The nodes arranged in the space represent links to familiar objects such as documents, images, comments, and links to WWW hypertext pages, plus more unique structures known as ‘composites’ and ‘collections’. Marshall and Shipman’s VIKI spatial hypertext system, for example, was designed to support new product development, helping teams to make sense of the many diverse kinds of business-related material relevant to the new product, by assisting them in arranging it spatially.

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Annexes

Table 1: Stimulus to extend perspectives to approach a problem

- List the elements that would bring on success.
- List the elements that we visualise as failure.
- Visualise success seen from the viewpoint of fifty years from now.
- Visualise success seen from the perspective of one hundred years ago.
- Look for impossible and desirable ideas.
- Create analogies with other things that have been successful.
- Imagine and write down ideas that are wild, illegal, crazy, etc.
- Insert the problem from its present scenario to a totally different scenario.
- Return from the fantasy scenario to the present scenario and try to associate the ideas generated in the fantasy scenario, with ideas that might apply to the real problem.
- Imagine what people we admire would say.
- Search for pairs of ideas that are apparently unconnected and that can be associated by a third.
- Imagine that everything exists and all we have to do is find it.
- Change the level on which the problem is approached.

Source: European Commission, *Innovation Management Techniques in Operation*, European Commission, DG XIII, Luxembourg, 1998.

Table 2: Brainstorming Phases

Phase	**Application**
Orientation	Define the problem to be studied for the participants, clarify the rules of the game.
Preparation	Gather data and information necessary to approach the problem in an efficient manner.
Warm-up	Carry -out the exercise: redefine a problem different from the one to be studied, experiment with it for a few minutes.
Production of ideas	Generate the maximum of ideas without prior judgement - always ask “what else” - quantity of ideas is quality - no limits - no criticise - modify other’s ideas to produce new ones.
Incubation	Let the subconscious work.
Syntheses	Gather the ideas generated - analyse them - work with logical thinking.
Evaluation	Evaluate the ideas gathered and analysed - develop and combine them before proceeding to put them in practice.

Source: European Commission, *Innovation Management Techniques in Operation*, European Commission, DG XIII, Luxembourg, 1998.

Table 3: Osborn's Checklist

Question	Description
Put to other uses?	New ways to use as is? Other uses if modified?
Adapt?	What else is like this? What other idea does this suggest? Does past offer parallel? What could I copy? Whom could I emulate?
Modify?	New twist? Change meaning, colour, motion, sound, odour, form, shape? Other changes?
Magnify?	What to add? More time? Greater frequency? Stronger? Higher? Longer? Thicker? Extra value? Plus ingredient? Duplicate? Multiply? Exaggerate?
Minify?	What to subtract? Smaller? Condensed? Miniature? Lower? Shorter? Lighter? Omit? Streamline? Split up? Understate?
Substitute?	Who else instead? What else instead? Other ingredient? Other Material? Other process? Other power? Other place? Other approach? Other tone of voice?
Rearrange?	Interchange components? Other pattern? Other layout? Other sequence? Transpose cause and effect? Change pace? Change schedule?
Reverse?	Transpose positive and negative? How about opposites? Turn it backward? Turn it upside down? Reverse role? Change shoes? Turn tables? Turn other cheek?
Combine?	How about a blend, an alloy, an assortment, an ensemble? Combine units? Combine purposes? Combine appeals? Combine ideas?

Source: J.M. Higgins, "Innovate or evaporate: creative techniques for strategists", *Long Range Planning*, Vol. 29, No 3, pp. 370-380, 1996 (reprinted from Alex Osborn, *Applied Imagination*, Charles Scribner's & Sons, Inc., New York).

Figure 1: Lotus blossom sample

1 by packaging	2 by design	3 other uses						
4 smaller / bigger	A product differenti ation	5 plus ingredient		B		C		
6 other material	7 change color	8 change meaning						
			A product differentiati on	B product quality	C customer needs			
	D		D lower cost	**core idea**: **increase** **product** **consumption**	E service quality		E	
			F supply flexibility	G product credibility	H competitors product strategies			
	F			G			H	