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AN ALTERNATIVE APPROACH FOR THE GENERATION OF INNOVATIVE CONCEPT FOR PRODUCT DESIGN

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1. Introduction

Two research projects linked by their common interest in the generation of innovative concept for product design will explain why it appears pertinent for companies on one hand to improve the creative potential (part 2) and on the other hand to scan and monitor the environment and use competitive intelligence (part 3). Usually, engineers consider creativity tools as useful only for problem solving and rarely for generating new product ideas. These tools can help engineers to mobilize all their technical knowledge to find technological solutions. But creativity tools cannot engender the exact solution; they only can help them to use their knowledge. So, we think it is possible to improve designer's creativity by expanding their access to information. Scanning and monitoring the environment will help engineers to know what is happening outside their enterprise; competitive intelligence will permit proactivity by acting on the environment. An application will be presented through an example of design of innovative ballast for washing machines (part 4), and then we will conclude and give some perspectives (part 5).

2. Creativity

Whereas the relationship between creativity and innovation is still problematic from a conceptual point of view [Carrier 1996], it seems easier to apprehend in practice. Innovation has a double need for creativity: to spark the process by generating ideas that build innovation opportunities, and to find creative solutions for the problems appearing during the process, whatever the dimensions concerned (technology, management, marketing...).

Creativity is the *capacity to generate novel and useful ideas and solutions*. For most authors, it results from the action of combining previously separate elements and changing existing combinations. Although creativity is multiple and has various forms [Guilford 1970], it is especially *a cognitive activity that implies collecting and analysing knowledge.* But this is not just an intellectual skill: it is a state of mind, a way of confronting situations and problems that can applied to any part of life [Barron 1955].

There are many descriptions of the different stages of the creative process [Osborn 1953, Parnes 1967] they have in common the four steps shown by Wallas [Wallas 1926]:

- *Preparation*: the person becomes aware of a problem and is oriented toward investigation and information acquisition;
- *Incubation*: a period of subconscious work on the collected data that sometimes gives the impression that the problem and its solution are getting more distant;

- *Illumination*: the heart of the creative process, the brief yet intense moment when the new idea or the new solution emerges;
- *Verification*: the new idea potential is logically evaluated and compared to reality.

Difficulties appear when we go further into the description of the cognitive operations implied in creativity. Indeed, it involves various and not specific intellectual processes that are often both opposed and complementary. Thus, if creativity is mostly seen as an intuitive and subconscious activity depending on divergent thinking, it also refers to conscious logical reasoning linked to convergent thinking [Osborn 1953, Guilford 1970]. In fact, creativity involves a wide range of cognitive abilities. However, relatively little is known about the way they are interrelated and their role in each step.

The cognitive dimension of creativity is clearly shown by the *creative situation* [Rouquette 1997]. For this author, creativity is defined as the result of a functioning unit's cognitive activity (a person or a group) placed in a particular environment that provides information and knowledge (figure 1).

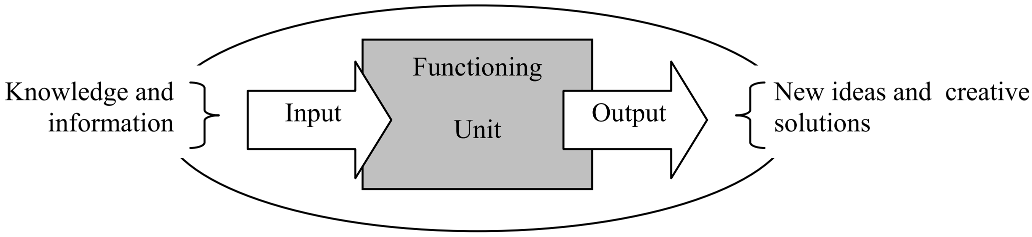


Figure 1. The creative situation [Rouquette 1997]

This model is interesting because it points out the importance of the relationship between the unit and its environment. It also focuses on the knowledge that feeds the process but does not insist on the operations performed by the functioning unit. As it appears quite difficult to determine the cognitive operations implied in the creative process, we may get inspiration from this model and consider that knowledge (whose acquisition and analysis processes are better known) could be a valuable way to improve creative potential.

3. Learning from the environment

3.1 By scanning and monitoring

Rather than start from zero to develop a new product, it would be better for the enterprise to scan and monitor the environment, to know what has happened, what is happening and what could happen. "Technological monitoring is the necessity for the company to collect in real time product data concerning the competing rivals, every new patent related to its activity domain, and generally all pertinent information on design (new components, technical press articles…)" [Ngassa 2003b]. The aim of this practice is to target, track, select, route and interpret the earliest information (called weak signs or signals) about an event in order to act more efficiently [Rouibah 2002]. An event, as a new rival product or the merger of competitors, is characterised by information emitted by enterprises, not only direct and indirect competitors, but also subcontractors and customers, states and associations too. These information are more and more precise as we are approaching the realization of the event, but weak signals, uncertain, ambiguous, fragmentary and dynamic are more interesting, because they let more time to act and react. To forecast the evolution of the environment, weak signals can be pieced together to get a mental map puzzle. This method is used to tie up and transform relevant weak signs into actionable information, meaningful maps [Rouibah 2002].

Scanning and monitoring the environment, generally turbulent and equivocal, is helpful at every step of the development of a new product to know what are the threats and the opportunities. Each step of the design process needs particular types of information (figure 2). For the phase of definition of needs or problems (dotted line), the information about the customers' needs and about competitors' innovative products are useful. The information about emergent technologies, new patents, technologies that can be transferred from an other domain or technologies used by competitors, are needed for the creativity phase (continuous line). For design phase (dashed line), the information about markets, laws, norms, specificities linked to the countries where the new product will be sold, and technological information from reverse-engineering are required. From manufacturing to delivery (dash dot line), information about customers' feelings, the impact of the new product on the market, compared to competitors', are necessary to correct the weaknesses of the product.

In this market pull process, the enterprise is just reactive and we call it "strategic fit".

3.2 By competitive intelligence

To be more efficient, the scanning and monitoring concept has to be improved by adding the concept of competitive intelligence. This management practice combines commercial and marketing intelligence, competitors' intelligence, technological intelligence, strategic intelligence. "It is a kind of radar spotting new opportunities or helping to avert disasters, enabling the firm to observe its environment" [Rouach 2001]. But we think that it is more than that: scanning and monitoring permit to listen to the environment, competitive intelligence gives the opportunity to act on the environment (figure 2).

This proactive, and no more only reactive, approach integrates economic forecasting and market experts for the definition of needs or problems (dotted line). A road map provides current and future trends in customers' needs and preferences, and the enterprise could take an opportunity in a creative segmentation. The enterprise will keep a close eye on new competitors' products, new product substitutes and new industry entrants. Benchmarking and lobbying information will permit to improve the creative process (continuous line). Technological partnerships and experts will contribute to the design of the new product (dashed line). Lobbying and experts will act on the environment to create the need of this new product (dash dot line).

In this technology push process, the enterprise is proactive and we call it "strategic intend".

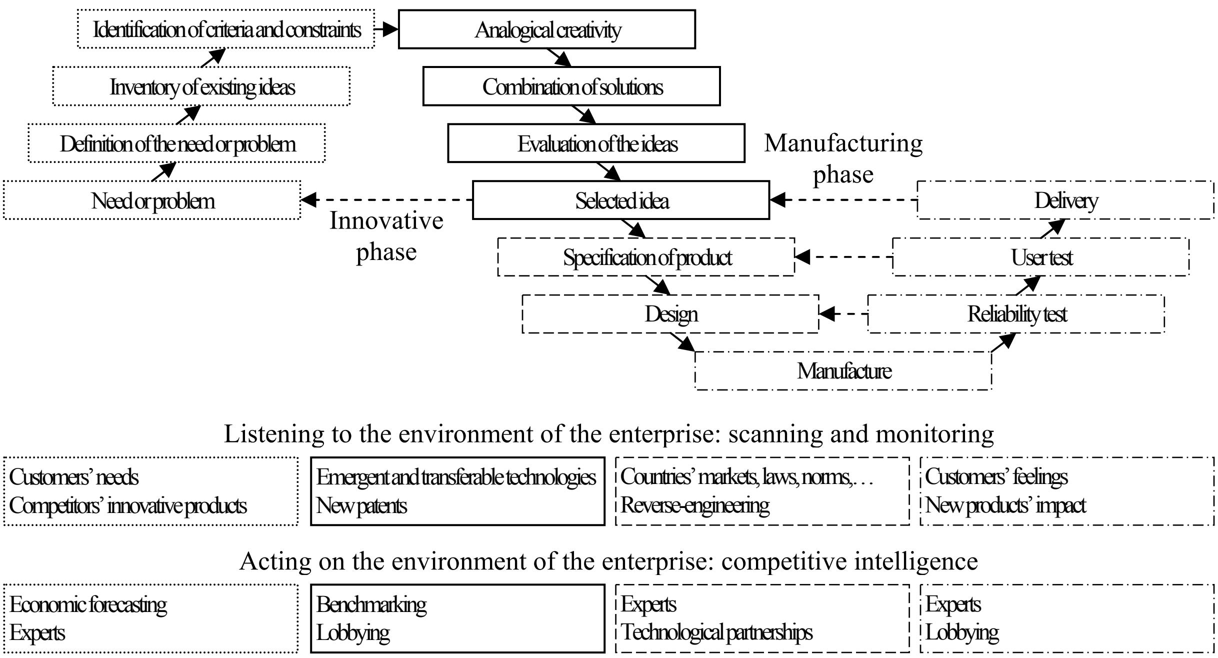


Figure 2. Innovation product design process [Ngassa 2003a]
then, phase by phase, types of information and practices improving it

4. Application: design of innovative ballast for washing machines using “Créassiste” software

To help designers’ creativity, the software “Créassiste” has been developed (figure 3).

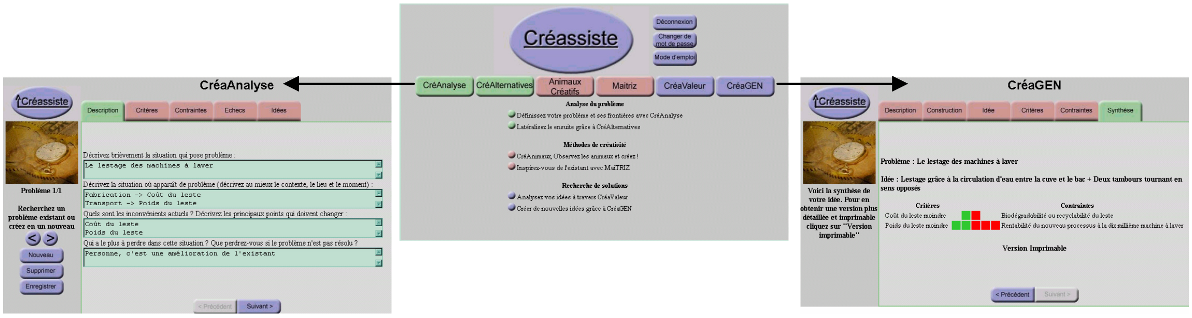


Figure 3. Interfaces of the software

Six modules could be used individually or in group.
“CréAnalyse”: definition of the need or problem, inventory of existing ideas, identification of criteria and constraints.
“CréAlternatives”: reformulation or simplification of the need or problem.
“Animaux Créatifs”: creativity tool based on an analogy to animals (Animal crackers).
“Maitriz”: creativity tool using a principle matrix (Triz).
“CréaValeur”: solutions evaluation.
“CréaGEN”: combinations of different solutions and combinations evaluation.

The software is presented through a study of generation of innovative solutions for design of ballast for washing machines.

1) Definition of the need or problem

Table 1 shows the questions asked to participants and their answers.

Table 1. Checking list of the questions for the definition of the problem and their answers

Questions	Answers
Describe briefly the situation which poses problem	Design of ballasts for washing machines
Describe the situation (context, place, moment) when the problem appears	Manufacture: expensive cost of ballasts Logistic: heavy weight of ballasts
Which are the current inconvenient of the situation	Expensive cost of ballasts made in cast iron Heavy weight of ballasts for transport

2) Inventory of existing ideas

The participants remember the existing solutions and why they did not work.
For example, concrete ballasts poured in a plastic piece were neither biodegradable nor recyclable.

3) Identification of criteria and constraints

Table 2 represents criteria and constraints chosen by participants (they are not linked).

Table 2. Criteria and constraints

Criteria	Constraints
A cheaper solution	Biodegradable or recyclable ballast
A lighter solution	Profitability of the new process at the 10 000th washing machine

4) Creativity

a) Animal crackers [Grossman]

This method makes link between our problem and an animal's behaviour in several life situations.
Participants chose the cow. The description was: "cows digest thanks to a stomach in several parts and to a rumination (regurgitation and remastication of partially digested food). It also allows certain ruminants to eat quickly in a dangerous place". A generated idea was to add a tank before the tub. A water tank that feeds the tub for washing and rinsing will ballast washing machines.

b) TRIZ

This method, based on the principle matrix, allows designers to link their specific problem to generic ones, determinated by an analysis of patents and scientific publications. Designers have to make a choice between several scientific parameters: some improve it, others damage it [Cavallucci 2002]. Participants can be inspired by generic solutions from the matrix in order to generate solutions answering to the problem.
Participants chose the principle of sphericity. An example was to use a centrifugal force. A solution was to design a two drums washing machine, with opposite forces.

5) Solutions evaluations

This analyse is based on the selected criteria and constraints. The light zone corresponding to a criterion is proportional to the satisfaction of this criterion. In the same way, the dark zone is corresponding to a constraint is proportional to the non-observance of this constraint. An "ideal" solution maximizes the light zone and minimizes the dark zone (table3).

Table 3. Evaluation of the solution to add a tank before the tub

Criteria					
A cheaper solution					
A lighter solution					
Constraints					
Biodegradable or recyclable ballast					
Profitability of the new process at the 10 000th washing machine					

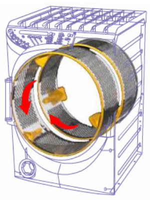
6) Combination of different solutions

Participants try then to reconstruct new coherent ideas by combination of several ideas. These new ideas are again estimated through criteria and constraints (table 4).

Table 4. Evaluation of the combination of solutions to add a tank before the tub and a 2nd drum

Criteria					
A cheaper solution					
A lighter solution					
Constraints					
Biodegradable or recyclable ballast					
Profitability of the new process at the 10 000th washing machine					

This second evaluation is worse than the first one: proportionally criteria are less satisfied and constraints are less observed. Participants can choose the solution to add a tank before the tub, or to iterate the innovative phase or a part of it, to have others solutions.
In others projects, as the design of an innovative alarm [Ngassa 2003b], combinations of solutions are better than just a solution.
Scanning and monitoring the environment is essential, actually Dyson Company has already patented a two drums system for washing machine (figure 4).



According to Dyson, "To replicate the movement of washing by hand Dyson engineers designed two aligned drums and engineered them to rotate in opposite directions at the same time. […] Instead of revolving in the old single drum pattern of "drop and flop", the clothes are much more active, moving in an infinitely variable dance, to flex the fabric and open the weave to the detergent."

Figure 4. Dyson Contrarotator™

Furthermore this constructor is placed on a niche market. Indeed, Dyson sells washing machines with big drums, so big volumes, but their washing machines are more expensive. In fact, a distortion of patent would have, may be, been possible, but the marketing target is not the same, indeed the chosen market is consumer. That is why, this solution won't be retained.

5. Conclusions and perspectives

This method can be used as a method of management to introduce communication between people. The software helps designers to define the need or problem, to make an inventory of existing ideas, to identify criteria and constraints, to be creative, to evaluate solutions and combination of solutions. This method based on the complementarity of scanning and monitoring the environment (by listening to the environment of the enterprise), competitive intelligence (by acting on the environment of the enterprise) and creativity (new ideas) permit to imagine new ways for innovative product design. Actually, for each new design project, it is better to know what has happened, what is happening, what could happen and how to act in order to break into a market, but it is not enough. A knowledge management system could permit to capitalize different types of information. Who has worked on a project ? Who were the decisionmakers ? What were the solutions ? Why some were not retained ? This capitalization would help designers not to start from zero in a similar project.

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