

## **DISCOVERING AND MANAGING CREATIVITY IN PRODUCT DEVELOPMENT**

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**Abstract.** *Creativity is a result of brain activity which differentiates individuals from each other and could ensure an important competitive advantage for a person or for a company. For very innovative branches – like soft ware industry, computer industry, or for automotive industry – creativity is the key of business success. The students should learn that every person can develop basic creative activities, but professional creativity should be trained and it could be enhanced over the level of employees' natural possibilities. They should learn that neurological research still does not offer a scientific basis for understanding creativity but thousand years of creative behavior observations offer some guidelines and procedures which could be used successfully in product development.*

**Keywords:** creativity, managing creativity, product development

### **1. Introduction**

*Creativity* is man's capacity to produce insights, new ideas, inventions or artistic objects, which are accepted of being of social, spiritual, esthetic, or technological value (Dictionary of Developmental and Educational Psychology, 1986). Creativity is a mental process.

There are two parts in this definition:

- The first one considers a very large activity spectrum – starting from having insights and / or having new ideas – up to developing inventions and artistic objects. This opens the creativity door to every one: almost everyone has several new ideas daily. Jane Piirto said: „Creativity is the process of a life.”
- The second part introduces a bottom limit in the very large creativity spectrum from insights to artistic objects: only these ideas, etc. which have intrinsic value – for others - are considered results of a creative process. Creative results are normally related to profession: when we speak about creativity we mean professional creativity.

Unlike many phenomena in science, there is no single, authoritative definition of creativity. It has been studied from the perspectives of behavioral psychology, social psychology, psychometrics, cognitive science, artificial intelligence, philosophy, history, economics, design research, business, and management, among others. There is no standardized measurement technique to determine the creative degree of a person. Although creativity is regarded as a simple phenomenon, it is in fact quite complex.

The creativity's importance was best underwritten by Dr. Mohamad Mahathir, a former Prime Minister of Malaysia, one of outstanding personalities of the 20<sup>th</sup> century. He said:

„The greatest asset of any nation is the creativity of its people.”

He championed in his underdeveloped country an unprecedented program – building schools, high schools and universities and offering development programs to open the young people's way to knowledge and to personal creativity.

Creativity manifests itself overall in everyday life: in business, in engineering, in medicine, in every intellectual activity. The USA itself was founded two centuries ago by very creative people, who imagined a democratic government in a time when nobody knew exactly what democracy should be. Today all American companies demonstrate very high creativity in both, new products and business practices. This allows them to stay ahead of international competition.

There are some activities where creativity is not accepted: one of them is manufacturing processes. The quality norms of International Standard Organization ask for exactly repeated operations for every manufactured piece: only this way every piece is identical with the previously manufactured ones and the product quality remains constant for an entire lot. In such cases, no creativity – that means no unapproved process changes - is accepted.

Employees' creativity alone is very valuable asset of every company but it is not enough to ensure company's success: creativity should be directed to serve the company's goals. It should be managed. A learning organization actively creates, captures, transfers, and mobilizes knowledge to enable it to adapt to a changing environment.(Tantau, 2008)

## 2. Analyzing creativity

Creativity manifests itself in all situations of daily life. It is interesting to analyze daily creativity aspects, which serve only a person and therefore are not considered as belonging to creativity (see the definition in above chapter): their mechanism could be the same as for more important discoveries.

### 2.1. Creativity as a brain activity

Creativity is the result of brain activity, but how the brain works, is not known: doing neurological researches on living brain is very difficult because this could be hurt. Nobody would accept such a risk. Researches on animals could be done but their brain activity differs immensely from the activity of a human being's brain.

External observations shows that the brain develops two kinds of activities:

- activities which are ordered from the human will. It allows to the human being to move, to learn and to communicate with other human beings. It is a conscious activity. The conscious activities could be improved, trained, developed, and modified.
- activities which are not consciously coordinated: body's growth and evolution, breathing and supplying cells with oxygen, eating and transforming food in

energy, birth of a new life and probably...creating new ideas. These activities – normally – cannot be influenced from the human will. They follow automatically, as if they were coordinated from a good programmed computer. The analogy with a computer is often used to explain brain functions.

Some Asian populations – especially Indians – developed procedures to influence not consciously coordinated body activities. For instance some special trained people could reduce their own heart frequency to values around 10 beats per minute which, from the point of view of scientific medicine, means almost dead: but they survive without damages. They could also reduce the breath frequency to values under one breathing per minute, they could renounce at food many days: they survive. They could „meditate”: that means they could eliminate every thought from their brain. All this capabilities show that the „unconscious functions” could be consciously changed. A scientific explanation for this possibility is not available.

In order to create a new solution it is probably necessary to concentrate the brain activity only on a problem: creativity is the result of concentrate brain activity. All other thoughts should be blend out.

Because the creativity process occurs in a particular brain, the result is attributed to an individual also in the case when a team contributed to realize favorable environmental conditions. „Team creativity” means that such conditions were realized during team activity that one of the team members had a new idea.

### *2.2. Creativity and profession*

The thinking process of professionals is formed during their study time and completed during their professional practice. The profession specific thinking process influences decisively the creativity but this one is influenced also by other, non professional experiences, accomplishments or interests. Because of so many influences, the creativity of every person has specific characteristics and is unique. There are no two people with identically creativity.

*Mechanical engineers* are using daily notions like: performance, consumption, efficiency, specific weight, cost, optimization, and the like. When they are thinking about creativity, they would consider all possibilities to improve these parameters. They would look for the newest research result, technological development or invention which would help them to reach their goal.

*Designers* are using daily notions like: shape, color, nuances, comfort, customer feeling, and costs. When they are speaking about creativity, they would modify some of these parameters in order to enhance the customer’s experience. To find ideas for their work, they would look in periodicals, would visit exposition, and would follow / or create fashion trends.

*Marketers* are working with notions like: customer value, competitors’ position, strategic positioning, price, and many others alike. For them, creativity means to find a unique combination of product parameters, product price, and advertising actions which would ensure the highest possible revenue for his company in a specific market.

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The creativity worlds of these three professions couldn't be more different. It couldn't be a more difficult task than to balance them. But the company's success depends of a harmonious collaboration of these specialists and on synchronizing their creative efforts.

### 2.3. Piirto's concept

Creativity in the work place is connected with a special understanding for the working world, which isn't described sufficiently in the literature and wasn't discussed with young people. Only few of the young professionals know, share, and use it.

The activity in the work place is more than a job, a source of income, to pay living expenses, although many employees think this way. These employee are interested to keep their job, to do what they need to, and to go home as soon as possible. Nothing less, nothing more.

But the work place is at the same time a permanent, very intensive, professional training place. If someone is interested and shows this interest to his employers, he would be assigned more and more complex tasks, with more and more responsibility. He would be encouraged to acquire deeper knowledge and experience, first in his own professional field and later in other, related fields. He would be asked to solve problems first related to new aspects of his profession, later to solve personnel management problems, accounting problems, marketing problems, and / or financing problems. The combination of specific techniques from every one of these fields offers the possibility to develop unlimited creativity. Successes in accomplishing such tasks bring not only a higher qualification, a higher income but also an important personality change: the personal attitude evolves from curiosity to professionalism. It brings also an incredible, incomparable fun in solving professional tasks.

Jane Piirto identified the following features which characterize highly creative people (the 7i):

– *Inspiration*. It is defined as „...an infusion into the mind or soul of an exaltation.” (Oxford English Dictionary). Inspiration is a result of brain activity and is perceived as a sudden established connection between disjointed facts or ideas, which brings solution to a problem. How it occurs, it is not known.

*Imagery*. „...is the ability to mentally represent imagined or previously perceived objects accurately and vividly.

– *Imagination*. „...is a mental faculty whereby one can create concepts or representations of objects not immediately present or seen.

– *Intuition*. It is the capacity to “feel” which one is the most promising solution, although a lot of important information is missing. It brings immense competitive advantages toward others, who are looking for scientifically or in other way defined „best solution”. “Creative people not only trust their intuition, they prefer to use it.”

– *Insights*. It is „the ability to see and understand clearly the inner nature of things, especially by intuition.” (Webster's New World College Dictionary).

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– *Improvisation*. It means the replacement of necessary but not available best instruments, machines, devices, software, etc. through others, which are not so good, not so efficient, not so performing, but are available. It means reaching results with improper tools. Improvisation itself is a highly creative activity.

– *Incubation*. Creativity cannot offer an immediate solution: it needs time to find one. For easier problems, a time period of some several hours to one day could be sufficient. In order to find solution for more sophisticated problems, weeks, months, or years are often necessary. „The mind is at rest. The body is at rest. You have gone to something else. The problem is percolating silently through mind and body. This is incubation.” (Piirt). Incubation is not a personal characteristic; it is a parameter (incubation time) of work planning. The first six features listed in „7I” cannot be met very often in a given population. Only few people exhibit some of them. Only few exceptional personalities exhibit all features. Training methods are few and their results are not guaranteed. That illustrate how seldom creative people can be encountered.

### *2.4. When and where creativity occurs*

Statistical studies made in Europe (Mihalcea,2002) about creativity in technical and scientific field show that creative idea appear only seldom in the work place (24%), but much more during free time (76%). That suggests a more complicated structure of the creative process, which could be characterized through the following:

– Most ideas don not appear during the intensive, concentrated, conscious effort to solve the problem. A new idea is „born” later, at a time when the person relaxes. Relaxing eases idea finding.

A new idea appears after a period of time: an „incubation” time – see Piirto – is required.

–It seems that in the time period from formulating a problem to the time when the solution is found, the brain is further working at the problem, even during the time when the person is not thinking or is not aware of it. It happens in the same way as other brain functions – breathing, digesting the food, growing tissue, etc.: unconsciously and automatically.

–In some works (Standler, 1998) the end of incubation is described as an „intuitive flash of insights” which appears suddenly, very often during the sleep. Following examples are given:

–Friederik A. Kekule found the shape of benzol molecule during sleep. He became awake and recognized that this should be the solution oh his problem.

<b>New idea appeared during working time</b>	<b>%</b>
Brainstorming and similar activities	1
During breaks	3
At work	4

<b>New idea appeared during free time</b>	<b>%</b>
During meals	3
During sport activities	4
While watching TV	6

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During tiring meetings	6	During business trips	11
During boring meetings	10	During holidays	13
<b>Total</b>	<b>24</b>	Walking alone	28
		During other activities	11
		<b>Total</b>	<b>76</b>

– Albert Einstein had a vision of traveling with light speed when he developed his relativity theory.

– Paul McCartney was dreaming the melody of „Yesterday” during sleep. He woke up and wrote the music down.

### 2.5. How creative people are looked upon

What seems to be sure is the perception that creativity cannot be planned. To be creative takes time, the result cannot be foreseen and it comes unexpectedly. Creativity needs conditions which do not match well with planned activities- used extensively in management. Therefore it is difficult to integrate creative people in a team: they are considered – very often – as arrogant, stubborn, uncompromising, tenacious, and persistent. All these are qualities which allow them to follow their own pathway and to create a new idea, very often against an important resistance and against generally accepted opinions. But these qualities are very different from the qualities which are asked for in a harmonious team. One needs a total team dedication to the final goal in order to integrate and support creative people. When the creativity is working, the individuals, the team and the company hit success!

## 3. Managing individual creativity and company goals

### 3.1. Teams, creativity and product development

The ultimate goal of a product development team is to create a new product idea. The main important goal is to achieve the product. Without realizing it, a product idea remains only a representation without any value. Value is created by transforming ideas in products.

In order to do so, people with different predispositions – see before – are needed to work together in a product development team. They have to accomplish different tasks necessary first to formulate and second to realize the documentation for a new idea. Normally, a product development team consists of some, few, very creative people and many others who help fix and analyze many ideas and choose the best one.

On a personal scale, people use skills and knowledge to specialize themselves in different professions; therefore, in a product development team, one could/should involve people with different qualifications – engineers, designers, marketers, production specialists, and many others – who bring in original points of view, characteristic to their profession.

In a product development team the required skills change over time because the tasks change also continuously. One can differentiate five time periods – or steps, or

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tasks – before the product can be sold: everyone is related to a specific activity and everyone needs a special type of creativity. There are:

– *Market and technical development evaluation.* Only some top engineers, some top marketers, and very few clerks belong permanently or only temporary to team. Their creativity is directed to identify the actual market situation and to formulate visionary ideas regarding customers' possible future needs. The team manager is the person who should coordinate the team activity and should ensure the continuity of concepts until the project ends.

– *Formulating the development goal.* This is the task of upper management and of team leader. Their creativity must consider both the visionary and the feasibility aspects of the new product idea.

– *Developing and designing the product.* The team consists of engineers with different specialties: designers, drafters, analysts, testing personnel, technicians, accountants and clerical support. Marketing specialists, production planning specialists, quality assurance specialists, and others are consulted from time to time. A great amount of detail creativity is necessary to develop product parts and subassemblies, to determine the form, color, packing and advertising of the new product. Every professional group gets involved in specific types of creativity.

– *Developing and designing the production facility.* Architects, production planners, specialists in manufacturing technologies, personnel department representatives, logistics specialists, quality assurance specialists, representatives of purchasing department and of finance / investment departments - they all collaborate in solving this assignment. Because their task differs substantially from the task of product development team, they could be organized in a totally different team, with another team manager, or in a sub-team, managed by the same project manager; it all depends on the complexity of the production facility, the company organization complexity, and on the team manager's qualification and self assertion.

In order to reduce time to market, both teams must work very closely together and could work – more or less – in the same time (simultaneous engineering). Requirements flow normally from product design to production facility design, but very often also the other way: not all product designers ideas could be manufactured economically so that some details of the product should and would be changed. This activity includes also highly creative individual tasks, but again the creativity type is different.

– *Developing marketing strategy.* Marketers, sales persons, advertising specialists have to accomplish this task. It includes cost calculation and price determination. This sub-team could also start working from the project beginning, but the most important activities and the greatest working volume will be just before product introduction on the market. Every one of participants develops a specific kind of creativity: this is directed to customer's perception issues.

### 3.3. Company's product development goals

Every company has two fundamental goals:

- To satisfy customers' requirements in its own activity field
- To earn dividends for its invested capital.

Every company defines its activity following strategic goals, valid for a long period of time and approved by the board. The main task of product development department is to develop such products which satisfy the fundamental goals within the approved strategy. Therefore, every proposal for a new product is analyzed from this point of view: if and how much it can contribute to reach the fundamental goals. If this is not the case or is not in a sufficient manner, the product development work is not started.

Companies are acting on markets, where customer requirements, technical knowledge, competitors' offer, and many other parameters evolve permanently. In order to be successful – that means in order to sell large quantities of its own products for a good price – the company should develop products which satisfy future customer's needs. The time interval from the first product idea until sales time varies between several months (for apparel) and a decade or more (for airplanes).

Because other companies bring steadily new products on markets, every company is forced to spend substantially in developing new products. Their quality must be better than the competitors', so that the company can earn enough to finance his activity and to satisfy shareholders' expectations. Successful product development becomes crucial in fulfilling these goals, such that – in between - companies compete less on the markets that through the results of their product development departments; the *companies compete with each other through the creativity of their employees*. Companies compete with each other also:

- In the personnel market, to attract the best qualified product development people.
- In the training market, ensuring the best training for their employees. The UIC-offer is highly welcome.
- On facility market, ensuring the best working conditions for product development employees.
- Through financing research and development work outside the company.

Experience shows that employees' intrinsic motivation brings the best results in product development departments. This one could be significantly enhanced when companies create a unique culture of performance using methods like:

- Highly motivating project goals.
- High and recognized product quality.
- Motivating company vision.

Good results are brought about also by extrinsic motivation like:

- Rewards (money, gifts, awards, medals).
- The power of decision. Especially team managers are highly motivated through it.

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– Self fulfillment. It represents the *highest possible motivation* for many individuals.

### *3.4. Entrepreneur's and small companies' product development*

The business environment of an entrepreneur or of a small company is totally different from the one of a multinational company. Normally an entrepreneur offers his products on local markets, his competitors are acting also locally and his customers are interested in products - and very often also in services - which satisfy their immediate needs. Both, a professional contact and a competition between entrepreneurs and big companies exists, but this is solved in one of three following ways:

– The entrepreneur avoids the competition because he sees no chance to compete successfully

– The entrepreneur collaborates with big companies completing their offer and adapting it to the requirements of local markets

– The entrepreneur studies the offer on market and develops his own range of products in such market spots, which are too small to be supplied by a big company. Such opportunities are widely available.

Therefore, an entrepreneur understands under „product development“ something totally different from a big company. For him, „product development“ means to develop an offer:

– Which can be sold in (small) markets where he participates

– Which can be realized with his own means and specialized knowledge.

Of course this „product development“ involves a certain quantity of creativity but – in most cases – an entrepreneur doesn't care about fundamental or applicative research and only in very few cases he realizes a „new product“ which did not exist on the market before. In most cases the product existed already, but it is “new” because he never offered it, or because this product was never offered in the local market. Very often the product is only one variant of an existing product adapted to the local requirements. Of course the adaption requires some creativity, but it is a totally different kind of creativity – much smaller – than that necessary for new products. Sometimes it might be a change in color, or shape, or improvement in quality to be considered as the creation of a new product. Market studies, voice of customers, fundamental research and other methods are replaced in this situation by the entrepreneur's personal contact with the individual customer.

Small companies follow the same path as individual entrepreneurs, but because their market is larger, they have to go further in adapting methods and procedures used by larger companies. Because there is an infinite variation of company's purpose and size, there is a broad diversity in the meaning of product development and how it can be accomplished.

An Idea Festival for small enterprises is organized every year in September in Louisville, Kentucky. This year recommendations in pursuing big ideas are:

– Think when you are not thinking, for example, on a run or on a walk.

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- Listen to classical music, go to a concert or a play, or sit quietly in a park to daydream.
- Read periodicals you would not typically read: a scientific magazine, for example, if you are more interested in business. Same with books outside your typical genre. Surround yourself with creative thinkers.
- Attend a conference outside your field.
- Immerse yourself in a problem; ask questions, investigate possible outcomes.
- Keep an idea journal.
- Take a course to learn a new language or some other skill outside your expertise.
- Be curious and experiment.
- Articulate your idea, seek feedback, put structure on it, harvest it.

### 4. Working methods in creative activities

#### 4.1. What hinders creativity?

There are some hurdles which hinder creativity in most people and most entrepreneurs. Some of them originate from the premises of creativity:

- *Lack of knowledge.* Deep knowledge in one's own activity field must be available, superficial knowledge is not sufficient. Knowledge from other activity fields and from activity fields not related to one's own field is useful: their thinking / working methods can be used in one's own activity field. Nowadays most innovations occur in interdisciplinary fields: computing and machinery, mathematics and medicine are only some examples for this reality.

- *Lack of dedication and passion.* We saw that new ideas do not appear spontaneously: it takes time until a solution is found. If the person is not dedicated to his/her work and doesn't look permanently for a solution, the initial ideas fall into oblivion. The incubation time leads to no result.

- *Lack of training and experience.* Most creative people continue to look for a source of new ideas in unconventional, nonrelated activity fields. A lot of training and experience is necessary to distill the small useful grains in a mountain of non-important knowledge.

Most causes of lack of creativity are individual. People do not like the emotions of discovering the unknown: they prefer the sure path of traditional knowledge and experiences. Most of them use a *package of excuses* consisting of the following three phrases:

*I cannot!; I have no time!; I have no money!*

If they would start to think passionately about creating a special new idea, they would – probably – find all what they are missing. They would find ways to do it; they would change their life plan such that they would find the necessary time to do it. They would find someone who is also interested in his/her idea and would be willing to lend the money.

But, in the majority of cases people wouldn't do any of these actions.

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To be creative in a company *where the innovation culture is missing* brings a lot of problems. Most of employees wouldn't encourage the new activity and would use one of following expressions to stop it:

– *We already tried that: it doesn't work!; It will never work! It is impossible!; You are crazy to do this!*

Even when it is proven that the new solution works, *they would refuse it and would say It is not invented here!*

Those obstacles cannot be overlooked: in most of cases it is the majority of company's personnel – and very often it is a loud majority – which opposes new ideas. This resistance can be overcome only through a visible, long term commitment of management and innovators and through a gradual change of company's culture.

To be creative one has to eliminate the obstacles which hinder people to become creative. One must become free, one must free one's thoughts. Thomas A. Bass formulated the idea in this way:

„The mother of inventions? Freedom!”

### 4.2. Analyzing the market structure

Marketing people analyze markets from different points of view so that they could offer a lot of idea about expected new products. They cannot design the products – this is engineers' task – but they can offer a lot of practicable ideas. Let's take only two examples.

*Social classes' concept* (Meece, 2008). It identifies 7 social classes in USA, shown in the left part of the chart below. Let's analyze what kind of car every class would – probably - like to drive in 2020, when gasoline price might be US\$ 10 / gallon.

Social Classes	Type of car
Upper Uppers (less than 1% of population)	Bugatti Vaeron (1001 PS, 250 miles / hour, less than 10 mpg)
Lower Uppers (about 2%)	Mercedes or Lexus luxurious car, hybrid engine, 50 mpg
Upper Middles (12%)	Middle class car with a hybrid engine, 60 mpg
Middle Class (32%)	Small car with hybrid engine, 70 mpg
Working Class (38%)	Electrically driven pick up
Upper Lovers (9%)	Public busses
Lower Lovers (7%)	They use no transport means

The choice of cars is already overwhelming...But that is not all: one can differentiate more and analyzes how the car choice could differ if the customer lives in California (a mild climate), in Texas (a hot climate) or in Alaska (a very cold climate)... The variety of car offerings increases much more and so do the incentives to create new products.

*Life cycle concept* (Meece, 2008). It identifies the stages in a family life, shown in the left part of the chart below. In the right part are the variants of a very common product – a bicycle – which are needed in different stages.

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Family life stage	Bicycle needed
Bachelor stage	A mountain bike
Newly married couples	A tandem
Full nest I	Town bicycle with chariot
Full nest II	More children bicycles, two town bicycles
Full nest III	Town bicycles and some sport bicycles
Empty nest I	Two sport bicycles
Empty nest II	Two comfort bicycles
Solitary survivor I	No bicycle at all
Solitary survivor II	A wheel chair

The market could be also analyzed considering the price – quality relation, safety requirements, consumption, environmental requirements and many others. Every factor combination is a guide for companies to develop new products different from the existing one. Marketing is a not equal source of new product ideas. The customer requirements are satisfied through efforts of designers and of engineers.

Some companies have developed matrices with marketing parameters, which helps analyze if they already offer products which satisfy every combination of parameters. This method ensures that the entire market is covered by the company's products. It is a very good method to complete the product offerings with new products.

### 4.3. Asking the Five Why's.

There are two very different methods that are both called Five Whys. Neither is really an idea generation method, but an analytical tool to find what is believed to be the cause of the problem. This method is intended to find the 'root cause' of a problem, or find ideas about the root cause of a problem. Ask „Why does this problem occur?“ When you have an answer, ask „Why is this so?“, and repeat this procedure until you have asked „Why?“ five times. The answer to the fifth „Why?“ is likely to be the root cause.

#### Example

Problem: We are losing sales.

Why? Because not enough customers are visiting our store.

Why? Because our prices are too high.

Why? Because our profit margins are high.

Why? Because we have high overheads.

Why? Because of shrinkage (pilfering by staff)

#### 4.3.1. Brainstorming

Brainstorming is a *group creativity technique* designed to generate a large number of *ideas* for the solution to a *problem*. In some circles it is considered as the classic ideas generation technique, and as one of the most effective methods when one needs to get a large number of ideas in a short time.

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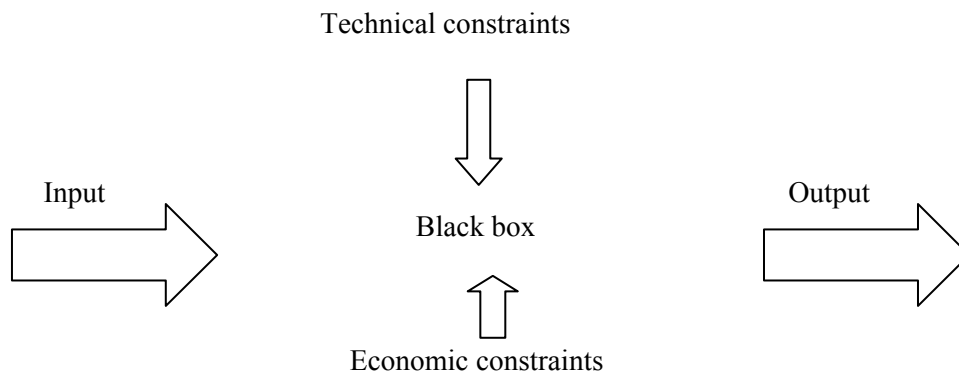
Although it has become a popular group technique, researchers have generally failed to find evidence of its effectiveness for enhancing either quantity or quality of ideas generated. Because of such problems as distraction, *social loafing*, evaluation apprehension, and *production blocking*, brainstorming groups are little more effective than other types of groups techniques, and they are actually less effective than individuals working independently (Amabile, 1982; Amabile, 1995; Andrews, 1965).

### 4.7. Thinkubator

This is the atelier name of a creative team in Chicago, managed by Gerald Haman. The team offers creative sessions to individuals or to companies which are interested to enhance their creative potential. Some main steps are followed in order to identify the investigative, the evaluative, the creative, and the active potential of participants and to organize them in teams with representatives of every category. The creative work starts with the presentation of KnowBrainer, a collection of acting lists for every one of four people categories. They contend most of parameters ordinary used by companies to ensure that all possibilities to create new products are analyzed and considered. More information about Thinkubator could be found in [www.solutionpeople.com](http://www.solutionpeople.com).

### 4.8. Black box

The black box method is largely used in development of complex industrial products. It establishes first an optical hierarchical visualization of all inputs, outputs, and collateral conditions and allows analyzing what solutions are best suited to reach the desired goals.



*Input* can be: force, moment, power, speed, consumption, intensity, material type etc. *Output* can be: force, moment, power, speed, consumption, intensity, price etc.

*Technical constraints* can be parameters of different procedures to transform input in output; safety, efficiency, noise level, maximal working temperature etc.

*Economic constraints* can be: cost, price, energy consumption, marketing requirements, investment, personnel etc.

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The procedure starts by listing all possibilities to transform input in output. For each possibility the technical constraints are determined and analyzed: as result, the list will be reduced. The procedure continues with the analysis of the economic constraints: several more possibilities are eliminated. One of the remaining possibilities is analyzed from input to output and models are built: if experiments on the model show that it satisfies all the requirements, the solution is retained. The procedure continues with the second, third, possibility etc.... The output parameters of every solution are compared with the others and the best solution is the one offered on the market.

### *Example*

Design the gear box for a totally new car...

It should transfer 160 HP from engine (input) to the wheels (output) considering the following technical constraints:

- a. the instant vehicle speed (which could vary from 0 mph to maximum 120 mph);
- b. the desired acceleration;
- c. drivability uphill or downhill (the torque should be higher or lower);
- d. engine engaged when vehicle is stopped;
- e. provide lowest fuel consumption in all driving conditions;
- f. allow backward driving;
- g. provide maximum driver's comfort.

The presumption „totally new car” is necessary in order to present the Black Box concept from beginning to end: in reality, the automobile producers have already accomplished such studies in the past and they use now the accumulated experience. They don't do this analysis again.)

### *Step 1*

The designer has to find, collect, analyze and classify all available data and information for the new product.

### *Step 2*

Having this information, the designer could imagine now how the gear box could look like when he places all the components in the black box.

### *Step 3*

The designer calculates the forces on every element of the gear and sizes them correctly.

### *Step 4*

The designer analyzes the possibilities to transmit the driver's actions on every gear element, calculates and designs them

### *Step 5*

The designer calculates the gear cost and compares them with his goal. He modifies the construction in order to reach his goal.

More steps follow, including durability tests on a special stand. The development work of an automotive gearbox could take two years and involve as many as 50 people in the team.

The Black Box Method is commonly utilized in mechanical and electrical engineering and could be utilized also in social fields like politics, communication, and others.

## **5. Conclusions**

Creativity is a very important asset and an absolutely necessary instrument in every department of a company. Supporting creative people, helping them to develop and to introduce ideas in daily practice of a company means increasing the company's competitiveness. A manager has to accept that only few of his employees will be creative. Do not expect creativity from all and do not try to obtain creativity from every one. Consider that creativity cannot be planned and that creative people use to work in a different way than the other employees: be patient with them and give them the necessary working conditions to be creative! Consider that conflicts between creative and other employees could appear: really creative ideas are far away from the actual reality and adopting those means a lot of efforts and risks for every employee and for company. In most cases the employees would refuse to modify their work methods and would reject novelties. Especially introducing innovations in a tradition rich company is a very difficult task: the entire company culture must be changed. This could take years! Cheering the innovators is a good method to develop a companywide culture for creativity.

Creativity can be trained. Training brings success if some conditions are accomplished: curiosity for knowledge and new learning; willingness to work intensively; readiness to persevere as long as necessary; to resist in face of negativity of some surrounding people; capacity to relate the creativity object to an advantage for humankind and not waste creative efforts for futile goals.

On the other side, consider that creative people have the tendency to create a lot of new ideas but only few of them are able to bring the company a step forwards into its strategic goal. From the proposed ideas select those which help achieving the company strategy and put aside the others. Do not let the attractiveness of an idea to detract you from moving along the way to the approved company goals.

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