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THE ROLE OF INNOVATION, CREATIVITY AND KNOWLEDGE MANAGEMENT IN DESIGN

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Abstract: *In the increasingly competitive global economy, innovation is critical to success. The product life cycle is getting shorter and shorter, new products must me introduced ever more frequently. The lead time between new product idea and its introduction to the market must be as short as possible (and sometimes even shorter). Moreover, the design-push approach, quite common for many designers – if we have superior product, customers will come and buy it – must be changed to market-pull: first find, what the market wants, and fight to satisfy customers' needs. The excellent new product is the necessary condition for success, but it does not guarantee it. There are numerous examples of technically superior product failing in market competition.*

1. INTRODUCTION

The price of the product is one of the decisive factors of product success in the market. It must be taken into account from the very beginning of the new concept development. As mentioned in [1], „Companies waste billion of dollars every year on new product enhancement that consumers do not want, cannot use, or will not pay for. The fact is that most new products ... are overengineered". The authors conclude that design-driven cost reduction for products in development can be as high as 10 to 30 percent. Overengineering is also the driving force of disruptive innovation – see e.g. Christensen [3],[4], Thommond and Lettice [5].

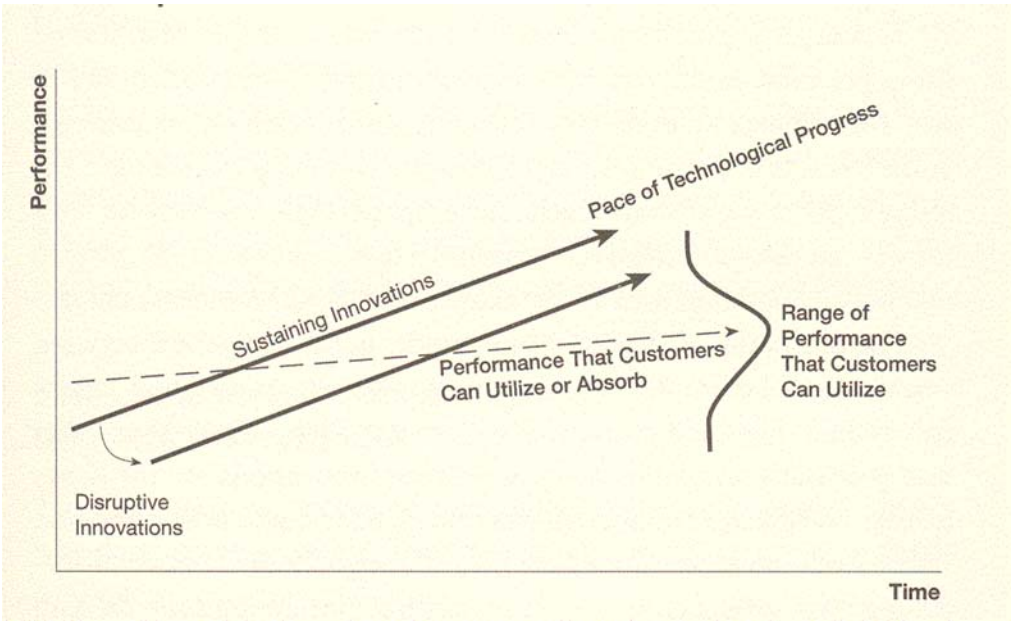
The results of the Accenture recent survey [2] among 350 CEOs suggest that innovation is considered key to competitive advantage. While there is no shortage of new ideas (more than 75% of respondents answered their people generate a sufficient number of worthwhile ideas), majority of businesses commercialize less than 20% of promising ideas. About a quarter of companies has no programs stimulating innovation and do not use any formal measurement of innovation (this percentage is probably much lower in transition economies of the CEE countries). For most, the biggest barrier is a lack of people with adequate skills; therefore companies often assign responsibility for implementing new ideas to cross-functional teams whose members also continue to be responsible for existing "day jobs". What is very important – companies view their customers as the most valuable external resource of innovation impulses, followed by suppliers and alliance partners.

This all implies change of the design paradigm. Design process must incorporate such disciplines as innovation management, team work, and creativity. With advantage it can employ basic concepts of knowledge management. In the following, let us summarize some recommendations and experiences.

2. DISRUPTIVE INNOVATION

The concept of disruptive innovation was introduced by Christensen in [3]. He distinguishes these innovations from sustainable ones, which improve the performance of established products, services or processes and enhance shares of mainstream markets. Disruptive innovation is defined in [5] as "a successfully exploited product, service or business model that significantly transforms the demands and needs of a mainstream market and disrupts its former key players." The disruptive innovation often starts by introducing "technically inferior" product

which is not considered competitive in mainstream, high-volume, high-margin markets and therefore is not attractive enough for main suppliers. However, it gains ground on non-traditional markets, satisfies new needs and often creates new niche markets. In time, the technology improves, becomes competitive in the mainstream markets and takes over the market from "sustainable" innovators (see Fig.1). Typical examples are successive generations of hard disk drives, mini-mills and many others, presented e.g. in [3],[4]. The only way of protection the company against external disruptive innovators is to disrupt itself from inside – to implement processes supporting this kind of innovations. Designers should not only study the historical examples, but they should be also trained in innovation management methods, tools and processes.



Source: CHRISTENSEN. C.M.: *The Innovator's Dilemma*, Harvard Business School Press, Boston, Massachusetts, 1997

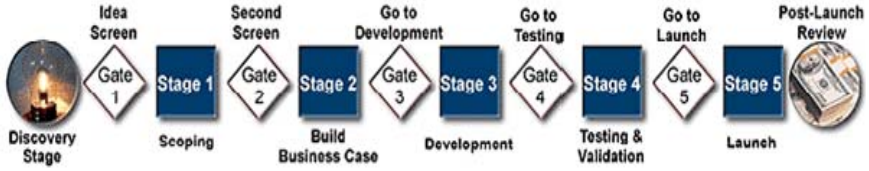
Fig. 1: The Disruptive Innovation Model

3. DESIGN-DRIVEN COST REDUCTION

As mentioned earlier, the product price is one of the decisive factors of its success in the market. According to [1], there are four cornerstones of the design-driven cost reduction:

- Process discipline imposed at every stage: idea generation, evaluation and prioritization, and implementation through production. Each step has an expected duration, every idea is tracked. Increasing number of companies incorporate the Stage-Gate new product process ([6], [7], [8]) that divides the effort into distinct stages separated by decision gates (see Fig. 2). The team must successfully complete a prescribed set of tasks in each stage prior to obtaining approval (and financing) to proceed to the next stage.

This approach results in higher success rate of new product development programs by 10-30%, shorter time from idea to market (by 30% and more) and improved adherence to time schedules and budgets (while the average project in industry is 50% behind the schedule, the 20% of the top companies using proper NPD processes complete most of their products as planned). And this all is reflected in



Source: http://www.prod-dev.com/stage-gate.shtml

Fig. 2: *Example of Stage-Gate process.*

more satisfied customers willing to pay a price premium [7].

- Target setting and transparent monitoring. Targets can be derived e.g. from benchmarking. They should be measurable to allow transparent monitoring ensuring that deviations from targets are quickly corrected.
- A cross-functional organization removing organizational barriers and fostering collaboration and creativity. This organization facilitates parallel processing (concurrent engineering), therefore shortening time to market.
- Management commitment, empowering design teams to make and implement difficult decisions, e.g. the decision to kill unsuccessful projects in early stages, before they waste significant resources.

We are confident about the significance of knowledge management and creativity in design. Therefore the next two section of the paper are dedicated to these topics.

4. KNOWLEDGE MANAGEMENT

Knowledge management can be defined as a process of knowledge generation, knowledge codification and coordination and knowledge transfer. Knowledge management is extremely important in the new product development process, as we often work with huge amount of data and information and both tacit and explicit knowledge from various disciplines that must be effectively and efficiently processes, combined and integrated. Let us now focus on review of basic knowledge management processes.

4.1 Knowledge generation

We can identify five modes of knowledge generation: acquisition, dedicated resources, fusion, adaptation and knowledge networking [9].

- **Acquisition**

  The most direct way to acquire knowledge is to buy it. It can mean buying of a company or hiring individuals. For example, the Skoda Transport Technique company in Pilsen recently bought the Institute of Railroad Vehicles Development in Prague. In this acquisition, Skoda acquired knowledge that it has lost during the transformation period, when railroad locomotives have not been ordered and thus have not been developed and produced by Skoda.

  A company that buys another one for its knowledge is buying also its people and knowledge in their heads and some structured knowledge in document or in software form. You can imagine how difficult task is to measure and evaluate knowledge and setting the price for knowledge as an intangible asset that is not reflected in enterprise accounting.

  Licensing or leasing of external knowledge is another ways of knowledge acquisition. A frequent example is hiring of a project manager or hiring an IS integrator.

- **Dedicated resources**

  The most common way of knowledge generation in an organization is establishment of units specifically for this purpose. R&D departments are the standard example. Their main purpose is to generate new knowledge. Another example is corporate library or documentation centre. Only great global companies can fund big R&D departments. Other companies, especially SMEs, often focus on near-term profit and may be under pressure to cut costs by cutting R&D. These enterprises should use innovation management tools and support employees´ creativity. They also can use external assistance provided by universities, patent consultants, business innovation centres, etc.

- **Fusion**

  Fusion means bringing together people with different knowledge and experience [10]. The differences among individuals prevent the group from falling into routine solutions of problems. There are the following principles recommended for fusion:

  1) Understand the value of knowledge seeking and be ready to invest in the process of generating it.
  2) Identify key knowledge workers who can be effectively brought together in a fusion effort.
  3) Highlight the creative potential in the complexity and diversity of ideas, seeing differences as positive, rather than sources of conflict.
  4) Make the need for knowledge generation clear also as to encourage and reward.
  5) Introduce measures of success that reflect the true value of knowledge more completely than balance-sheet accounting could do.

- **Adaptation**

  The business environment is permanently changing. To survive, enterprises, products and people must adapt to change, adopt and/or generate new knowledge. Only steady stream of innovations, inventions and discoveries can save both enterprises and people.

- **Networks**

  Knowledge is also generated in informal, self-organizing networks. They may become more formalized over time and develop into communities practice. Networks share knowledge,

communicate and collaborate effectively, and their ongoing exchange and sharing of ideas often generates new knowledge.

4.2 Knowledge Codification and Coordination

The target of codification is to transform knowledge within an organization into a form making it accessible to anybody who needs it. It transforms knowledge into organized, explicit, transferable and easy to understand form. It does not mean entire knowledge can be codified. It is well known that transformation of tacit knowledge into codified one is very difficult or even almost impossible. The primary problem in codification is how to codify knowledge without losing its distinctive properties. Organizations wanting to codify knowledge successfully should therefore use the following principles [9]:

1. Management must decide what goal the codified knowledge will serve (for example, the design department is implementing new software and all modules must be described and registered).
2. Manager must be able to identify knowledge existing in various forms appropriate to reaching the goal.
3. Managers must evaluate knowledge for usefulness and suitability for codification.
4. Codifiers must identify an appropriate medium for codification.

Important part of the codification is mapping of the corporate knowledge resources.

- **Knowledge Mapping**

  Knowledge maps identify knowledge sources (individuals, databases, documents, etc.), their addresses (e.g. department, e-mail, web address) and the kind of knowledge they contain. But that is not sufficient. Individuals having knowledge have to be also willing and able to share it with everyone who asks for it.

- **Tacit Knowledge Codification**

  It is very likely that some tacit knowledge belongs to an organization's essential inventory. Tacit knowledge is not codified and only the owner of that knowledge can be found in the knowledge map. This kind of knowledge is available only when its owner has time (and is willing) to share it. It may be completely lost if its owner leaves the company. The problem can be partly solved by forcing the knower to transfer as much knowledge as possible to interested persons. Multimedia computing can codify meaningful fraction of expert's knowledge, converting tacit to explicit one.

4.3 Knowledge Transfer

Everyday knowledge transfers are a part of organizational life. Whoever needs certain knowledge consults the person having the deepest knowledge about the problem. Knowledge exchange is going on in any organization; people talk and listen to one another. Furthermore, organizations use various strategies of knowledge transfer.

- **Strategies for Knowledge Transfer**

  Spontaneous, unstructured knowledge transfer is vital to a firm's success, especially for knowledge based firm. The firm should develop specific strategies to encourage such spontaneous transfer. Conversation among persons in knowledge firms is considered working. One of the strategies recommends establishing talk rooms. Conversations are more likely to generate new solutions than keeping employees at their desks solving their task individually. To transfer knowledge either from experienced fellow worker or from customer to designer is very important for designer's creative work. Designers working in industrial enterprises and designing complex and unique machines should participate at starting of machine operation in order to transfer knowledge about machine operation at customer's site immediately to designers. There are many more strategies, e.g. knowledge fairs or open forums, and our strategy must be carefully chosen to suit the national and enterprise culture. Knowledge transfer as well as knowledge codification depends on the kind of knowledge. The transfer of tacit knowledge without personal contact with its owner almost always leads to failure. Therefore it is recommended to create transfer relationship as partnership, mentoring, training or an apprenticeship. The transfer of explicit knowledge embedded in documents, rules, procedures, databases, firm portals, etc. is much easier and information technology can be widely used.

5. CREATIVITY

No new product, no new knowledge can be generated without creativity. Creativity is not a mystery; it can be trained, practiced and stimulated. Creativity support can be summed up into a sort of "ten Commandments":

- Keep in touch with a creative person; show a keen interest in his or her activities. Warm and open approach is encouraging.
- Accommodate the effort to the targets. Many creative people need to feel a slight "tightening up of the reins". They need to have a certain goal and at the same time a deadline that needs to be met. That is something different from a pressure forcing them to hurrying or permanent concentration. Very often creative person works best in sudden strokes.
- Effort evaluation: Creative people need recognition or purposeful criticism; they need to see the

evaluation of their effort and appreciation of their work importance.

- Creative employees need to be protected; the environment must be tolerant to creative people and their –sometimes a bit strange – habits.
- Many people get the best ideas during the periods of leisure following immediately after the period of intense concentration. Then the ideas and inspiration are transferred from their subconscience to their conscience.
- Provide the creative people with security. No person can work well if he/she is too uncertain, scared, distracted.
- Tolerate failures. You cannot be always successful. Creative ideas can sometimes be unreal or cannot be carried out. The fear of failure can block the creativity.
- Creative atmosphere. Comfortable and friendly environment that suits the creative person best supports the creativity. Somebody likes to listen to music while working, while other one prefers absolute silence. It helps majority of the creative people when they can talk about their problems, consult them even with somebody who is not expert in the specific area, but can bring enriching new ideas.
- Evaluate the creative ideas quickly. Nothing will discourage a person more than the fact that the evaluation takes a long time.
- Realize that nothing comes for free. Achievement requires energy and hard work, but also courage and enthusiasm. Support creative people in their effort to gain expert knowledge or to overcome something deep-rooted and outdated. It is possible to make use of all your positive qualities and thereby launch your ideas and dreams in the course of creative activity.

Various creativity techniques can be use in the new product development. Some of them were summarized in the training manual developed by the Department of Management, Innovation and Projects in the pilot project of the Leonardo da Vinci programme (see [11]). There are two main categories of creative techniques: divergent and convergent ones. Divergent methods aim to generate as many ideas as possible, without any constraints, and only later on the ideas are evaluated and suitable ones are selected for further development. Thy typical representative of these methods is brainstorming and its various modifications. On the other hand, the convergent methods are goal-directed, only the ideas supporting reaching the final goal are propagated to successive stages of the process; their typical representative is ARIZ and its software implementation TRIZ [13].

Very useful technique, supporting not only creativity, but also knowledge management, planning, team work and other activities, is mind mapping. Our department licensed MindManager software [14] that was installed in the computer laboratory and can be used by both staff and students.

Mind mapping uses natural visual thinking to organize, to structure and to represent information and ideas in graphic form. It uses branching, words, pictures, colours and other graphical elements. Originally it was used with pencil and paper, flipchart, etc. Today software applications enhance innovative and creative potential, facilitates capturing and sharing of information and knowledge.

The benefits of mind maps are summarized in Fig. 3 (which itself is a mind map example).

The mind mapping can be used to

1. create various reports;
2. organize ideas;
3. analyze relation among various elements of design processes, business plans, etc.;
4. effective and efficient project planning;
5. better preparation of meetings;
6. preparation of notes for papers, articles, etc.;
7. setting priorities of project activities;
8. development of a company structural maps;
9. project design;
10. project result presentation;
11. organisation of computer files;
12. linking of various project document with the map, sharing of documents within a team;
13. planning of activities (meetings, visits, travels, ...);

The map can be more vivid as a traditional document, it can be easily modified. It can contain hyperlinks to other maps and/or documents.

The use of mind mapping in the new product development is illustrated in Figures 4 and 5 below (snapshots from the MindManager 2002 Overview). In Figure 4 you can see the initial mind map showing all important issues identified at the beginning of the process; Fig. 5 then extends some issues in more detailed steps. Other branches can be extended in the same manner and the details can be added any time. In later stages, you can identify and draw links between branches, establish priorities, add hypertext links to documents, etc.

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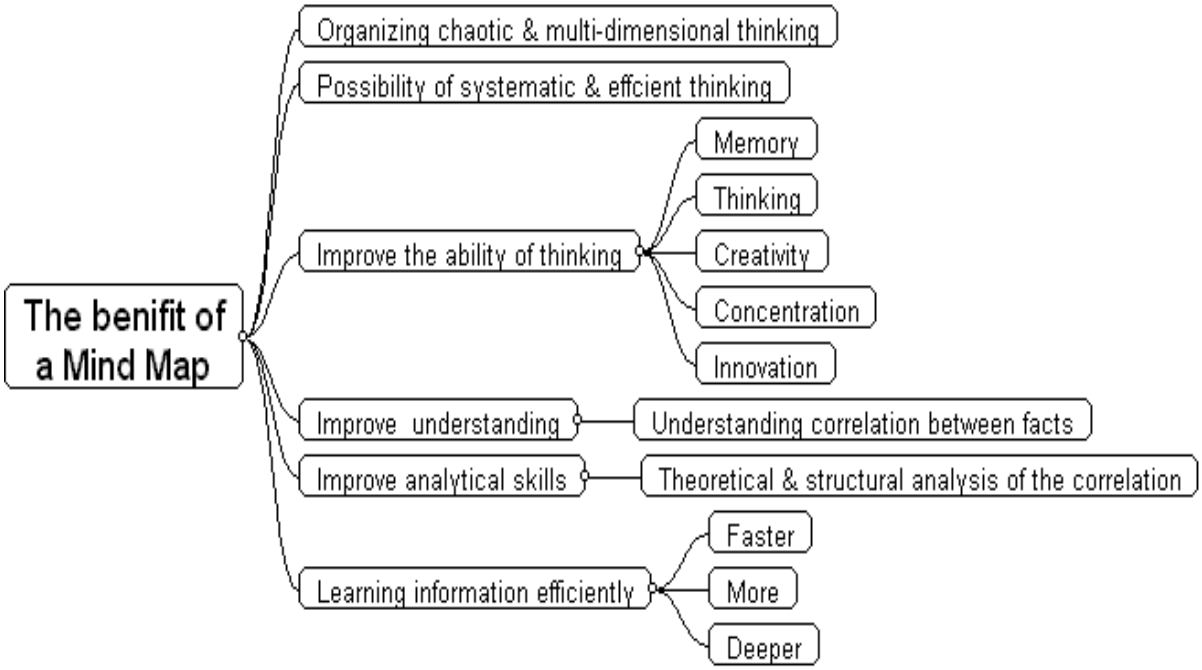

Source: MindMapper Basics + important Features, http://www.mindmapperusa.com/features.htm

Fig. 3. *The benefits of a Mind Map*

Source: Mind Manager 2002

Fig 4: Initial mind map

Source: Mind Manager 2002

Fig. 5: *Extension of specific branches*

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