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## CONTINUOUS INNOVATIVENESS SUPPORTED BY INTEGRATED COMPUTER-BASED AND PLM SOLUTIONS

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**ABSTRACT:** Motivating product designers and research groups to think “outside the box” is of special interest for companies and research centres willing to remain competitive even in times of crisis. It is proven that those leaders which realized that the continuous innovativeness is a result of in-crossed creativity support and sustained quality are more prepared for changes and bring their companies to success. Innovation management has significantly changed towards approaches that support innovation process especially the early phases in which creativity is more than needed. Approaches towards Product Lifecycle Management are changed also. In the advent of Web.2.0 these approaches have become increasingly computer-based enabling access to large user communities evolving into open or semi-open Enterprise 2.0 platforms. The parallel development of tools that could support innovative (creative) thinking based on off-line so-called Classical methods and IT solutions which claim to be collaborative and support idea generation brings to doubts about the choice of most suitable solutions. On the other side, companies are more eager to use solutions which can follow the different business processes including product lifecycle and that can aid their innovative capacity by being closer to customers. In this research an integrated solution is suggested that includes ideation and collaborative tools cross-used with PLM solutions which could support continuous innovativeness. Existing concepts and approaches on computer-based solutions for innovation and PLM are presented, with a focus on the “creative” phases such as product design that elevates the success of the products. The overview is made with a scope to underline the necessity of integration of the pragmatic aspects of creativity into solutions having features recognized with literature and test analysis that could support mainly creative thinking and knowledge sharing in companies.

**KEYWORDS:** Web 2.0, PLM, Collaboration, Creativity, Innovations

### INTRODUCTION

To succeed today companies must be more effective at Product Lifecycle Management (PLM) which covers all phases from initial ideation to marketing and eventual retirement of the product. Two factors are identified to play a major role in the product success: the quality of execution of pre-development activities and a well-defined product and project prior to development phase [2]. Pre-development activities are: idea generation and enrichment, opportunity analysis, identification, idea selection and concept definition. In the PLM these activities are more connected to the design phase not excluding the idea and knowledge exchange between Research and Development (R&D) and other departments. The innovative process begins with a creative impulse from the ideas generated by industrial designers [17] for which a free access to data, information, idea exchange and discussion as well as idea protection is required. The company should be ready to provide the transformation of their ideas from initial inspirations to marketplace success stories. With the advent of Web 2.0 and especially Enterprise 2.0 companies are given an opportunity to capture, protect, share and collaborate on their new ideas and innovation – based projects whether with internal groups or external partners. Researches have shown that in the arrival of

Web 2.0, knowledge workers are more willing to use methods and tools which are social and provide open access to data and information [9].

The parallel development of pragmatic approaches [16] towards creative thinking and IT solutions which claim to support communication, collaboration, idea generation and knowledge sharing brings to confusion about most suitable tool. This means that creativity researchers mainly streaming from social sciences have to work hand-in-hand with the IT solution developers.

In order to give a starting direction about which solutions and which features are needed to support innovative thinking especially in the design phase we analyse several existing concepts and approaches on computer-based solutions that could be used in the early phases of the innovation process including design activities.

As a beginning an overview of the recognized computer-based systems for collaboration and their characteristics is given, evolving into more holistic platforms. Then a description is made of a computer-based solution that supports individual creativity and an example of PLM solution.

According to literature and test analysis we give roadmap to the features of an integrated computer-based platform which can support idea generation

and enrichment, design, capturing, idea sharing and discussion, and rating, as a part of the continuous innovativeness and PLM.

#### THE HISTORY OF COMPUTER - BASED SYSTEMS FOR COLLABORATION

Organizations invest many financial resources on technologies and on implementation of computer-based solutions such as decision support systems, collaboration systems, data flow etc. Unfortunately very few experiments are made with respect to the impact of creativity resulting from the use of group support solutions including computers and web - based platforms [5].

For more than a quarter of a century research has been conducted on group support systems (GSS) [6]. They are defined as: “A set of techniques, software and technology designed to focus and enhance the communication and decision making of groups” [12, p.357], and treated as solutions that could overcome the process losses during group meetings. GSS were meant to support a variety of tasks following a similar sequence of events. The early systems from the 80s were designed to support system analysts and users in the constricting of information systems [13]. Later on they were used as support methods for almost every meeting. The participants on the meeting used their computers to give comments and the results were integrated and displayed on a large screen in the front of the room. In that way the communication between the participants was assumed to be eased and ideas more easily exchanged. In the years that followed these meetings were also supported by more internet enabled applications such as Groove, MSN Messenger, Yahoo, Chat, ICQ, Lotus Notes and other Web applications to enable members to communicate [13] and to support meetings with geographically distributed members. On the other side there was a significant interest on decision making and idea sharing accomplished by computer networks [15]. Computer - based tools which supported idea generation primarily were based on the brainstorming face-to-face method [12] and are called Electronic Brainstorming Systems (EBS) [15]. Electronic Brainstorming Systems have received significant attention by researchers. There was an optimistic belief that computer - based brainstorming systems will overcome the problems of inefficiency and low productivity in idea generation group meetings [7], [8].

Facing with the fast changing economy companies started to require and search for computer - based solutions not only for group meetings support but also that could foster their knowledge management activities and collaborations. A new social technologies embedded in the so called “Web 2.0” has

appear on the market. These technologies were originally used to describe consumer technologies that enable groups to organize and share information and media called Enterprise 2.0 [4]. According to Eastwood (2009): “Enterprises quickly caught on the value of these easy to use tools for capturing and sharing ad hoc information that may be otherwise not documented”. IT enterprises had to respond to the requirements of their customers with solutions that contain features for collaborative working across regions, knowledge capture, and community and brand building outside the firewall (Oracle company, 2008). This led to a creation of new and improved, more holistic tools called Social Enterprise Applications that would enable the “next wave of knowledge worker productivity” (term coined by Oracle company [14]).

The use of the technologies associated with Web 2.0 has implicated the opportunity for companies to literally think “outside the box” by searching for new product ideas outside the organization.

#### COMPUTER – BASED PLATFORMS AIMED TO SUPPORT CREATIVITY

Some IT vendors together mainly with psychologists and sociologists developed computer – based solutions which can help individuals in the creative thinking process. For example simple solutions are developed that provide the use of (collaborative) mind maps (e.g. Mindmeister.com) and brainstorming features for creative decision support, or based on the logic of existing methodologies (e.g. TRIZ [1]) or Lateral thinking [3]). With a closer observation of all those solutions it was noticed that features that support group interaction and idea generation activities are minimized or even excluded completely which make these solutions partially creativity supportive. Also many of these solutions offer only use of analytical tools which is in line with the tendency of the creators to support the analytical thinking rather than creative.

From the existing computer-based systems for collaboration only few solutions include idea generation phase and even fewer are capable for Open Innovation. One of these solutions is Neurovation platform which is developed as a result of a research project from 2005 with an overall aim to combine innovation and knowledge management on a psychological and neurophysiologic basis in order to improve the innovative capability of organisations in the long run. Based on the findings obtained in the course of the research project as well as on the insights from existing literature a focus has been made in favour of the first phase of an innovation process so called “Fuzzy Front End”, in particular the idea generation activity. The computer-based

platform is based on tests made on persons given different challenges which aim to provoke creative thinking [11]. Neurovation.net allows an individual to use different challenges – tools (Figure 1) which provoke his/hers creativity, to draw and memorize ideas and associations, to make them visible through the “idea pool” and to be discussed and rated by other users of the platform [10].



Fig.1. The creativity tools on Neurovation.net

The platform has two target users: employees in companies and external users. With its use there are two beneficiaries also: the employees/ individuals who can establish their ideas, communicate with others about the quality of the idea before realization (with the stakeholders, partners, product consumers) and be awarded for the same; and consumers who are given an opportunity to improve or change products and even become innovators with a successfully soled idea [10].

Neurovation was tested by a group of experts in a course of doctoral research [9] with an aim of identifying the additional expectations of such “ideation” platforms which could aid in the early phases of the innovation process. In a two day workshop the use of the computer - based ideation solution was compared with an off-line creativity (ideation) technique. The reason of comparative use of tools was not the number of developed ideas only, as usually measured by many creativity scientists, but the differences between the steps and the presentations of the use of the tools to be identified. The results were analysed according to five group criteria [9]:

- the interface – including the simplicity of the use of the tools, the dynamics, graphics, etc.
- teamwork – available places and spaces for teamwork, supporting tools;
- leadership – the need of leadership or only moderator in both cases;
- structured problem-solving opportunity – whether and in which manner the tools support successive idea development and even analysis, and
- time – which ideation phases need more time, which method provide more effective idea generation and development, which method and tool need less learning time etc.

Even at the beginning a very positive comments about the use of solutions supporting creative thinking (ideation) were received. The literature of creativity lists thousands of experiments and tests where off-line techniques known as classical are used. They all represent a never ending enthusiasm of individuals to be challenged to show their creativity and originality which lead to innovations.

The tests of the Neurovation showed the same tendency and enthusiasm. The test group was given real cases for which new ideas were expected to be developed. Even though in the time of the tests held Neurovation was under another development stage, which meant more close upgrade of the features of the tools for group use rather than individual, the participants of the test were more willing to use computer - based solution of that kind rather than off - line classical technique only. This is because they were able to establish their ideas not only ad-hock but using their knowledge and analytical skills. The role of the leader when using computer - based solution was minimized which contributed ideas not to be influenced by authorities and to be more original. When it comes to structural problem - solving with Neurovation several features were identified as important for the same to be provided. Even in group idea generation a mutual working area was required where ideas can be shared and captured by all participants. The use of other tools such as CAD, Mindmaps, MS Project with which ideas and designs could be presented with technical drawings, maps and to track the evolution of the project, was seen as necessity. The participants had several remarks on the rating system such as involvement of expert groups or customers. Within the final phase of the development of ideal solution an access to patent offices and external data bases of existing products were required also which would aid in avoiding duplicates. The test made with Neurovation.net showed that individuals respond very positively on the design which supports:

- arena where members can argue their knowledge – a blog where ideas can be publicly or privately argued;
- space for socialization – the users can discuss and can share pictures and information;
- the idea generation can be made in group and individually;
- free information exchange is provided with the external environment;

The participants positively reacted on the knowledge that their idea can be protected, according to their choice it can be publicly shown or hidden and by that it can be decided whether to be marketed and sold to companies.

**EXAMPLE PLM SOLUTIONS**

With the analysis of the existing product management and innovation management platforms a lack of existence of integrated solution that would aid the ideation phase as well as idea capturing, design, protection, rating, collaboration and knowledge sharing is identified.

Teamcenter SIEMENS PLM one of the most selling solutions in the world is an IT solution which connects people throughout the lifecycle with a single source of product and process knowledge. It includes end-to-end solutions from: bill of materials management, community collaboration, compliance management, content and document management, engineering process management, enterprise knowledge foundation, formula, package and brand management, lifecycle visualisation, maintenance, repair and overhaul, manufacturing process management, mechatronics process management, portfolio, program and project management (ex. Figure 2). Through Teamcenter PLM the company is given an opportunity to create, share, manage, follow data and documents for different product projects and collaborate by changing it.

Teamcenter PLM is a platform on which the company can design its processes, design products and follow their development. In each phase an idea generation is required as well as collaboration in which ideas are not only exchanged but improved, discussed, upgraded, compared with the needs of the market, the best practices and the future expectations. This collaboration need in Teamcenter is resolved by data and document sharing which can be accessed individually. Every change is made separately by every user without a possibility of simultaneous group work, except if the group is in one room and are looking at one desktop.



Figure 2. Example of interface of Teamcenter

The possibility of design is given through NX (ex. Figure 3) product which can be introduced with Teamcenter which offers the industry’s broadest suite

of integrated, fully associative CAD/CAM/CAE applications.

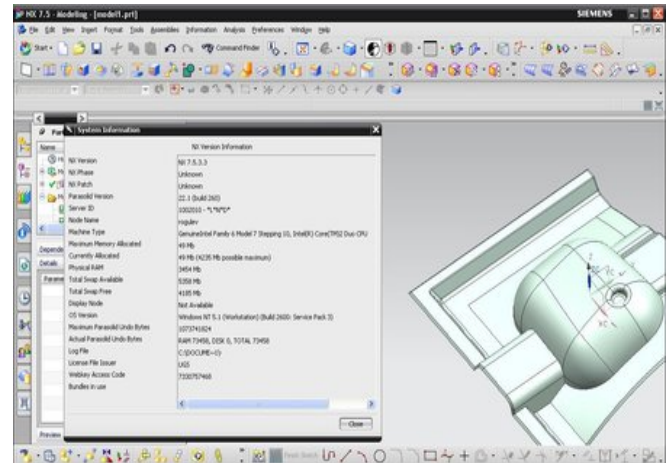


Figure 3. NX interface

NX offers: industrial design and styling, package design, electromechanical systems design, mechanical simulation, electromechanical simulation, tooling and fixture design, machining, engineering process management, inspection programming, mechatronics concept designer. All these activities require collaboration and exchange of ideas and knowledge between the designers on a high level. This does not mean that only data and drawings should be exchanged but also discussions of ideas, requirements from the customers etc.

**SUGGESTED FEATURES OF SOLUTIONS FOR CONTINUOUS INNOVATIVENESS**

As seen from the architecture of some PLM solutions there is a lack of communicational and ideation “space” important for the success of the entire product. In the architecture of the solutions we suggest a small attention on the collaborative part in which individuals especially designers would be given an opportunity not only to develop ideas and drawings based on trial-and-error but “space” in which they can stimulate their creative thinking, they can share their ideas with some created community (external and/or internal), ideas can be rated, designed in a mutual way and selected as best solutions. For this to be provided according to the literature and test analysis several additional features has been identified that should be included in the platforms such as PLM. The suggested features of a solution which will support continuous innovativeness are:

- Existence of Ideation tools – such as stimulations of pictures, photos, music, videos, people, etc.;
- Discussion arena – blogging system, virtual meeting room etc.;
- Socialization space – a space for sharing written ideas, drawings, pictures etc.;

- Rating mechanism – with the possibility of creating internal or external communities a rating system which can be used by the community to evaluate different suggested ideas is recommended. The rating system should be transparent with predefined rating scale.
- Rewarding mechanisms – established motivation mechanisms for good idea published online by the users;
- Design and decision making tools – CAD/CAM/CAE, CATIA, conceptual maps etc.,
- Access to product or patent data-bases from where the users (product developers) can “learn” whether their ideas are innovative or not
- Access to expert knowledge sources such as scientific journals, white papers, market analysis etc., from where the users can improve their knowledge and be up-to-date with the newest scientific researches.

The existence of these functionalities presents an integrated computer-based solution that would support the idea generation, enrichment, sharing and selection in line with the time schedules of development of product projects.

#### CONCLUSIONS

The innovation process is a process which includes several phases from idea generation to commercialization. A company willing to be successful and profitable has to find ways to support innovative thinking continuously involving different methods, tools and techniques no matter of its size and history. It is evident that as the market requirements are growing the innovation approaches are changing, making companies more open and much more customer oriented. Today most of the tools which support innovation activities are computer – based differing one from another from the purpose, target user groups, impact on the innovation process as well as on the human resources. In this paper we focused on solutions that might influence the basic activity of the innovation process and its outcome – the idea generation. Beside the numerous questions and views that might be discussed on this topic a brief overview on the needs of the companies and their employees of solutions which include creative (innovative) thinking was given in this paper.

The purpose of the IT solutions is to fasten the process from idea to launch of the product. Activities that are connected with the separate phases of the product development should be integrated into a “smart” solution that will guide the user through all phases. The lack of many IT solutions dedicated on the innovation process or at least product management is

that they exclude the phase where the human has the most important impact on the success of the product – the initial phase (ideation, or creative phase). Sociology and psychology scientists and researchers suggest a use of ideation tools which will help in matching the idea with the production processes in a successful product. Test analysis of the use of computer-based platforms aimed at ideation phase show that for the development of a successful and innovative product several features are needed. Users expect from a computer - based platform to provide more space for idea generation, development, discussion and even rating of ideas individually and in group. It has been shown that only idea generation and document flow virtually does not guarantee any success, any activity should be left to be described, elaborated, changed, designed, and even rated until is chosen. These features might be included very successfully in PLM solutions such as PLM Teamcenter and NX. The integrated features into such platform will provide more open and user-friendly platform in which the user will have an opportunity to collaborate and create creative collaborative to networking space. On the other side a creation of idea data bases and idea following will be provided too. With this kind of computer-based systems a continuous innovativeness will be supported successfully.

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