

ENGINEERING AND DESIGN APPROACHES TO PRODUCT DEVELOPMENT: A COMPARATIVE ANALYSIS

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Abstract. The objective of the paper is to compare the Engineering and Design approaches to Product Development Process (PDP). In both areas it can be identified different methods that guide, in its proper manner, the PDP. This can be explained by the fact that Engineering traditionally develops the products with emphasis in technical aspects of the products whereas Design investigates the users – product interfaces. Based upon this background, this paper also discuss the appropriateness of applying the planning models often used by the Engineering field into the Design field, with special attention to systematization and coordination of the creation activity.

1. INTRODUCTION

For a better understanding of this work some concepts are defined as follows. The concept of Process Management is defined as management action whereas *Design* concept is defined as projectual action (GONÇALVES, 2000), which starts from the enterprise's strategic business – the strategic *Design* – up to its operational aspects (ISCID, 2005). Therefore term *Design* is referred herein not only to the result of the design action, but also to designate the process of transforming actions. (MOZOTA, 2002) The overlapping of both concepts is not accidental: the evolution observed in Process Management has occurred in a similar manner to that of *Design* area. Process Management has evolved considerably since the Second World War, as a consequence of the evolution of the System Theory; the same has happened to the *Design* field, and the methodological theories developed in the 50's were supported essentially by the System concept, particularly due to the contributions of Hochschule für Gestaltung Ulm and Christopher Jones.

On another hand, due to the conceptual crisis experienced in the 70's with the emerging of Post-Modernism, the methodological theories of the *Design* field started being based on intuitive basis, drifting away from the analytical procedures that had guided so far. In the 80's, the business process area resumed its influence in the *Design* field, by creating a new theoretical trend that looks at Design from a macro point of view, on a strategic level. This trend is known nowadays as Design Management. (GONÇALVES, 2000), This dual view points is reflected in the research results of *Design* field. From the market's point of view, the *Design* activity has a basis on a business theoretical structure, but when one thinks of its materialization through productive processes and technological aspects, *Design* is viewed from a Production Engineering standpoint.

Hence, in this paper, the *Design* activity is considered as a project activity oriented to the resolution of interface problems that someone can have with his surroundings. *Design* creates, conceives objects, brands, spaces to satisfy specific needs according to a logical process, coordinates activities, thinks and researches the coherence of the objects.

Another correlation that needs clarifying is that of *Design* as a project activity and the concept of Product Development (PD) – chain of activities developed by Engineering. In both *Design* and Product Development (PD), many functional areas of an enterprise are involved. In both concepts, activities, tasks, data and information are used to generate product specifications and from this, it is a company task to create and produce products that fulfill the expectations of the markets where they are requested. This process is referred herein as Product Development Process (PDP). With regards to how the PDP takes place, it can be verified that both Engineering and *Design* perform on strategic and operational levels. This is further developed as follows.

2. PRODUCT DEVELOPMENT PROCESS: STRATEGIC LEVEL

2.1 Engineering's Approach

At the strategic level, the Engineering's approach to PDP is characterized by Product Development Management (PDM). Cheng (2000) further splits PDM into two (2) distinct approaches: (1) Production Engineering which focuses on the processes and products development production and (2) Marketing approach, which focuses on strategies of products intended for the market.

When analyzing the PDP from a strategic level, Cheng poses as a central question the *Portfolio* Management, characterized by three (3) objectives:

- 1- Aligning development project strategies with the business strategy;
- 2- Maximizing the *Portfolio* values by taking into consideration the available resources; and
- 3- Balancing the projects under many different criteria (CHENG, 2000).

It worth noticing that some authors (ROZENFELD, 2006) have a broad view about PDP as they present it far beyond the sole Engineering view point and include other areas such as Business, Marketing, Production, Strategy, Quality, Information Technology, Knowledge Management, among others. However, *Design* is present in a reduced perspective as the authors mention Design as merely the study of Ergonomics and Aesthetics of a product. This reduced view can lead to a number of misunderstandings as the behavioral aspects of an individual in a society related to the product itself would not be considered.

2.2 Design's Approach

At the strategic level, the *Design* approach to PDP is characterized by Design Management (DM), which is also named, according to some authors like Mozota (2002), Wolf (1998), Magalhaes (1997) as strategic *Design*.

Hetzel apud Mozota (2003), states that *Design* plays a important role in the enterprises' financial behavior. In 1975, in the *Design Management Institute* (DMI¹) has been established in Boston, which is nowadays, the reference in Design Management issues.

According to Wolf (1998), *Design* Management "organizes and coordinates all design activities, such as structuring of projects and activities, planning of due-dates, selection and planning of personnel, planning and controlling the budget". What should be incorporated into the enterprise's mission and to its basic premise for efficiency is the view of design as a quality and strategy factor by the management.

3. PRODUCT DEVELOPMENT PROCESS: OPERATIONAL LEVEL

3.1 Engineering's Approach

At the operational level, the Engineering's approach to PDP focuses on the operational matters of the product development; a special attention is given to the project itself and to the use of methods and techniques. This approach quotes two (2) models widely used:

- 1- The funnel structure, with its variations (CLARK & WHEELWIRGHT, 1993); and
- 2- The "*stage-gate*" generic structure, with its stages and decision processes (COOPER, 1993).

CHENG (2000) presents a list of references that approach PDP from the operational level.

3.2 Design's Actuation

From a *Design* perspective at the operational level, this activity, is defined (MAGALHÃES,1997) "actions turned towards the design process, sorted as work 'from the inside to the outside' in intellectual conception style and functional simplicity (European view) as well as of what is worth selling and advertising (American view)."

Contrarily to what has been presented in Cheng (2000), in the *Design* field, there was no significative development of methods and techniques that guide the *Design* Process in the way that Product Development is practiced nowadays.

¹ DMI's goal is helping design managers to become leaders in their professions; making studies available, financing, promoting and conducting research in design management and sustaining the economical and cultural importance of design (DMI, 2004).

Despite there having been a moment in which Design has worried about developing a methodology of its own, which congregates many branches of knowledge, whether they are artistic or technological, apparently, throughout history, there was no development of project methodologies, methods or techniques according to the requirements of the product, like Engineering does it. On the contrary, the empiric methods and with a strong basis on creative processes is a common practice of the professional dedicated to this activity. Maybe, that is what led the other areas to see *Design* as an area that only worries about the product's aesthetics. Due to its lack of attachments with a methodology, more strongly based on an analytical thought, whether it is reductionist (Cartesian) or deterministic (cause/effect) or even to the mechanicist methods or the deepening of the system theories

It is true that in the end of the XIX century, with Morris e Ruskin, there was a search for the return of craftsmanship production processes, and that the ideas adopted by Muthesius, who contributed to the standardizing concept, led, in this period, to generating a method for projecting objects, which, with time, generated the need of establishing rules not only for the draw itself, but to the whole *Design* process.

And, even if in 1923, Theo van Doesburg affirmed that "in order to be able to build a new project, we need a method, that means, an objective system". Or even Walter Gropius (1919) followed with Bauhaus's (first design school) same idea. And among many other *Design* characters, Josef Alberts, Hannes Meyer and Marcel Breuer considered the results of their work as product of the work methods. And with the use of a group of techniques coming from the First World War, like: informatics, operational research, cybernetics and system theories, it was possible to start the first *Design* methods, as well as Product Development's, having as a basis, however, different thought currents. (BAYAZIT, 2004).

A historical analysis of the design methods evolution is done, initially, by scientific disciplines, General Systems Theory, Information Theory, Decision making Theory and Creative Process Theory. However, what is found in the *Design* methods is that, in its majority, its methods have two (2) good bases, one base guided by the systems theory and another guided by creativity.

And, among the many analyzed authors who dedicated themselves to building up a new methodology for *Design*, there is a tendency of searching for an orderly *Design* Method and with a strong link to the systems theories, some of these authors are: Bruce Archer, Christopher Alexander, John Christopher Jones, Gui Bonsiepe, Bernad Bürdeck, Hans Gugelot, Don Koberg and Jim Bagnall, Bernard Lobach, Mike Baxter. There are others with a tendency for searching a Method based on creativity and with techniques like brainstorming (Alex Osborn, 1938), Sinetics (Gordon e Prince, 1961) which consists in the analogy between a problem to be solved and a similar one, and also the lateral thinking – characterized by Edward de Bono as a deliberated and systematic process that allows us to activate our capacity of developing and implementing solutions with an optimized productivity – and with this focus, many authors who consider perception as the guidelines to the project can be found, they are: Bruno Munari, Tomás Maldonado, Gillo Dorfles, Taboada and Nápoli.

4. PRELIMINARY CONSIDERATIONS

With what has been exposed, what can be concluded at this stage of the work, and it is important to observe is that Design as well as Product Development (PD), activity developed by Engineering, are very wide human activity branches that center on problem resolution, creation, and coordinating and systemic activities. Each problem to be solved implicates generating balanced results for a number of products developed under the optic of technology, of production and of the market, of the user, of the economy among other factors presented by the two activities.

Besides that, it is possible to conclude that Product Development (PD), activity developed by Engineering, has given special attention to process improvement theories due to programs like Quality Engineering and especially after the enterprises adopted the ISO 9000:2000 norm, which orientates enterprises to guide their organizational structures through processes. This fact led processes to be systemized, the information flow to be mapped and the group of activities to be clear and objective, so that, activities and tasks of the process itself that aggregate value to the PD could be done, moreover, capacitating people with different skills and knowledge, generating indicators that improve the process' performance for a constant improvement.

In the approach made by the author CHENG (2000) it was shown that there are two (2) main Product Development Management (PDM) approaches, one by Production Engineering whose focus on production developed a series of methods and applied techniques, and the other, by Marketing, whose market focus equally developed a body of knowledge in corporate strategies, which, nowadays, guide most corporations. In both approaches, there are now many teachings available that are worth being learned and applied to enterprises in order to reach the objective of continuous improvement from a strategic level as well as from an operational level.

However, in the *Design* activity, there was more preoccupation in developing a knowledge body, in other words, models with strong links to business, marketing, planning, strategies and management, which means there is an advance in the developing of *Design* at a strategic level, as shown before and whose term used by the professionals of the area is *Design Management*. As the models at a strategic level, the methods and techniques became outdated or simply were not used anymore by most designers, there was a failure of the methodologies that had been developed more rigidly until the 70's. Especially in Brazil, whose activity initiated after the 60's, during Carlos Lacerda's government, and period in which the *Bauhaus* and *Ulm* schools educational models were adopted. Models and empiric methodologies slowly substituted the teaching models and consequently the professional activity with strong links to the creative process.

The creativity in the process of the project is characterized frequent by the occurrence of a significant event, "of a creative jump", this theory has for base the Gestalt (ALENCAR, 2003) which gave beginning to the research on insight, that is, that moment of the creative process where it usually appears of sudden form, a new idea or solution for a problem and whose resulted if it recognizes an innovation, a same differential or a new solution to a detected problem.

However, Alencar (2003, pág. 01) affirms that "in last the 20 years, new theoretical contributions had appeared, englobando distinct components considered necessary for the occurrence of the creativity" (.) the author explain three models of creativity that had been elaborated on the basis of the new researchs, and is the theory of investment in creativity of Sternberg (1988, 1991; Sternberg & Lubart, 1991, 1993, 1995, 1996), the componencial model of creativity of Amabile (1983, 1989, 1996) and the perspective of systems of Csikszentmihalyi (1988a, 1988b, 1988c, 1996).

The different boarding's of creativity of the authors emphasize that, even so the individual have an active paper in the creative process, introducing new combinations and variations, are essential that if it also recognizes the influence of the social, cultural and historical factors in the creative production and the evaluation of the creative work. Thus, in order to get vision more ample of phenomenon creativity, must to lead in consideration interaction between characteristics individual and ambient, fast transformations in society that establishes new paradigms and demands more adequate solutions to the challenges that appear, and the impact of the creative product in the society.

We remember that, to stimulate the creative expression in the academy, in the professional environment or in another context, it is necessary to prepare the individual to think and to act of creative form, as well as planning interventions in these contexts in order to establish conditions favorable to the development of the creativity. In the project environment habitually one becomes necessary that some problem or necessity is direction, so that if can give existing knowing scientific and/or empirical so that all they are applied and exactly stimulated with objectives to generate creative solutions of the problem. E even so the creativity in the process of the project can be considered as a powerful tool frequent is characterized by the occurrence of a creative jump, is something difficult to be described for logical rulers for the conventional optics it process it project.

Some authors had interpreted it and presented diverse techniques of creativity, such as: Sternberg (1988), Kim (1990); Boden (1991); Gero & Maher (1992); Gero & Maher (1993); still Geschka (1996) that it revised three techniques, brainstorming, the visual confrontation, and the morphologic techniques, which had been developed and had been used in the German since 1960; Krohe (1996) another author presented a summary of 22 techniques to stimulate the creativity; Remko van to give Lugt (2000) elaborated experiments with the use of graphs to stimulate the generation of ideas, inserting graphical in the technique of brainstorming and still Dorst & Cross (2001) had considered refinements model of the co-evolution, used in the process of development of products, and had used the term "burst of the development" after the evaluation of the process.

To put CARVALHO (1999) described a possibility to insert enters the some Methods for Creative Solution of Problemas (MSCP) which support the process of solution of the project problems to guide the Process of Development of Products. In the model of the author it suggests the use of the MCSP, for two phases of Development of Products, being that the phase of planning of the Product this contained the macro Daily pay-development phase and the phase of the Conceptual Project that this contained the macro phase of Development. Soon, the contribution of the author is significant the measure that the objective of its model demonstrates a concern in integrating of systematic form the MSCP to the Process of Development of Products, thus assisting the development of the activities of the phases of planning and the conceptual project.

Moreover, another characteristic that calls attention in the model is that in some points of the process the author included stages for the decisions who guides to who of this model makes use, to evaluate the results of the gotten ones, to give continuity or, or same not to remake the previous stages, until if getting a satisfactory result. One is about a prescriptive model, whose main structure this guided by intuitive, systematic and guided methods. The author more

suggests for each type of problem the attainments of synergy if using of adjusted methods, and recommends that initially the methods most easy to be applied and learned are applied during the process, in case that they are not gotten resulted satisfactory with this initiative, then the author suggest the adoption of methods with bigger degree of learning difficulty and application. That is, the impact caused in the creative process, of a systematic and organization of phases of projects, will be beneficial the measure that will be possible to determine a Process of Design, in such a way strong on, the characteristics of the models adopted for Engineering, how much of the Methods of Creative Solutions of the Problems, as well as of a Model of Process of Design, that contemplates varies them pertinent activities of this n activity to the project

However, contrary to the methodologies, or models, developed by Engineering, searched to systemize activities performed at the PDP, and taking advantage of the analytical theory, organized the steps logically the phases of the product's project to reach the pre-established objectives. In its majority, methodologies present systematic procedures that conduct the analysis, generating proposals so that they can be verified and, therefore, contrary to the project requirements initially defined. And in the repetition of these models, a constant perfecting and continuous improvement on each phase of the PDP would be attempted. These constant improvements allow models developed to provide more trust in all of the process, whether it is during the collecting, analysis, proposals generating or making decisions that a Project's team requires in order to continue the PDP, and allow the enterprise to reach its goal its desired success.

Subsequently, from the operational level perspective, *Design* can be considered as an integrating part of the knowledge body needed from the Product Development Process Management (DPM) as well as Marketing, Product Engineering, Manufacturing, Logistic and it does not, in anyway, substitute the PDM, it is just one (1) among the processes that as a group of activities aggregates values to the products developed and that deals with information in a differentiated way, as it adopts as a focus of its actuation, the interactions Man/Object/Environment. So, *Design* must reconsider its methodologies, models, at an operational level, in other words, it must explore, develop and update in the same way as Engineering does. Besides that, these methodologies must consider in its structure *Design's* main tasks, which are identifying and evaluating structural, organizational, functional, expressive and economical relations targeting the enlargement of a global sustainability and environmental protection; offering benefits and freedom to a human community as a whole, to the final individual and collective users, protagonists of industry and commerce; and still must support cultural diversity, despite the world's globalization; give to the products, services and systems, forms that are expressed semi-optimally and be coherent with the aesthetics of its own complexity.

So, maybe the lack of a speech in favor of *Design*, which is a fact that is discussed by the scientific and business communities, comes from this lack of demonstrating that its performance contributes for the progress, or even from the development and application of the methodologies available, or even from the creation of a model that can suit the new market conditions, executives, organizations and even go against the new business models that make all of the market's technologic, economical and industrial context more dynamic.

The current methodologies, the models, are little systemized and little deepened. That permeates teaching, and with that, professionals without a more dynamic and contextualized project methodological basis are formed, without the knowledge of managing tools, like diagnosis, accompanying, evaluation, time and investment return, without any security in the evaluation of the market's product results, which needs to accompany the dynamic now found in the many industrial sectors.

The authors FREITAS et al. (2003) when they analyzed eleven (11) articles, quote the importance of *Design* in the organizational model, among their conjectures, the authors write the following: "the Brazilian designers must be better prepared, so that they can take over a strategic position in enterprises", and also that "the focus given to the formation of a *Designer* is manly to send out in the job market just a professional with technical knowledge (use of tools, computers, manufacturing processes) and with little capacity of reflecting about organizational problems", and even of contextualizing with changes that happened during the strategic planning of the enterprises, and even how the PDP of new products occurs, or even how the enterprises structure themselves in front of the market's dynamic.

In a brief analysis of the articles published in the P&D *Design* 2006, which happened in the city of Curitiba, it is evident that the Design articles in the Management and Education areas have no references to the authors quoted by [8]. In other words, in the available literature about PD whether it is through the Engineering, Marketing, Logistic, Manufacturing, P&D, approach or even through other points of view demonstrated that the Design professional or theorist is left out of the consulting basis.

5. FINAL CONSIDERATIONS

During the presentation of information about the new product development process, the approaches of engineering and design about this issue were shown. Primarily, what can be concluded is that to the theorists and professionals of *design*, it has become essential that they constantly update themselves and that they are in tune with the tendencies adopted by corporations that search constant innovation, product efficiency and adapting to changes among other factors.

In this sense, in order for the professionals to act more appropriately in the organizations, they should look for already consolidated methods that were widely divulged by other areas of knowledge. Or they could incorporate methods, techniques for project problem resolutions to the *design* process by considering the current innovation theories, knowledge about innovation politics, knowledge of market and economy, of engineering strategies for the development of science and technology, of the administrative techniques of project managing, among others.

What should also be considered is that the *Design* process is different in each enterprise, because each one of them has its particularities, specific needs related to their business, and that way, the design process must be flexible enough to the particularities of each organization, since there are no rules for that. It can usufruct of information from, methods, techniques, evaluation methods of the reached results, proceedings already consolidated for the product's documentation, organization of the project team, term control, cost and quality, available in the many departments of an enterprise.

Subsequently, to the new designer, who will design not only the near future, but to who still has not been born, he should constantly seek innovation, not just for the novelty, but because it will bring many benefits to society.

6. REFERENCES

- ALENCAR, Eunice M. L. Soriano de & FLEITH, Denise de Souza. **Recent theoretical contributions to the study of creativity**. *Psic.: Teoria e Pesquisa*, ene./abr. 2003, vol.19, nº 1, p.1-8. ISSN 0102-3772.
- BAYAZIT, Nigan. [2004] **Investigating Design: A Review of Forty Years of Design Research**. Design Issues: Volume 20, Number 1 Winter. Massachusetts Institute of Technology.
- BODEN, M. [1991]. **The Creative Mind, Myths and Mechanisms**, Wiedenfeld and Nicholson, London.
- CARVALHO, Marco Aurélio. **Modelo prescritivo para a solução criativa de problemas nas etapas iniciais do desenvolvimento de produtos**. Dissertação de mestrado submetida ao Programa de Pós-graduação Eng. Produção, UFSC, 1999.
- CHENG, L. C.. [2000]: **Caracterização da Gestão de Desenvolvimento de Produto: Delineando o seu contorno e tópicos básicos**.; 2º. Congresso Brasileiro de Gestão de Desenvolvimento de Produto; São Carlos; Brasil, Palestra de abertura do Congresso.
- DORST, Kees & CROSS, Nigel. [2001] **Creativity in the design process: co-evolution of problem-solution**. Design Studies, Vol. 22, No. 5, pp. 425-437.
- FERRARA, Lucrecia D'Alessio. [2002]. **Design em Espaços**. São Paulo: Rosari.
- FREITAS, Sydney Fernandes de. Et al. [2003] **Perfil da produção intelectual do design**. P&D Design. Rio de Janeiro: Congresso Internacional de Pesquisa e Design.
- GERO, J. S. & MAHER, M. L. [1992]. **Mutation and analogy to support creativity in computer-aided design**, in G. N. Schmitt (ed.), *CAAD Futures '91*, Vieweg, Wiesbaden, pp.261-270.
- GERO, J. S. & MAHER, M. L. (eds) [1993]. **Modeling Creativity and Knowledge-Based Creative Design**, Lawrence Erlbaum, Hillsdale, NJ.
- GONÇALVES, José Ernesto Lima. [2000]. **As empresas são grandes coleções de processos**. São Paulo: ERA – Revista de Administração de Empresas / EAESP / FGV.
- HOLANDA, Aurélio Buarque. [2002] **Dicionário do Aurélio da Língua Portuguesa**. 3ª edição. Editora Positivo.
- ICSID. Internacional Concil of Societies of Industrial Design. [2005]. Disponível em <<http://www.icsid.org/static.php?sivu=3>>. Acesso em setembro, 2006.
- KISTMANN, Virginia Borges. [2002] **Tendências estratégicas e design: O consumidor como nova competência**. **Estudos em Design**, Rio de Janeiro: v. 9, n. 3, out., pág 67-78.
- KIM, S. H. [1990]. **Essence of Creativity**, Oxford University Press, New York.
- KRISHNAN, V. & ULRICH, Karl. [2001]. **Product Development Decisions: A Review of the Literature**.

Management Science INFORMS. Vol. 47, No. 1, January pp. 1–21.

MAGALHÃES, C.. [1997] **Design Estratégico: integração e ação do Design Industrial dentro das empresas.** SENAI/DN-SENAI/CETIQT-CNPq -IBICT - PADCT - TIB.

MOZOTA, Brigitte B [2003]. **Design Management.** Paris: Éditions d'Organisation, cap.1, 335p.

ROZENFELD, H. et. al [2006]. **Gestão de desenvolvimento de produtos.** São Paulo: Saraiva, 2006.

STERNBERG, R. (ed.) [1988]. **The Nature of Creativity,** Cambridge University Press, Cambridge.

WOLF, Brigitte. [1998] **O Design Management como fator de sucesso comercial.** Florianópolis: FIESC/IEL, ABIPTI, Programa Catarinense de Design, SEBRAE, CNPq.

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