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ON PRODUCT LIFE CYCLE CONCEPTS

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Abstract: *The paper approaches a very interesting aspect for academic, engineering and even social field: the meanings of the concepts of product life cycle. There are two denominations including the syntagma "life cycle" used with different senses in literature: product life cycle and product life cycle management that will be presented. The product life cycle seen from different points of view is also discussed: on the one hand, from the point of view of turnover and profit; on the other hand, from the point of view of the field of application. Schemes and considerations about these concepts and meanings are given. Own proposal of a product life cycle scheme in (mechanical) engineering is largely analyzed. Final conclusions comment the paper results.*

Key words: *designer, product life cycle, product life cycle management, product development, mechanical engineering, turnover, profit.*

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1. INTRODUCTION

The products from different field of application have a history of life. Product life cycle is in a simple sense the useful life of the product. There are different interpretations in literature of the significations (contents) of product history or life cycle:

- the possibility to see the economic image of the product during time, in connection with the turnover and profit determined along its use;
- the opportunity to organize the producer activities in connection with the life of product, aspect very important to ensure a main task close to the product utility: the organization profit by the use of the product.

The mentioned points of view of interpretation of the product history leaded to specific concepts including the syntagma "life cycle":

- product life cycle (revealed and simply defined);
- product life cycle management.

From these aspects result the importance of study of the product history events in connection with the product history.

The paper discusses the significations for these denominations in literature:

- the connection with the turnover and profit;
- management of the entire product life cycle.

Also the application of the product history (product life cycle) in different field (engineering, logistics, finance, etc.) is stated. Own considerations bring forward a product life cycle application in (mechanical) engineering that is largely examined. Final conclusions point out the main results of the paper, including own contributions.

The analysis takes into account large considerations from literature about different aspects of life of cycle and product development, for example: Eder, Hubka, Hosendal, 2007 [4]; Lindemann, 2000 [8], Pahl and Beitz, 1996 [10]; Ulrich and Eppinger, 2000 [13], etc.).

2. DEFINITIONS

2.1. Product life cycle

The concept "product life cycle" is defined in different ways. Two variants are examined below.

Variant 1. A first definition (or interpretation) is connected to the economic point of view: the product life cycle contains stages determined by the market in correlation with the turnover or profit brought by product. A very illustrative image from this point of view is given by Kramer (1986) [7] (Fig. 1). The turnover and profit determined by product have a specific variation over time, with a maximum in the stage of saturation of the product market.

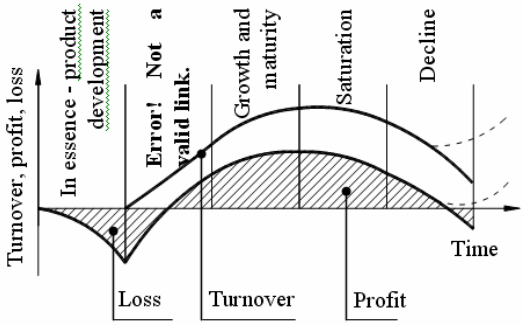

Fig. 1. Life cycle of product (after Kramer, 1986 [7]).

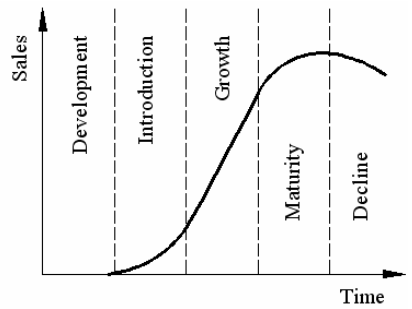

Fig. 2. Life cycle of product (`www.netmba.com/marketing/product/lifecycle/` [9]).

Another image of sales over time is shown in Fig. 2 (www.netmba.com/marketing/product/lifecycle/ [9]). The figure gives the product revenue over time by the sale volume.

Two observations could be noted about these stages:

- the producer have generally the strategy to ensure a longer duration of the saturation phase;
- life cycle stages become shorter over time about some authors, but others declare that this affirmation can not be sustained by specific studies taking into account industry, product category, product technology, or product model level (Bayus, 2003 [1]).

Variant 2. The second definition (or interpretation) of the product life cycle is connected to brand (field, area: engineering, logistics, finance, etc.) or category of product of application. The names of the stages of this second variant could be different from the ones of the first definition. The variant 2 is considered to emphasize stages in developing the product. This variant will be discussed largely for engineering in the chapter 3 of the paper, using a proposed scheme of the product life cycle.

But it is very interesting to see in the sense of the variant 2 the definition aligned to the ISO 9001 requirements [5] given by JLG Industries (one of the many engineering companies elaborating specific methods for optimizing the design) [6]: "The product life cycle process consists of idea, concept, feasibility, design, engineering, pre-production, production, maintenance and termination". This definition is a main need in the JLG corporate policy "to operate at a higher level of efficiency and become more competitive through the implementation and sharing of best practices" (the sentence in quotes is conforming to [2]).

2.2. Product life cycle management

This second concept regards – conforming to the denomination – an important general task: the management of the stages of product life cycle, to maximize the market and revenues by sales in this market [11]). This general task is accomplished by management activities (tools) having specific roles or functions to manage all data covering the product life cycle. Conforming to [12], some of these activities of product life management could be:

- management of design and process documents;
- construction and control of bill of material (product structure) records;
- offers for electronic file repository;
- inclusion of built-in and custom part and document metadata ("attributes");
- identification of materials content for environmental compliance;
- control of multi-user secured access, including "electronic signature";
- export of data for downstream enterprise resource planning systems, etc.

3. APPLICATION OF PRODUCT LIFE CYCLE

3.1. Scheme of product life cycle as application in (mechanical) engineering

Previously it was mentioned that the general scheme of product life cycle stages is applied in different ways in different field of applications. Figure 3 gives a synthetic, but a complete inclusion of the product development stages intervening in product life cycle. The representation was elaborated using different proposals on the life cycle process given by literature (for example: VDI 2221 [14], Pahl and Beitz, 1996 [10], JLG Industries [6], Liendemann, 2000 [6], etc.

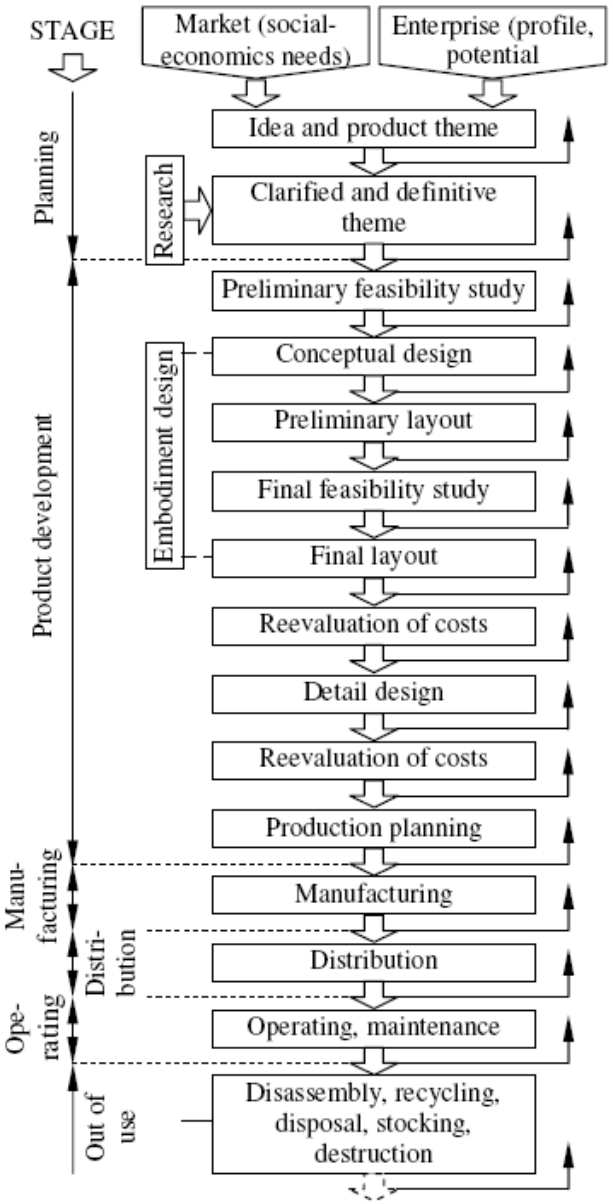

Fig. 3. Life cycle stages valid for (mechanical) engineering (after Dobre, 2003 [3]).

3.2. Discussion

A short discussion about the meaning of the product life cycle conforming to Fig. 1 is given bellow. This discussion is benefit for product engineers (developers) to understand better their tasks in a global activity to create the products.

It might say that that the formulation of product idea and the clarified and definitive product development theme result from:

1. the study of market in the present and even future social and economical requirements on national (and even international) plan, offering databases

regarding the economic development level covering needs of the market with concrete product types;
2. conjugated analysis of the enterprise profile and potential to establish the possible product ideas that might be approached by organization at national (and even international) level, with the resources existing of researches and manufacturing.

The stage of clarifying and definitization of the theme contains:

1. the collection of information about the requirements which have to be accomplished by the product;
2. establishment of the general objectives and possible constraints for the product structure and operating;
3. formulation of the definitive requirement list on this basis.

The imposed constrains in the product development can be functional or of general type. Indifferently of their nature, they are classified from different point of views (Pahl and Beitz, 1996 [10]):

1. operating safety (product reliability, operating safety of components, etc.);
2. ergonomics (the context people-system);
3. technology (kind of technology, technological facilities, the maximum dimensions for the gauged technology, etc.);
4. quality assurance (in any phase of the production process);
5. assembling (during and after manufacturing);
6. transport (inside and outside of the industrial organization);
7. operation (market area, special utilizations – in special conditions, rest states, etc.);
8. maintenance (upkeep, maintenance, inspection, repair);
9. recycling (replacement);
10. costs (limited weight, maximum costs permitted by fabrication, tools costs, investments, liquidation, etc.).

A main stage of the product life cycle follows: the product development. In this stage, the formulation of the product theme could be partially re-contoured doing the feasibility study made especially in the case the products influencing decisively the organization indicators. The pre-feasibility study is followed by the one final carried out normally after the preliminary assembly design. The feasibility study is a complex activity containing:

1. the analysis of the organization potential and strategy;
2. the economic analysis of product and production costs and other economic indicators (as it was mentioned, this study might be more exactly after the preliminary layout design);
3. the financial analysis pointing out the necessary credit for investments and starting the production; this analysis is made by financial specialists using the bank norms required for this credit.

The conceptual design and embodiment design represent basic stages in product development phase.

The conceptual design means the establishment of the product principle solution or solutions (product concept or concepts). It contains (see also Pahl and Beitz, 1996 [10]):

1. the identification of the essential problems which should be considered and analyzed to find the principle solution (practically the establishment of the general function of the product);
2. the proposal of general product functional structure, which represent the successive combination of the basic sub-functions (determining directly the general function) and eventually – if there are – of the auxiliary sub-functions (that not directly influencing the general function);
3. searching the working principles for the accomplishment of the sub-functions. The working principle is a combination of the physical principle or phenomenon (being at the basis of carrying out the sub-function) with geometrical specifications (working surfaces, working motions) and with material. It results thus possible solutions (concept variants);
4. the restriction of the number of concept variants if this is considered too much, that could be done by the preliminary analysis of the accomplishment of a selection criteria set (requirements).

The embodiment design permits the establishment of the so-called preliminary layout, followed by the elaboration of the definitive layout and of detail drawings. The preliminary layout is carried out trough:

1. the elaboration of many preliminary drawings by choice of materials, calculations and shape conception;
2. the choice of the optimal variant by evaluation of preliminary variants on the basis of technical and economical criteria, for the establishment of the optimal solution (principle solution).

The definitive layout supposes the check, refining and optimization of the preliminary layout:

1. the check of possible construction errors and aspects influencing negatively the operation;
2. the optimization and the completion of the shape of pieces by elimination of the weak spots;
3. the elaboration of the final list of components.

The detail design leads to the specification of production and operating. The specific documentation:

1. the detail drawings;
2. the instructions for production and assembly, transport to the operating place as well as for operating.

It is very interesting to mention that the production planning is a stage included in the product development stage, because this offers:

- the possibility to have the entire product documentation to pass to manufacturing stage;
- a main opportunity to solve any mistakes or errors in product development solutions caused by chosen technologies and manufacturing processes.

In this moment the product documentation is elaborated. This documentation will be completed and validated after other product life cycle stages:

1. manufacturing,

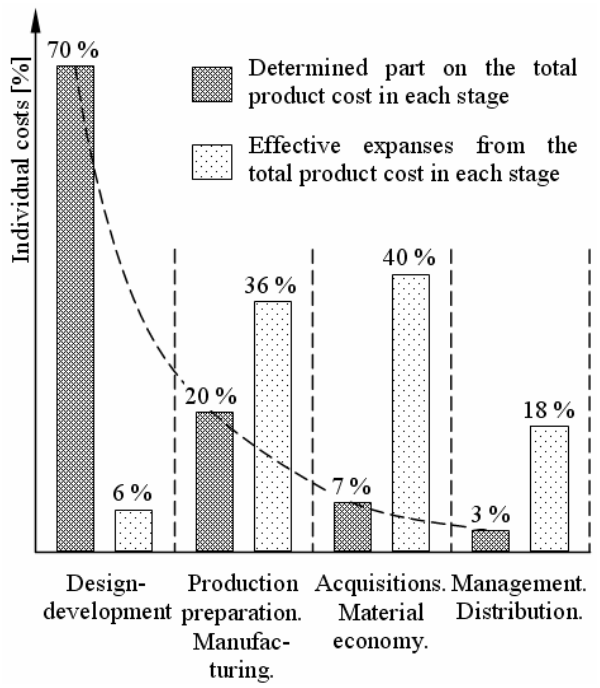

Fig. 4. Determined part and effective expanses from the total costs (about VDI 2225, Blatt 1, 1977 [15]).

2. product operating,
3. out of use (disassembly, recycling, disposal, stocking, destruction).

The product life cycle contains permanently calculations of costs by specific technical and economical analysis, to ensure a profit for producer.

3.3. Decisive role of product development

All phases of the product life cycle participate in a specific percentage to the defining the product value. The scientific research and the industrial reality show that the steps of product development (excepting production planning in the scheme from Fig. 1) determine a decisive weight (of about 70%) from the total product price, in the conditions of low expenses in this stage (of about 6%) from the total product price (Fig. 4).

4. CONCLUSIONS

1. The product life cycle concept could be applied in specific ways for different field of application (engineering, marketing and sales, logistics, finance, etc.). This aspect has to be considered in the creation of products.
2. The product life cycle management is accomplished to manage the company capabilities for maximizing the profitability on market using the developed product.
3. A scheme-proposal of authors offers an application in (mechanical) engineering of the product life cycle.
4. The scheme-proposal promotes a detail discussion about specific stages (principally of product development).
5. The discussion concludes the importance of a better understanding of the life cycle by product engineers (product developers) in the creation of the product.

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