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IMPROVED PRODUCT DEVELOPMENT APPROACH WITH MULTI-CRITERIA ANALYSIS

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Abstract: *The early stages of the new product development process are most often defined as idea generation, idea screening, concept development, and concept testing. These stages represent the development of an idea prior to its taking any physical form. In most industries it is from this point onwards that costs will rise significantly. It is clearly far easier to change a concept than a physical product. The innovative approach has become an important aspect in the design and implementation of the organizational strategy. The multi-criteria (MC) model allows for the systematic planning of successful investments.*

Keywords: *product development, innovation, multi-criteria analysis*

INTRODUCTION

Multi-criteria decision-making or multiple-criteria decision analysis (MC) is a sub-discipline of operations research that considers multiple criteria in decision-making environments especially in field of early stage of product development. Usually are multiple conflicting criteria evaluated in making decisions from general specification of product to special detailed function.

A prime advantage of the improved methodology is the systematic approach, something that leads to the complete continuity throughout the whole investment cycle, even though it is already a primary tool in the early phases of the cycle.

During the application of the methodology, the number of ideas – originally in the form of futuristic projections and innovation potentials and then in detailed product concepts – is constantly being reduced. This reduction in the number of ideas through the so called idea funnel is necessary as the required work content is increasing as the ideas are becoming more and more concrete – there is a reduction in flexibility and agility available per idea.

It can be summarized that the described model of the MC analysis can be a possibility for PD in "fuzzy front end" stage. The MC approach is a powerful tool in terms of perception, resources considerations, and detailing with appropriate data support. What both concepts ("fuzzy front end" and MC) have in common is that they are based on empirical research, especially case studies of sanitary fittings. Hence, even across different companies, industries, and strategies of product and process development, the front end innovation challenges and threats seem to be very similar.

The purpose of the future analysis phase is the identification of innovation potentials and the formulation of specific innovation activities for the company. To start off with, general trends as well as more specific developments within the chosen formation fields are analysed. Following this, the impact these will have on the formation fields and the company in general is projected. Based on this, and taking into account the company potentials, innovation potentials are deduced which will correspond with future market or technology developments. Output from this phase is therefore information regarding the company innovation potential or more specific innovation tasks [1].

Today's computer aided design technology, for example, makes it relatively easy to create three dimensional (3D) models of a part. However, simultaneously translating inarticulate customer tastes into a product concept, or a verbal product description into visual styling designs and numerical specifications remain difficult. Similarly, the timing of problem solving in consecutive stages of development, such as prototyping or tool building, and the number of iterations in the design-build-test cycle may affect the overall lead time and the productivity of the development process [2].

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The main requirement for a methodology used to plan technical innovation can be summarized by the innovation funnel presented in Figure1. The multi-criteria (MC) method used in the methodology is mapped and modified according to this relationship between the concreteness of an idea and the number of ideas. This means that the more concrete the formulation of an idea - depending on the stage within the planning timeframe - the more detailed and specific the relevant methods used become (push for creativity, analysis, evaluation etc.). The MC method is integrated in all stages of the innovation funnel. Figure 1 shows how computer-aided engineering (CAE) can be used. From that point of view a new product can be tested and examined in a virtual environment.

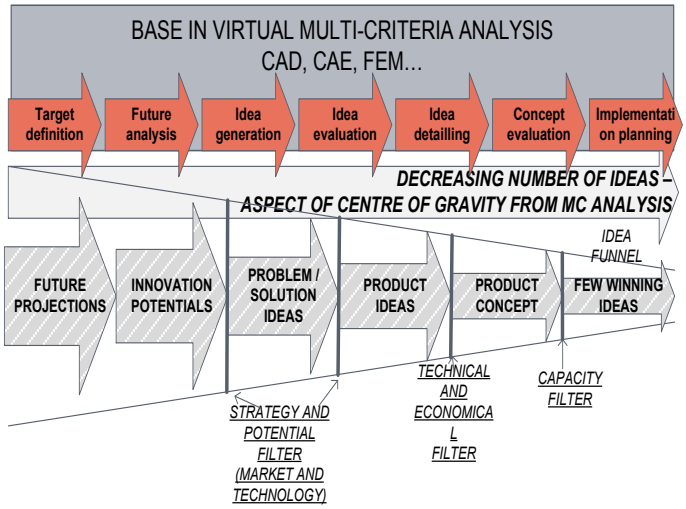

Figure 1 *– Successive choice or elimination of ideas and refining / focussing them and possible CAE use*

In our article we present a unique approach to a product development project in the area of an idea recognition and of investment idea evaluation in the early phase. This model has already been proven on various products and has already been used for the development of potential ideas with software such as CAE. It is the broad usage of computer software to aid in engineering analysis tasks and to build in the MC analysis in that virtual environment.

IMPROVED PRODUCT DEVELOPMENT APPROACH WITH MULTICRITERIAL ANALYSIS

It is useful for firms to regard their projects as living things. A PD is accepted only because the management believes that the combined technologies and market opportunities fit well with each other and with the firm. Concept testing and forecasting does not assure financial success but intended users agree that there is a need for something like the developed concept and want to try it out.

An early look and test of a potential product – prototype will also not assure success, yet it can say whether intended users like what they see. The marketing and developing engineer cannot guarantee success either, but he can assess whether the new item will be brought to the attention of potential new buyers. From the production point of view it is also possible to optimize the shape and material used for the prototype and final product.

In some cases the potential user does not know the purpose of a certain element in a product, in which case the functionality of a product is in a complete domain of engineers and they have to optimize the product though body optimization – for example weight and size. The software solution tested was SC/Tetra – from the CRADLE software which can, with simple operation and hi-speed computation, reduce the development time and costs.

Since the mid-seventies of the 20th century, CAE has advanced within most of mechanical engineered based industries rapidly enough that it is an indispensable part of the PD process. Companies which are using large-scale application of CAE in every phase of PD have an advantage. In fact, the timing of the PD phase has been shrinking continuously since the early nineties, largely due to the trust that the CAE has gained as a dependable tool for engineering decision-making for all major attributes. In comparison to the centuries, in which the maturity of traditional engineering methods can be measured, the CAE has been considered a viable engineering tool for two to three decades. The CAE is an emerging technology and its advantage is in robust engineering solutions.

The confirmation prototype is much more expensive to build and test, compared to the first production model. Obviously, this is the area where the future development in CAE methodology needs high priority. Learning about defects from the confirmation prototypes results in information that is too little too late. [5]

Sequential CAE analyses are needed to converge to the optimized solution with the minimal physical verification. Advantages are in the field of reliability/robustness based on multi-functional design optimization which is one of important tools that support achieving this goal.

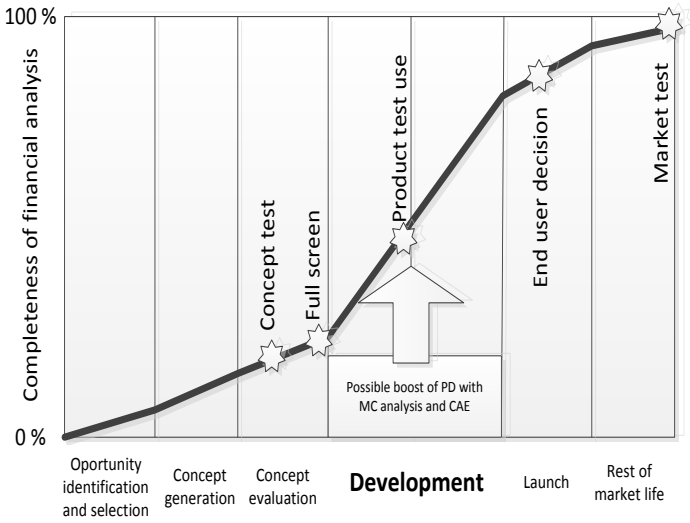

Figure 2 *– Financial analysis as a living thing: the life cycle of assessment [4]*

Figure 2 presents the organic approach with PD in product test use area where additional use of the CAE, such as computational fluid dynamics (CFD), can overlap with the process of product prototyping. CFD is a branch of fluid mechanics that uses numerical methods and algorithms to solve and analyse problems that involve fluid flows.

Computers are used to perform the calculations required to simulate the interaction of liquids and gases with surfaces defined by boundary conditions. With high-speed supercomputers better solutions can be achieved. The on-going research yields software that improves the accuracy and speed of complex simulation scenarios such as transonic or turbulent flows.

A simulation can involve moving and rotating boundaries, also including passive motion by the surrounding flow and it can be used in a variety of turbulence models as well as a variety of analysable fluid multiphase flows and even in cavitations. In the field of free surface flow and in Figure 3 we can analyse aerodynamic noise which can give the engineer the opportunity to shape the body by reducing the air flow.

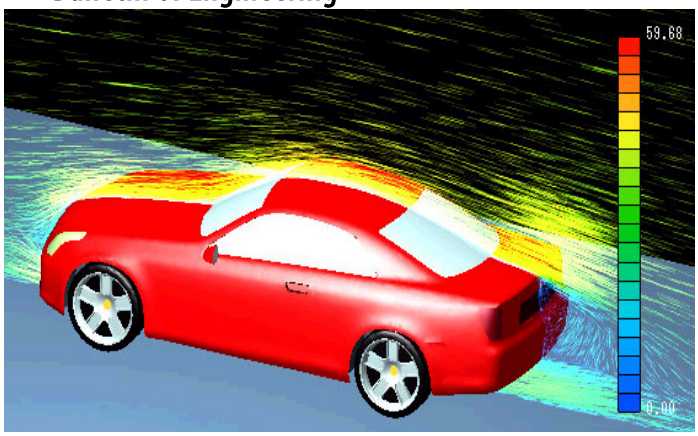

Figure 3 *– Analysis with multi-propose CFD unstructured mesh (SC/Tetra CRADLE)*

Besides strategic goals, for product innovation planning an analysis of the technological potentials is required. Here the enterprise potentials refer to the totality of all company capabilities, in answering requests for problem solutions and reacting quickly to new market requirements as well as to develop and apply new products and commercial success.

The analysis and collection of trends is a continual process used in the early clarification. A trend can be described as the basic direction of either a development or a development bias. The "trend scanning" takes place in different observation areas, which together form the observation field. It represents the global environment of the formation field. In the ideal case, detailed information on developments in single observation areas already exists in the business so that these can be analysed formation field-specifically.

If the trend-scanning in a business is established, a list of trends from the various observation areas exists, that is reviewed, updated permanently and/or analysed regarding its relevance. In addition to the available trends, the observation areas can be examined formation field-specific. Obviously, a complete analysis of the collection of trends is required.

CONCLUSION

Future product developments can be predicted independently from the current production boundaries. This gives development much more flexibility. Reliable trends for the most important product parameters can be evident from market demands.

The need for CAE engineers to enable the effective application of more efficient CAE methods is escalating. However, competitive pressures and the ever-growing need to keep PD costs within reduced money spend often lead to a reduction in the CAE headcount.

From the perspective of the decision makers within the industry, the continuous growth in the number of CAE engineers is not justified by the number of physical prototypes and tests that have not been realized.

In favour of the CAE is the fact that the reason for this is that while companies have spent generously to maintain a minimum level of required CAE resources, the customer requirements that are satisfied largely with the help of CAE have grown at a faster rate than in previous decades. This is especially true for the field of the automobile industry – the area of safety and relation quality / durability.

Figure 4 presents a simple operation and hi-speed computation to reduce development time and costs on all the managerial fields. All fields are well-balanced between functionality and usability to meet various demands from clients.

In empirical evaluations of projects and publicly provided goods, multi-criteria decision theory seems to be an appropriate policy tool, since it makes it possible to take into account a wide range of assessment criteria (e.g. environmental impact, distributional equity, etc.), and not simply profit maximization, as a private economic agent would do [6].

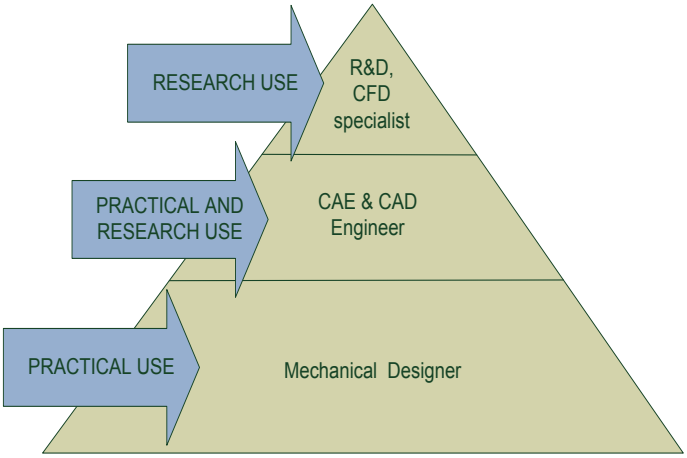

Figure 4 *– Use of CAE / CAD as opportunity for mechanical engineer in PD process*

Life cycles of technologies, products and processes are becoming ever shorter, so technological foresight is a very important aspect of their planning. In a time when foretelling the development of products is difficult and the price of error as steep as it is, the article offers a solution for the development of products through multidimensional analysis. Future products developments can be predicted independent from current production capabilities. This gives much more flexibility. Reliable trends forecasted in MD analysis can be evidential for the most important product parameters hence an idea generation route of product development can be established.

This concept can be applied in the development of mid-range washing machines, which according to mathematical results and in accordance with the time change, move from the direction of unexplored elements to the direction of product design.

In the presented model, the fulfilment of requirements within a company is not viable or technologically possible, capacities are not achieved or that is not in the strategy of the company. A graphic display makes it easier to show the direction of movement of the most important parameters within the company, through a visualization of the problem. Using inputs from the process of generating ideas, analysis by lead users and MC concept selection, the PD team creates a smaller set of high-potential product concepts and with a higher forecast ability set affective product diffusion. [7]

Following their concept the PD team gives the result with great potential. This means linking engineering solutions to customers' needs and vice versa not only on the analytical basis but also on the basis of future trends' mathematical analysis. In this paper we suggest further integration of the possibility introducing CIM methods into the development of new products directly, and by forecasting the trends based on years of experience. This model of developing products by multi-criteria analysis is useful for almost all large-scale products. [1]

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