

Cost Management Integration into a Product Engineering Process:
A Case Study in the Automotive Industry

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1. Introduction

1.1. Competitive Environment

One of the most prominent advances in manufacturing in the last decades was the rise of *Lean Enterprises*.¹ Lean techniques aim at the reduction of wasteful activities within all aspects of the value chain. *Just-In-Time* technique, developed by Toyota, serves as a primary example in this case.² Toyota was the first automotive manufacturer to start eliminating part inventories from its assembly lines. Instead, suppliers had to deliver components shortly before they are installed. Savings could be realized because the need for space and investment decreased. The philosophy behind JIT and other lean activities is not simple cost reduction. Instead, a focus on value-creating aspects is emphasized and all non-value-adding activities are reduced. This philosophy is reflected in the simple yet powerful *Pull* principle, which is one of five central lean cornerstones. Pull principle is the name of a postulate that no component should be delivered to the next manufacturing stage, no product should be created and no other action or service performed until there is a clearly stated and proven need for it.³ That way there is no risk of creating something not immediately needed and maybe never will be used.

Over time, lean methods have spread from shop-floor management to administration, supplier management, distribution and other business processes. Service providers and non-profit organizations started to adopt philosophies from manufacturers in their routine. The positive effects of lean techniques reshaped the way companies were able to compete, first with traditionally managed and then with other lean enterprises. Observations made in this context stand in stark contrast to the *Theory of Competitive Advantage* developed by Porter.⁴ According to this theory, companies have to pursue one of two possible generic strategies to be successful in the long term. A *price leader* is able to offer lower prices than any competitor because of the unmatched cost base. A *differentiator* on the other hand creates additional value for money to a specific set of customers, targeting their individual needs and avoiding competition by doing so in perfection.

Although Porter published his work in the early 1980's, Kato specifically denies its validity in the Japanese automotive industry already for the beginning of the 1970's.⁵ Because of the elimination of waste in production, Japanese automakers were able to reduce costs and offer qualitative products for competitive prices. Careful evaluation of customer demands and continuous pursuit for innovation gave their products unique and valued features. This way, lean enterprises were able to become price leaders and differentiators at the same time.

Cooper/Slagmulder explain the transformation from traditional to lean competition with the help of what they call the *Survival Triplet*.⁶ Business environment is captured based

¹ A wide series of tools and methods, which is used to reduce non-value-adding cost in business processes, is combined under the term *lean philosophy* or *lean management*. Therefore it is out of the scope of this paper to describe these concepts in detail. Only a basic introduction is given. For further information on lean methods and techniques see e.g. Womack/Jones (1996).

² Explanation is based on Monden (1992), pp. 49-63.

³ Womack/Jones (1996), pp. 67-89.

⁴ Porter (1980), pp. 34-46.

⁵ Kato (1993), pp. 36, 37.

⁶ Cooper/Slagmulder (1997), pp. 30-39.

on three dimensions: price/costs, functionality and quality of a product. Assuming an existing long-term correlation between price and costs, a distinction between these dimensions is dropped at the second stage. The customers define minimum accepted functionality and quality as well as a maximum acceptable price. On the other hand, businesses and influencing outside factors define maximum feasible quality, functionality and lowest possible price respectively. Connecting those levels marks the *Survival Zone* of a product.

In traditional competition, a firm can build sustainable advantage by staying in the relatively narrow cost leader survival zone or creating a unique combination of dimensions in the broader differentiator survival zone (*Fig 1a*). Lean enterprises reduce costs while learning and applying new technology faster than traditional mass-producers.⁷ They reshape the survival zone by matching the price of the cost leader and expanding functionality and quality beyond those of differentiators. The survival zone is narrowed down at the same time, because customers demand the same high standards and low prices from all competing products (*Fig. 1b*). Long-term advantages are not possible because fast-learning lean enterprises imitate new technology at a very high pace, urging each other to push the boundaries even further.

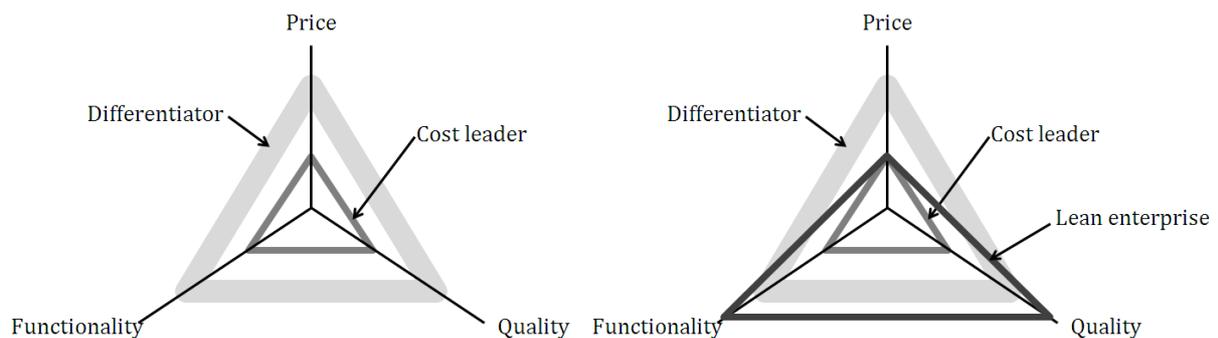


Fig. 1a: Survival triplet of traditional Mass-producers.⁸

Fig. 1b: Survival triplet of lean enterprises.⁸

Major car manufacturers have been engaged in a competition ever since the beginning of mass motorization.⁹ The quality of their products equalized over time, rendering it an invalid selling point.¹⁰ Against this backdrop, low pricing and technological advancement became especially important. Today, connectivity, lightweight materials, alternative powertrains, and other aspects offer a wide range of paths to innovate.¹¹ At the same time, global economic tensions push down prices and cater for volatile markets.

The need for rationalization at automotive *Original Equipment Manufacturers* (OEMs) has also operational consequences on their suppliers. These are also pressured to trim costs and lower margins.¹² At the same time a steady rise in the share of development activities taken over by suppliers is presented in *Fig. 2*. *Fig. 3* additionally shows the growing influence of highly specialized suppliers delivering complete subsystems. These

⁷ Cooper/Chew (1996), p. 90.

⁸ Fig. 1a/b is based on Cooper/Slagmulder (1997), p. 35.

⁹ Holweg (2008), pp. 16-20.

¹⁰ Monden (1995), p. 3.

¹¹ Corwin et al. (2012), pp. 1-3.

¹² Kinkel, Lay (2004), pp. 3,4; Roland Berger (2013), pp. 4,5.

gather concentrated knowledge and OEMs are profiting from their know-how. Consequently, suppliers also become involved in marketing activities. They base their decisions increasingly on their understanding of customer demands and innovate along with future expectations.¹³

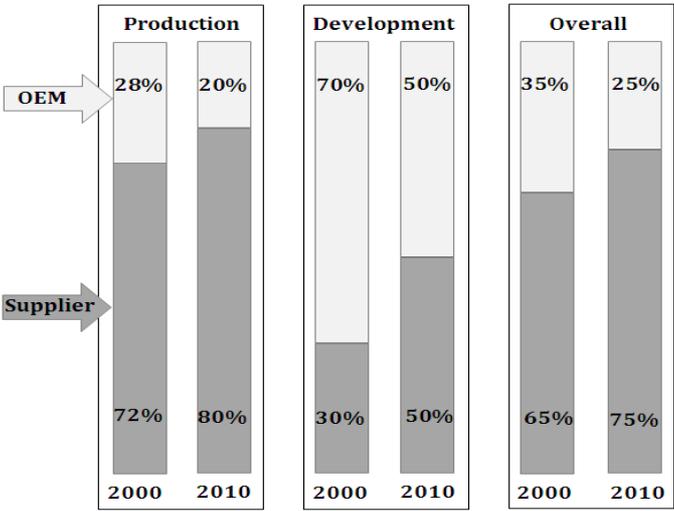


Fig. 2: Supplier Involvement in Automobile Manufacturing.¹⁴

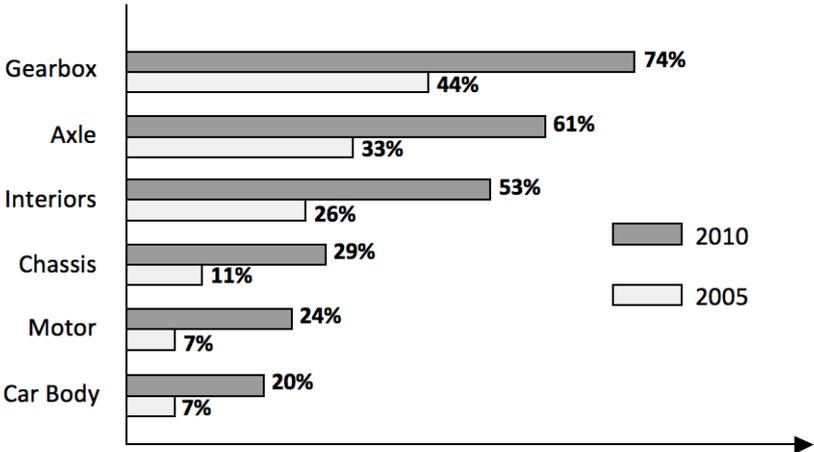


Fig. 3: Specialized System Supplier Development Effort.¹⁵

Binder/Clegg elaborate: "Economic success for the automotive sector, like most others, is generally based upon a mixture of competitive advantages gained from reducing production costs and increasing innovation; which when compared to the competition result in a more attractive value proposition for the end customer."¹⁶ The environment automotive companies are operating in clearly shows the attributes of a lean competition.

¹³ Ansari et al. (2006), p. 22; Corwin et al. (2012), p. 3.
¹⁴ Schulte-Henke (2006), p. 73.
¹⁵ Arthur D. Little (2004).
¹⁶ Binder/Clegg (2010), p. 2.

1.2. Role of Cost Management

To adjust their processes to the rules of the competitive environment, OEMs as well as suppliers need effective cost management methods. These have to balance the outside perspective on markets and at the same time have an inward view on the operation of the business. *Gagne/Discenza* state: "Cost management methods must help with the production of new products which meet customer demands at the lowest cost, as well as with cost reduction of existing products by eliminating waste."¹⁷ Consequently, cost management methods are applied over the entire lifecycle of a product, from planning to disposal.

Various publications mention that, in general, 80 to 95% of costs are designed into the product.¹⁸ In other words, a substantial part of costs is predefined in the first stages of a product lifecycle. The typical cost pattern in a development project is shown in *Fig. 4*. With sophisticated production planning methods in place, cost cutting measures after product launch only have incremental potential.¹⁹ To achieve a substantial effect on cost, a product redesign may be the only possible solution. Often assembly lines have to be rebuilt, customer deliveries deferred or supply chains reworked, as a consequence. The costs incurred through implementation of these measures may outweigh any benefit resulting from the redesign itself.²⁰ 'Upstream' cost management techniques, therefore, promise the most effect, because they are applied in a phase where high impact on product costs can be achieved.

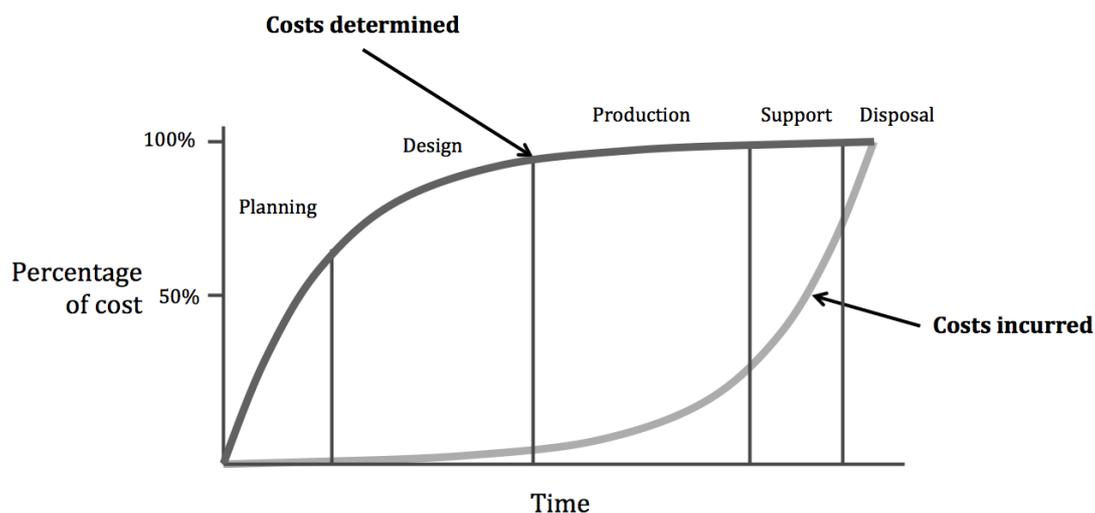


Fig. 4: Usual cost pattern in development projects.²¹

Target Costing is a concept, which integrates customer requirements, technical attributes and cost information within the scope of product development.²² Therefore, it

¹⁷ Gagne/Discenza (1995), p. 16.

¹⁸ Tanaka (1989), p. 49; Kato (1993), p. 35; Cooper/Slagmulder (1997), p. 72; Kaplan/Atkinson (1998), p. 223.

¹⁹ Kato (1993), p. 35.

²⁰ Swenson et al. (2003), p. 13.

²¹ Cooper/Slagmulder (1997), p. 73; Kaplan/Atkinson (1998), p. 224.

²² Cooper/Slagmulder (2003), p. 29; Zengin/Ada (2010), p. 5594.

is suitable to manage competitiveness of new products in the lean survival triplet. As such, it plays a central part in the presented paper.

1.3. Conceptual Approach

Research in this paper is focused on integration of a cost management method in a new product development (NPD) process. Target Costing (TC) was chosen as a suitable research object.²³ This concept itself is described in literature in form of a process. It is also seen as a part of the broader NPD process.²⁴ An integration problem arises. At the same time, ambiguity in the understanding of the term *process integration* is present in literature.²⁵ In this paper, it is defined as a specification of a sub-process within the scope of an overarching process and creation of links with other sub-processes.²⁶

Recent research suggests that the TC process applied in practice varies from its descriptions in literature.²⁷ This paper attempts to close this gap. The objective is to compare the philosophy and specific process steps of TC found in literature with its actual application in industry, understand possible issues related to its implementation in practice through critical assessment, and show possibilities to unify theory and practice.

Research is divided in two sub-objectives. First, a comprehensive literature review is prepared. A unification of methods and best practices described is conducted. Individual tools are described only briefly for better understanding of the underlying techniques, as these are only relevant in a company-specific context. Issues mentioned are collected and generally valid requirements for an effective TC application are derived.

At the second stage, an analysis of a TC process applied in an automotive supplier company is conducted. Commonalities with theory and deviations from it are revealed. Process improvements are proposed and theoretical aspects critically reviewed. A case study approach ensures high relevance of the described methods in practical application.²⁸ Distinct aspects attributed to the environment in the automotive industry play a predominant role in all parts of the work due to the operational background of the research subject. Examples from automotive industry are used where appropriate.

Research on specific concepts of TC has existed for several decades and descriptions of practical implementations have been published. Nevertheless, a closer analysis regularly reveals an absence of specifics. Most publications only capture the concept in its broader sense.²⁹ This can have several reasons. One important of them is surely the mentioned secrecy surrounding product development. Companies may be reluctant to reveal best

²³ Section 1.2, p. 4.

²⁴ E.g. Monden/Hamada (1991), p. 25; Gagne/Discenza (1995), p. 17; Ellram (2006), p. 13.

²⁵ Berente et al. (2009), p. 120.

²⁶ Following the definition by Browning (2002).

²⁷ Evraert et al. (2006), p. 237.

²⁸ On case study research in Operations Management see e.g. McCutcheon/Meredith (1993).

²⁹ Ellram (2006), p. 14 for US literature. The same observation was made by the author during preparation of this paper regarding studies of German or early Japanese publications. Notable exceptions are: Rösler (1998), Schulte-Henke (2007).

practices applied at this stage due to fear of losing competitive advantage.³⁰ Another reason may lie in the nature of scientific method and its strive for generally valid assumptions.³¹ As development processes are often industry or even company-specific, uniform causalities are difficult to formulate.

This paper is aimed predominantly at practitioners, who can use it as an implementation guideline for an advanced cost management system in their own business, learning from the presented lessons. Academic researchers at the same time may receive a possibility to test assumptions and identify areas of research, which may need additional focus.

1.4. Paper Structure

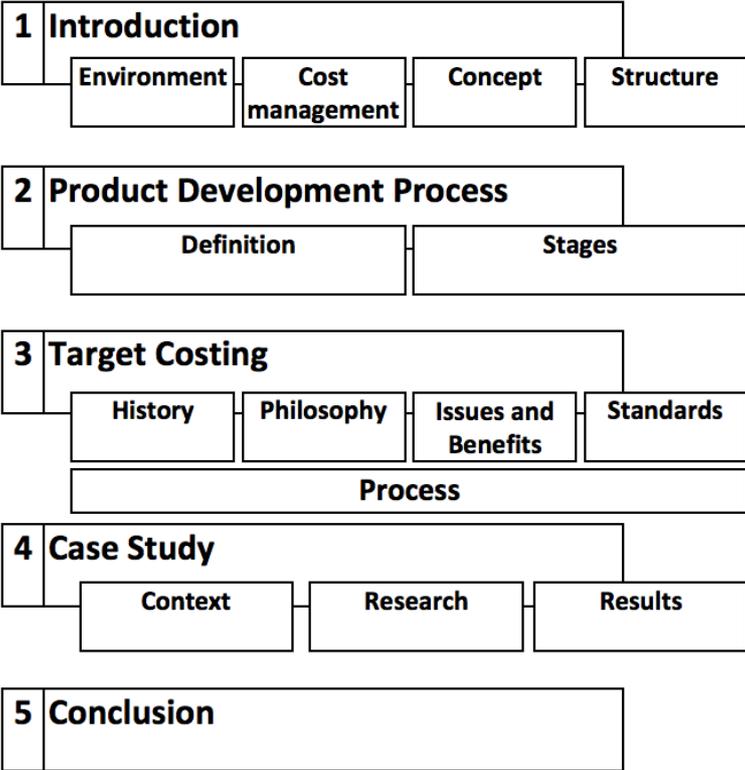


Fig. 5: Paper Structure.

As shown in *Fig. 5*, this paper is divided in five major chapters. The introductory *chapter #1* at the beginning illustrated the relevance of presented research. It is grounded in the introduced major developments within the competitive environment prevailing in the automotive sector.

Chapter #2 is dedicated to the *Product Engineering/Design Process*. An introduction into basic design processes with special attention to the automotive industry is given. Specific actions completed during stages of the process are described. These are used as a reference for further research. It is clearly out of the scope of this paper to illustrate

³⁰ In some works this is cited as a reason why scientific literature on new cost management aspects lags behind their implementation in practice. E.g. Kato (1993), p. 36. This impression was reinforced during the search for interview partners for this study, as most declined or were reluctant to give detailed answers about cost management systems deployed during product design in their corporations.

³¹ Cronbach/Meehl (1955), p. 282.

the variety in industrial engineering processes. Instead, the aim is to provide an introduction into basic concepts of process development. A generic process described in standard literature is used.

Chapter #3 concentrates on Target Costing as a primary relevant cost management tool. A brief historic overview of its development and an assessment of the rationale behind it are followed by an analysis of issues and benefits surrounding the application of TC. From this context and theoretical descriptions a unified view on TC as a concept is attempted. On the basis of this research a TC process is defined and individual steps are introduced and outlined in detail.

To validate theoretical studies some interviews (personal and on telephone) with practitioners were conducted. Open-ended questions were used to capture specific views on TC in different organizations, as suggested by *Ellram*.³² At the same time, the issue of secrecy around actual application of TC in companies was circumvented by 'leading' interview partners into providing more information. Six individuals were convinced to participate in the study. These consisted of three representatives from manufacturing companies and three engineering consultants. All have encountered TC regularly on professional level. Findings gathered during interviews are presented when appropriate.

Chapter #4 describes a case study conducted by the author at an automotive supplier. Insight into the cost management process employed presently within product development is given. A global survey among engineering teams of the enterprise and interviews with selected project managers provide additional information for this purpose. A set of questions regarding the implementation of TC in development processes was sent to all leaders of engineering teams. Managers of new development projects were asked additional questions. Based on collected insights and theoretical research a revision of the cost management practices employed was conducted without providing specifics.

Chapter #5 concludes the paper. Important findings are recapitulated. Limitations and paths for future research are shown.

2. Product Development Process

2.1. Definition

The product development process is an integral part of this paper. A definition is therefore required, which will be used as a reference for further research. In the following section a generic development process is described.³³ Its aim is to represent the majority of processes actually employed in manufacturing industries in principle.

*"Product development is the set of activities beginning with the perception of a market opportunity and ending in the production, sale, and delivery of a product."*³⁴ Following this definition, stated by *Ulrich/Eppinger, New Product Development (NPD)* per se could only

³² Ellram (2006), p. 22.

³³ Following section is generally based on Ulrich/Eppinger (2008), pp. 11-32.

³⁴ Ulrich/Eppinger (2008), p. 2.

development. Historical project data could be analyzed on the basis of the sound cost information and technical solutions employed. There is no database to exhibit such solutions yet. Therefore, project teams have also to rely on their personal experience while projecting costs.

5. Conclusion and Outlook

The primary focus of this paper was an integration of TC into an applied NPD process. Several issues have been identified in the course of this paper, which complicated such an implementation in practice. These issues have been addressed when possible.

An introduction on topics of cost management and industrial development processes was given to create a foundation for further understanding. Subsequently, the TC process published in scientific and practical literature and the rationale behind it were described in a comprehensive manner. Detailed steps of the process have been elaborated.

The created reference process was used to analyze cost management in an NPD process employed at an automotive supplier. It has been established, that the company follows the general trend, which was already noted by *Seidenschwarz*.²³⁷ Good cost management processes and tools have been created in some areas, while others lacked depth, resources and infrastructure. The orientation to customer-related cost management has not infused all areas. The case study reinforced this impression. Some components of TC have been found present and well implemented, others were lacking completely. It cannot be stated that the TC approach predominant in literature has found its way into practice.

A possible explanation of this discrepancy lies in the idealistic view of the process publications regularly state. Businesses on the other hand face a magnitude of difficulties, created by competitors accepting lower margins, own technological and resource constrains, and other factors. It would be impractical to assume they direct their NPD processes only towards customer markets. On the other hand TC with its strict orientation on market reality should be the mainstay of product development. It faces challenges on its own, such as lack of resources, resistance to change, and wrong incentive measures.

Several topics for further research have been identified in the course of this paper and have been excluded from further consideration because of scope and time limitations. Nevertheless, they offer a wide range for explicit focus. One of these topics is the modeling of cost. This concerns especially new technology. On the other hand, the use and distribution of information among development team members and shareholders has to be reviewed.

Another important issue for a successful implementation of TC, which has been only touched here, is organizational structure and culture. The success of cost management depends completely on the will and the ability of the people applying it. Especially *Seidenschwarz* addresses incentive and empowerment systems for the members of

²³⁷ Section 3.3, p. 15.

product design teams.²³⁸ All in all Target Costing gives ample opportunities for further research and remains an interesting topic. As Ansari et al. have established, there are still a lot of steps to go.²³⁹

²³⁸ Seidenschwarz (1995), pp. 123-125.

²³⁹ Ansari et al. (2007), p. 511.