Postponement planning and implementation from CE perspective

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Abstract. Nowadays manufacturing companies are facing the challenge of meeting increasing specific customer needs and even so, to offer short delivery times and low price products. Companies must have flexibility to customize products in a rapid way. A product customization strategy, named "Postponement", has been adopted by a growing number of companies to address the products' differentiation requirements, demanded by the new global market. This paper aims to contrast and compare a proposed postponement strategy definition method with existing postponement approaches found in the literature. The paper reviews various approaches from different authors, to identify how postponement is described in terms of its benefits, implementation barriers, factors that enable or make difficult its practice and the relationship with other theories and techniques. The paper then highlights the contribution given by a proposed method to plan and implement the postponement strategy in a company, using a concurrent engineering perspective.

Keywords. Postponement; Concurrent Engineering; Product customization strategy.

1 Introduction

The markets for mass production low cost standard goods, actually, are a hostile environment and of decreasing profitability. The wide scale production is still a requirement, however a new market characteristic emerges: to customize products according to specific customer needs. The current economic scenario is characterized by uncertainty and high competition level.

As a consequence, companies are facing difficulties to forecast the product demand. For many companies, a bad demand forecast means changes in the schedule of customer orders generating product's reconfiguration down to the assembly line [10]. The high competition level in the market creates a more stringent customer profile, who asks for more customized products, shorter delivery times and lower prices [14]. Then, the following conflict is generated: the

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higher the level of product customization, the higher the probability of reconfiguring the product at the assembly line.

In order to easy this conflict, nothing can be done to change the market characteristics or the customer profile. Thus, the unique way left to reduce the product price and delivery time is to tackle the product customization processes within the company, trying to make it more flexible.

Many companies are adopting a strategy that postpones the product configuration to as late as possible in the production phase [5].

This strategy is named postponement: an operational concept that consists of delaying the product configuration until the actual customer demand is known [23].

Postponement is not a recent concept; there is information about its preliminary practices since 1920's [3]. The concept was originally developed in the marketing literature by Wroe Alderson in 1950 [23] as an approach to reduce risk and costs related to the product differentiation uncertainty. Today it can be identified more than 2500 published papers on this matter, and their number grows rapidly [19]. However, a great part of this literature focuses in high-tech and mass production industries, such as HP and Dell [3].

This paper aims to contrast and compare a proposed postponement strategy definition method with existing postponement approaches found in the literature. Reviewing various approaches from different authors, it is intended to identify how the postponement is described in terms of its benefits, implementation barriers, factors that enable or make difficult its practice and the relationship with other theories and techniques. The paper then highlights the contribution given by a proposed method to plan and implement the postponement strategy in a company, using a concurrent engineering perspective.

2 Existing postponement approaches

This section discusss different postponement approaches, and identify factors that impact their implementation.

2.1 Factors that impairs the postponement implementation

The main challenges observed in the literature that impairs the postponement implementation are: little knowledge about the benefits and associated costs, technology limitation, difficulties to estimate gains and weak alignment among departments in the organisation [21].

Other factors such as inefficient transportation, manufacturing and information technology systems also raise difficulties to postponement implementation [29].

There are no quotations in the literature that refer to the lack of Concurrent Engineering (CE) culture in the company as a factor that turns difficult the postponement implementation. In this paper it is shown that the CE practice is primordial to have success in the postponement strategy implementation, specially when an enterprise develops complex products .

2.2 Types of operational strategies

According Bullock [3], there are two main kinds of postponement referred to in the literature: *form* and *time* postponement.

Form postponement aims at delaying certain stages of the product manufacturing process until a customer order has been received.

Time postponement refers to the situation where the distribution or the actual delivery of a product is delayed until customer demand is known.

Iyer *et al* [10] presented a postponement strategy ,where the customer order is postponed, thus establishing a trade-off between the payment of contractual penalties and operational costs reduction. There are some authors which propose to mix postponement and speculation strategies [23][25].

The present paper proposes to use a different strategy from those just mentioned. It consists of applying CE concepts, to define some manufacturing strategies during the preliminary design phase. Manufacturing and market teams work together to define optional items kits, using analysis tools which cope with uncertainty [2]. Then, the company builds up buffers of these kits that might be applied in the product assembly line to increase the flexibility and agility of the customization process.

2.3 The influence of postponement on industrial costs

Zinn and Bowersox [28] classify the postponement costs as: inventory, process, transportation and cost with lost sales.

One can observe that there is no agreement among the authors about postponement costs. It is also found that higher postponement levels lead to lower inventory holding costs [28], there is also a literature quotation [7] which claims that in some cases, customized components must be on the shelf (stock) to keep the production line flexible and agile.

The transportation costs and the cost with lost sales are not well elaborated, because of the uncertanties shipments size and the unknown balancing between customization levels *versus* product delivery time.

Some authors say that the manufacturing costs increase with postponement implementation because of the new technology requirements [3][12], however this viewpoint is questioned by Waller [28].

. The kind of relationships among postponement and its associated costs can change from one case to another. This evidences that the current formulations for postponement cost are not yet mature.

This paper takes into account a cost-postponement relation that has not been found in the literature so far: the product reconfiguration cost.

2.4 The relationship between postponement with other theories

There are authors that relate postponement to other theories, pointing out cases where one theory can help the other, for example Just in Time (JIT). Some authors say that JIT often results in postponement [28].

Shihua [13] and Yang [30] relate postponement to modular design. Shihua says that through commonality, it can be possible to reduce risk and uncertainties associated with lead-times. This might help to reduce stock in a safe way, improve the wide scale production, simplify the planning task and improve the product development process. However, the commonality brings in higher costs per unit due to excess of performance, greater workload and work-in-process variability [13]. Other consequence of the modular design is that components tend to be weightier, what is extremely bad for aerospace industries.

As can be observed, just few authors relate postponement to product design, and an even lower number mention the importance of Concurrent Engineering as a enabling factor to postponement. When this does happen, usually it is presented in a superficial, ad hoc manner, without practical examples to support it [26][23][3].

This gap in the literature is partially fulfilled by Tseng [4], Du [25] and Jiao [26]. They propose a certain relationship between postponement and concurrent engineering, bringing the customer close to product development, to help the creation of a Product Family Architecture (PFA) that enable the postponement and generates value to customer.

2.5 Benefits

Most authors say that the advantages of postponement are: customer satisfaction improvement, inventory costs reduction and uncertainty reduction of demand forecast [21] [3].

However, there are other authors that, in particular cases, relate postponement to the investment reduction [10], by delaying customer orders when there are unpredicted demands, to avoid production capacity overloads as well as investments in new equipments, as a consequence. Then, they propose the following trade-off: either pay contractual penalties or invest in production capacity. In the next section, it becomes evident yet another benefit brought through the postponement utilization: the product reconfiguration cost reduction.

3 Proposed method

The detailed presentation of the proposed method, including case study applications, is described in previous papers [7][8]. Its main characteristic, is the utilization of CE tools to:

- identify, during the product development phase, the best way and level of postponement that should be adopted in an aerospace company;
- map the relationships among the functional and physical characteristics with the customer needs and, at the same time, assure that the costs comply with the product development limitations;
- determine the best moment to take the main decisions related to postponement during the product development phase.

Figure 1 provides an overview of the referred postponement method:

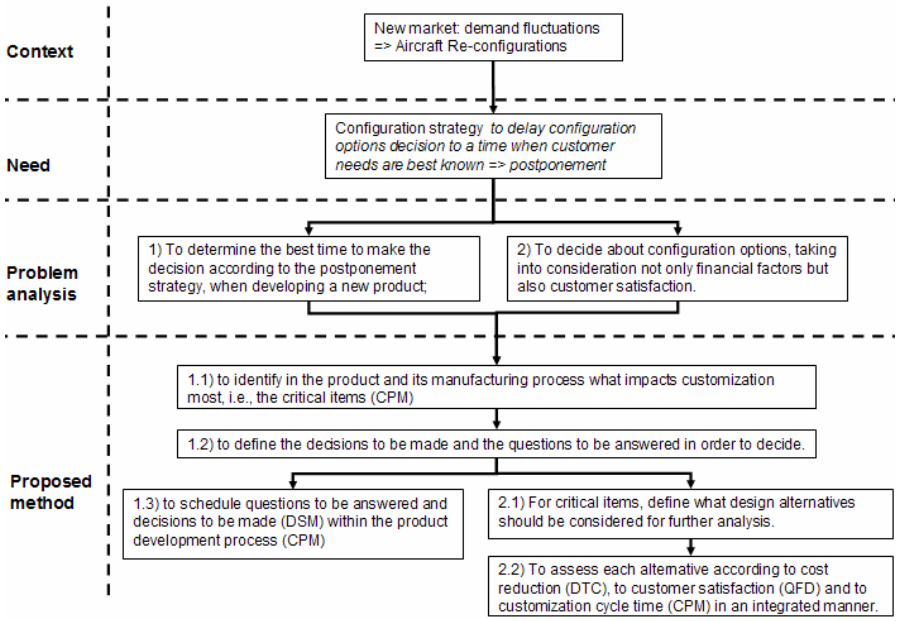

Figure 1. Method overview

The Critical Path Method (CPM) is used to identify the most critical processes to the customization cycle time [6][17][20][24]. Then, through a technical analysis, design alternatives are created for customized product components and manufacturing processes. After that, the Quality Function Deployment (QFD) [11] and Design to Cost (DTC) tools help to determine the best product design and manufacturing alternative according to cost constraints and customer needs. The customer needs are related to the company's engineering and manufacturing requirements through the QFD matrices; they also help to weight the relationship between the requirements and the product's parts and manufacturing processes. The DTC technique, by its turn, is used to compare the target costs with the estimated costs, singling out the product part or process that must be redesigned to meet the target cost. All the CE tools mentioned are combined to perform the postponement strategy definition process. Then, the activities which compose this decision process are classified as questions, decisions and milestones [15], to be scheduled through Design Structure Matrix (DSM) [9][15][18][22], generating the postponement strategy definition process planning.

4 Comparison: proposed method *versus* current methods

Nowadays the literature about postponement keep focus on its utilization in high-tech and mass production industries [3], mainly because these industries have serious problems with inventory costs (risk of obsolescence and great product volumes).

This paper proposes to study postponement in an aerospace company, where the production rate is not so high, but other characteristics as high value added per unit, long production lead-times and high product customization justify the postponement utilization.

Basically, the current work consider as main benefits of the postponement utilization the inventory costs reduction, demand forecast uncertainty reduction and even investments reductions. In this paper, is proposed the postponement strategy utilization to provide a new kind of benefit, the product reconfiguration cost reduction.

Literature provides various postponement operational strategies to reach these benefits, as form, time, logistic as well as customer order postponement. But there is not a model to define the best postponement strategy from a CE viewpoint.

This is the main goal of the method proposed herein, that, based on CE tools, such as QFD, DTC and DSM, defines the best postponement strategy that should be adopted by an aerospace company, which complies with customer needs and product development cost constraints.

There are some shy attempts in the literature that relate postponement feasibility to product design concepts. Just few authors establish a direct relationship between postponement and Concurrent Engineering [4],[25],[26], They developed methods that use CE approaches to create product family architectures according customer perspectives, enabling to assess the impacts on the customer needs by the process and product changes. However their methods are but simple and can be applied only for simple products, like a power supply.

Thus, the literature lacks of a method to evaluate the feasibility of postponement implementation for complex products from the CE perspective. This is fulfilled by the proposed method.

5 Conclusions

After comparing the proposed postponement strategy definition method with existing postponement approaches found in the literature, it can be formulated its main contribution: it helps to define the best postponement strategy that should be adopted to develop a complex product, from a CE perspective.

There were found some works which propose product customization strategies aligned with customer needs, but due to their non-pragmatic approach, they can not be used for complex products. The main contribution of this paper is to provide a method, based on CE concepts and supported by tools as QFD, DTC, DSM and CPM, to create systematic links from customers needs to product functional

requirements and product physical characteristics, and at the same time, assuring that the costs comply with the product development constraints, to determine the best postponement level. The method also assures that any change in the functional or physical characteristics in the product or its manufacturing process will be evaluated according to the customer needs, product development costs limitations and postponement level.

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