Available online at www.sciencedirect.com

ScienceDirect

Procedia CIRP 52 (2016) 74 – 79

www.elsevier.com/locate/procedia

Changeable, Agile, Reconfigurable & Virtual Production

Impact of Product Platform and Market Demand on Manufacturing System Performance and Production Cost

Sufian K. Aljorephani[a,*], Hoda A. ElMaraghy[a]

[a] *Intelligent Manufacturing Systems (IMS) Center, University of Windsor, 401 Sunset Avenue, Windsor, Ontario, Canada N9B 3P4*

* Corresponding author. *E-mail address:* aljorep@uwindsor.ca

Abstract

Due to the rapid change in customer demands and needs, manufacturers are increasingly shifting from mass productions to mass customizations. Product platform strategy, which is one of the enablers of mass customizations, has been implemented by many companies in order to offer a wide range of products that belong to a family. Recently, a new platform approach was developed where an optimal platform is formed for a product family and is customized for different variants by adding, removing, and/ or substituting platform components to form product variants as orders are received. In this paper, the effect of product platform design and customers' demand on the production cost is investigated using Discrete-Event Simulation (FlexSim). The product platform and the product platform scalability concepts are examined and compared. The findings of this research demonstrate that effective platform implementation has a direct effect on the overall production costs as well as improving customer satisfactions by offering the desired level of customized products.

Peer-review under responsibility of the scientific committee of the Changeable, Agile, Reconfigurable & Virtual Production Conference 2016

Keywords: mass customization; product platforms; product family; product platform scalability; production costs.

1. Introduction

Over the years, trends in customer demands have changed significantly in terms of what people desire and what the market offers them. There is an increasing trend of customers demanding similar products but with diversified features and fluctuating demands, which has necessitated the need to develop numerous concepts for the enhancement of mass customization applications [1]. Therefore, rather than mass producing goods, manufacturers have turned to adopting mass customizations.

The current manufacturing industry is competitive and requires the players to ensure that products are introduced to the market at a relatively low cost and with a short lead time. This is facilitated by the producers consistently seeking innovative means of reducing the cost of production while simultaneously ensuring that customers are offered attractive goods [2].

Consequently, this has resulted in an increase in the variety of products with associated diverse challenges since the production cost tends to always be proportional to the number of available models. The product platform approach offers an advantage in coming up with diverse variants that belong to families while maintaining economies of scale and scope, and increasing manufacturing responsiveness and flexibility [3]. A product variant can be formed by adding, removing, and/or substituting one or more component to / from the platform to satisfy targeted market segments.

A discrete-event simulation model was developed and used to investigate the effect of customers demand on the production cost for different product platform designs, namely static pre-designed product family platforms and customizable platform based on demands for each variants.

2. Literature Review

Meyer & Lehnerd defined the platform as "a set of common components, modules, or parts from which a stream of derivative products can be efficiently developed and launched" [4]. Also, Robertson and Ulrich introduced a comprehensive

Peer-review under responsibility of the scientific committee of the Changeable, Agile, Reconfigurable & Virtual Production Conference 2016
doi:10.1016/j.procir.2016.07.068

definition of the platform as the collection of assets such as components, processes, knowledge, people and relationship, shared by a number of products [5].

Researchers have been discussing the product platform formation concepts over the years, mainly: (a) qualitative approach based on individual cases and (b) quantitative approach based on mathematical or simulation techniques [6] and several related strategies found in the literature on how to efficiently and effectively use platforms to form product families including:

- The development of commonality matrices [7]
- The utilization of model-based approaches for determining suitable product platforms [8]
- Suitable optimization approaches such as design optimization etc. [9]
- Other diverse mathematical and analytical approaches for using platform to form product families [10]

The above approaches intended to either identify or optimize the group of common components that form the product platform. The application of a platform in mass customization is essential in the development of diverse variants with significant cost savings from a unified platform [11]. Products that rely on a platform architecture facilitate easy variation without necessarily redesigning the whole product [13]. This is because the platform is the starting point for the addition or removal of components in a bid to increase the base product's variety, performance, and/or features [14].

Moreover, in an environment where demands tend to vary, the utilization of a platform allows storage of inventory based on semi-finished products with minimal final assembly time [12] which improves response to customers and inventory management while simultaneously minimizing holding costs and shortages [15].

The formulation of a product platform is based on the determination of a defined group of shared features across a given product family [1]. The common core components are produced using mass assembly lines and additional product variants are produced by addition, removal, and/or substitution of components to the current platform with postponed differentiation [1]. Ben-Arieh et al. [2] proposed the disassembly and assembly of components for the formation and customization of product platforms [2].

Due to the advantages deduced in this literature, there are many manufacturers that have adopted product platform strategy to enhance their overall product variety level and maintain economy of scale. [12]. Volkswagen has utilized the product platform strategy to reduce production and development costs [16]. Black and Decker have incorporated this strategy to their diverse power tool products manufacturing [4]. Sony has also utilized it in its overall product development process [17].

3. Impact of Product Platform Design and Customer Demand on Production Cost

3.1. Product Platform Concept:

The product platform is the core components shared by all variants in the product family. This approach has enabled companies to develop a series of product variants by adding, removing, and/or substituting parts or modules which reduces the manufacturing complexities, hence, improving the efficiency of the system and reducing the overall cost of production. Figure 1, represents a typical single product platform assembly line of a product family. By increasing commonality of the platform components, manufacturer can produce a wide range of products at a lower cost.

3.2. Product Platform Scalability:

The product platform scalability is an optimized version of the product platform concept, where customer demand is considered during the design phase of the product family platform. Platform scalability changes / adapts platform components to match customer demand. The scalability concept could be applied to both single and multiple platforms which are described in subsection 3.2.1 and 3.2.2.

A new product platform formation methodology is proposed to take the demand into account. Consider Figure 1, where three variants are to be produced V1, V2, and V3 with demand of 100, 20, and 10 respectively. It would be more economical, according to relative demand, to base the platform design on the first product variant V1 then customize 30 products by adding, removing and/or substituting V1 components to form V2 and V3 as illustrated in Figure 2. Hence, the differentiation point between product variants is delayed to adapt to variation in demand and to increase manufacturing efficiency.

3.2.1. Single Product Platform Scalability:

Single product platform have been widely researched in the literature and implemented in many manufacturing industries as an important enabler of mass customizations. It allows

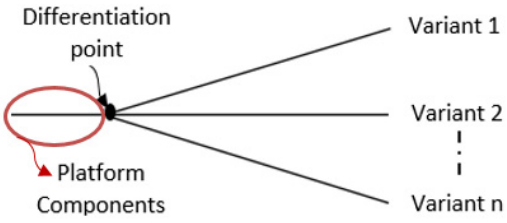

Figure 1: Single Product Platform

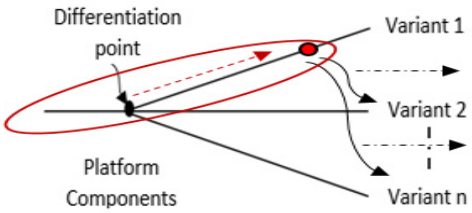

Figure 2: Single Platform Scalability