Technovation xxx (xxxx) xxx–xxx

Contents lists available at ScienceDirect

Technovation

journal homepage: www.elsevier.com/locate/technovation

A conceptual framework for platform-based design of non-assembled products

Thomas Lager

University Mohammed VI Polytechnique, Benguerir, Morocco

ARTICLE INFO

Keywords:
Product innovation
Production platform philosophy
Platform-based design
Production platforms
Process industries
Non-assembled products
QFD

ABSTRACT

In this study, the use of platform-based product family design of assembled products has been reconceptualised into a framework of platform-based design of non-assembled products for the process industries. As a point of departure, platform-based design is defined as shared logic in a company's activities, and a "function-based" leveraging strategy is employed to identify non-assembled products with similar characteristics and commonalities among product families, related production processes and raw materials. It is proposed that a production platform philosophy and platform-based design of non-assembled products should rely on *Product platforms*, *Process platforms* and *Raw-material platforms* that are well-integrated into common *Production platforms*, in an end-to-end perspective. However, platform-based design of non-assembled products may differ depending on whether company production relies solely on a captive raw material base or on purchased raw materials on the open market, or on both. The congruence of the development of *Production platforms* with the QFD methodology and House of Quality was noted in this study, as well as the simplicity of using the methodology on homogeneous products compared to multi-level hierarchical assembled products. It is argued that the proposed conceptual framework can be used in internal company discussions and reviews whether and how such an approach in product innovation can be a fruitful avenue to explore and adapt.

1. Introduction

The general importance of platform-based product family design in manufacturing industries today is unquestionable (Halman et al., 2003; Robertson and Ulrich, 1998; Jianxin et al., 2007). Sawhney (1998) presents the industrial case, which is also valid for the process-industrial context:

> *…customers are becoming very sophisticated and are thus demanding customized products and services to match individual preferences and tastes. These demand-side pressures are forcing marketers to adopt high-variety strategies. … The key to leveraged high-variety strategies is platform thinking – the process of identifying and exploiting commonalities among a firm's offerings, target markets, and the processes for creating and delivering offerings.*

Today, the platform-based product family design concept is primarily reported and used for the development of assembled products and is generally defined as *"a set of subsystems and interfaces that form a common structure from which a stream of derivate products can be efficiently developed and produced* (Meyer and Lehnerd, 1997). However, is this concept also applicable and of equal importance for use in the process industries?

The cluster of industries generally known as the "process industries" spans multiple industrial sectors and constitutes a substantial part of the entire manufacturing industry. It is generally considered to include petrochemicals and chemicals, food and beverages, mining and metals, mineral and materials, generic pharmaceuticals, pulp and paper, steel and utilities (Lager, 2010). One of the principal differences between companies in the process industries and those in other manufacturing industries is that their inputs and outputs are materials or ingredients rather than components or assembled products (Flapper et al., 2002; Lager et al., 2013). This is probably of significant importance from the perspective of platform-based design of non-assembled products. One can thus initially observe that the previous definition of platform-based design is not fit for non-assembled products, since they are not made up of components and there are consequently no interfaces.

In a review of the platform-based product family design concept, only one study was located in a process-industrial environment. Meyer and Dalal (2002) recognized the significant importance of the close relationship between the product and the production system in this cluster of industries:

> *As process technology gets more complex, available technology choices widen. It becomes even more essential to create robust and flexible product line architecture that links product development and process*

E-mail address: thomas.lager@um6p.ma.

http://dx.doi.org/10.1016/j.technovation.2017.09.002
Received 23 December 2016; Received in revised form 13 August 2017; Accepted 24 September 2017

development.

They further asserted that product development in the process industries is not getting its just deserts in academic publications and that platform-based product innovation also falls into this category (Meyer and Dalal, 2002). One could speculate whether this might be the reason why a platform-based philosophy has not yet been reported on in the process-industrial environment or, alternatively, whether it is because the area has not yet been discovered in the process industries. The scarce reporting of platform-based design in the process industries incentivized a study of how the original concept could be adapted for use in the process-industrial environment.

Moreover, company work processes for platform-based product innovation in general (Muffatto and Roveda, 2000), including the use of facilitating methodologies and tools, have received less attention in academic research. In a review of the use of quality function deployment (QFD) in platform-based product innovation, only two studies were found (Luo et al., 2010; Park et al., 2008). Since platform-based product innovation in the process industries should interface well with the production system and product line architecture (Meyer and Dalal, 2002), the potential use of QFD downstream matrices was of particular interest to investigate. In light of this, the following research questions were outlined:

RQ1 Could "platform based design" be a feasible concept to deploy in process-industrial product innovation?
RQ2 If so, what are the principal structural components in a conceptual framework for "platform-based design" and the development of non-assembled products?
RQ3 Could the QFD product development methodology be of particular interest to use as a facilitating instrument for "platform-based design" in the process industries?

This article is organized as follows. Following this introduction, the research approach is outlined in Section 2. Platform-based product family design of assembled products, the environment for process-industrial product innovation and the use of QFD as a supporting methodology are then reviewed in Section 3 as a frame of reference. In Section 4, the development of a conceptual framework for platform-based design of non-assembled products is presented. In Section 5, the major research findings are discussed and a research outlook is presented; in Section 6, managerial implications. Finally, the study conclusions are presented in Section 7.

2. Research approach and methodological considerations

In his study "Theory Construction as Disciplined Imagination", Weick (1989) gave an interesting perspective on the theorising process and remarked that theorists often write trivial theories because their process of theory construction is hemmed in by methodological strictures that favour validation rather than usefulness; this posture is also supported by Schmenner et al. (2009). When a theory is nascent or intermediate, the following research approach recommended by Edmondson and Mcmanus (2007) guided this study.

> *Before collecting extensive quantitative data, the researcher wants to be confident that the key hypotheses are sensible and likely to be supported. This requires extensive conceptual work to develop the ideas carefully, obtaining considerable feedback from others, and refining the predictions before data collection.*

2.1. Iterative conceptual development with industry professionals

Because innovation management can be considered an applied discipline, it calls for systematic observations so managers can deal with their actual problems, and this may sometimes favour a "grounded theory approach" (Binder and Edwards, 2010). Such a research approach is not solely driven by "gaps in the literature" but also by a need for knowledge in practice as well as theory through a process of "problematizing" (MacCarty et al., 2013). Grounded theory (Glaser and Strauss, 1967) is suitable for identifying patterns in the relationship between actors and their environment by "letting the practitioners speak" (Binder and Edwards, 2010). The practitioners in this study included the author of this article, since he has extensive industrial experience in the process industries, enabling him to input first-hand knowledge of innovation management into this study. The advantages of prior understanding within a study of this kind can be many, as expressed by Markus (1977):

> *The problem is how to get beyond the superficial or the merely salient, becoming empirically literate. You can understand little more than your own evolving mental map allows. A naive, indifferent mental map will translate into global, superficial data and interpretations – and usually into self-induced bias as well. You have to be knowledgeable to collect good information.*

Because of the scarce reporting of the industrial use of platform-based product development in the cluster of process industries, the decision was made to supplement the theoretical development with some exploratory empirical information. Thus, four industry representatives were contacted from the author's network of professionals from the food, mineral, steel and forest industries to assist in the initial crafting of the preliminary ideas into a more coherent conceptual framework (Rindowa, 2008).

The four industry representatives had either long personal working experience as R & D directors or managers or were presently in such a position from a selected sector of the Swedish process industries. They were first asked to give comments and suggest improvements on a draft framework and to give their accounts of personal experiences with platform-based design and the industrial use of this concept in their own sector of the process industries. The industry representatives thus acted as "informants" in line with the research approach (Miles and Huberman, 1994). After the final version of this article was prepared and language checked, it was again sent to the informants to verify their earlier comments.

3. A frame of reference

Frameworks can be defined in various ways. Miles and Huberman (1994 p.18) referred to them as intellectual bins and this "bin of information and references" makes up the intellectual bin for the further development of a conceptual framework for platform-based design of non-assembled products. The literature review of platform-based design was initially intended to capture the use of this philosophy in general as well as to give ideas and suggestions on the development of a conceptual framework for process-industrial use. The process-industrial environment for the production and development of non-assembled products was then reviewed to better elucidate conditions for platform-based design. Next, the QFD product innovation methodology was revisited as a supportive tool in platform-based design, as well as to be used as a structural guiding instrument in the further development of the conceptual framework.

3.1. Platform-based product family design of assembled products – a point of departure and an introduction to the topical area

The necessity for companies in all kinds of manufacturing industries to deploy a "platform philosophy" in product development was well formulated by Jianxin et al. (2007):

> *To compete in the marketplace, manufacturers have been seeking for expansion of their product lines and differentiation of their product offerings with the intuitively-appealing belief that large product variety may*