



# The interface between “product design and engineering” and manufacturing: A review of the literature and empirical evidence

Rob Dekkers<sup>a,\*</sup>, C.M. Chang<sup>b,1</sup>, Jochen Kreutzfeldt<sup>c,2</sup>

<sup>a</sup> UWS Business School, University of the West of Scotland, Paisley PA1 2BE, United Kingdom

<sup>b</sup> State University of New York at Buffalo, Buffalo, NY, USA

<sup>c</sup> University of Applied Sciences Hamburg, Hamburg, Germany

## ARTICLE INFO

### Article history:

Received 20 January 2012

Accepted 25 February 2013

Available online 6 March 2013

### Keywords:

New product development

Order entry points

Product life-cycle management

Outsourcing

Concurrent engineering

Productivity

Supplier involvement

## ABSTRACT

Managing the related but distinct processes of “product design and engineering” and manufacturing in an integrated way poses significant challenges for many industrial enterprises. This study presents a systematic review of the literature focused on the interface between these two areas. The review has identified six core themes based on 49 retrieved papers: (A) Integral Productivity, (B) Order Entry Points and Modularity, (C) Product Life Cycle Management, (D) Sourcing Decisions and Supplier Involvement, (E) Integrated Processes and Coordination, and (F) Enabling through Information and Communication Technology. Five of these themes, A-E, are discussed in the paper, using the retrieved works complemented by additional literature, case evidence from the literature as well as additional cases. A generic reference model is used to support the in-depth review of literature and cases. The study shows that tremendous progress during the past 20 years has been made in approaches for managing the interface by both researchers providing generic concepts and practitioners to overcome obstacles for implementation; at the same the paper also identifies gaps in the literature from both theoretical and practical perspectives. An extensive research agenda is proposed to address the gaps identified. It is argued that across all themes further research on this critical interface needs to consider the degree of novelty in new product development, engineering and manufacturing as mediating factor. However, it is also noted that companies seem to manage this interface effectively despite it being challenging, albeit sometimes very practically and intuitively.

© 2013 Elsevier B.V. All rights reserved.

## 1. Introduction

Our search for a review of the interface between “product design and engineering” and manufacturing not only revealed that the lack of it had already been indicated about two decades ago, but also showed that some literature that should have embraced this interface had not done so to a full extent. Before going into more detail about the interface, we note that the definition used in this text is a more limited interpretation of “engineering” than the traditional Anglo-Saxon interpretation that covers more aspects (e.g. Lannes, 2001). This more limited definition, restricting it to activities related to new product development, guides the paper. To avoid confusion, the term “product design and engineering” is mainly used; at some places

in the text it is referred to as “design and engineering”, and, where appropriate, as “new product development”.

Looking back in academic literature, Riedel and Pawar (1991) highlighted that “product design and engineering” and manufacturing strategy were insufficiently linked in literature. This interface must be seen as starting point for integral management approaches (e.g. Gunasekaran and Yusuf, 2002). In that respect, a question is how far this gap has been closed since then, particularly since these processes and their management are strongly related. One strand of research has looked at methods for new product development and related engineering processes that incorporate manufacturing aspects; for example, Concurrent Engineering (e.g. Abdalla, 1999; Jo et al., 1991), and design methods like Design-for-Assembly and Quality Function Deployment (e.g. Carnevalli and Miguel, 2008). Approaches for multi-project management have also been investigated (e.g. De Maio et al., 1994) as well as product families (e.g. Meyer and Utterback, 1993), albeit the latter mostly from a manufacturing point of view. But none of these writings has addressed the interface from an integral or systematic perspective. Additionally, it might be expected that literature on manufacturing strategy would have

\* Corresponding author. Tel.: +44 141 848 3876.

E-mail addresses: [rob.dekkers@uws.ac.uk](mailto:rob.dekkers@uws.ac.uk) (R. Dekkers), [cmchang@buffalo.edu](mailto:cmchang@buffalo.edu) (C.M. Chang), [jochen.kreutzfeldt@haw-hamburg.de](mailto:jochen.kreutzfeldt@haw-hamburg.de) (J. Kreutzfeldt).

<sup>1</sup> Tel.: +1 716 645 4697.

<sup>2</sup> Tel.: +49 40 42 875 8765.

investigated this link. Surprisingly, the interaction has either been ignored (e.g. Dangayach and Deshmukh, 2001) or mentioned only implicitly (e.g. Banerjee, 2000) in overviews covering manufacturing strategy. Moreover, the few works that address this specific relationship concern only specific issues or specific cases (e.g. Ulrich and Ellison, 2009). These three indications imply that none of these strands of literature has explored in detail the interaction between product design and engineering management and manufacturing management from an integral perspective.

Accordingly, this review represents a first attempt to systematically address the interaction between “product design and engineering” processes and production activities, with a particular emphasis on the implications for the management of the interface. More than two decades after Riedel and Pawar’s assertion that reflected the state-of-the-art at that moment, three questions have guided the review presented in this paper:

1. What are the main themes for the interface between “product design and engineering” and production?
2. To what extent have these themes been explored in the context of related primary processes and as managerial control mechanisms? And how have these improved our understanding towards managing this interface?
3. Which topics concerning the interface have been investigated? And what areas can be identified for further research into the interface between “product design and engineering” management and manufacturing management?

Since the focus of this paper is to investigate the interface between “product design and engineering” and manufacturing, it should be noted that the review only looks into collaboration with suppliers in the context of networked industrial structures to a limited extent; other works already cover this point (e.g. Chen et al., 2008; Dekkers, 2009).

Two paths have been followed for our systematic review of the interface between “product design and engineering” and manufacturing. The first path was a literature review carried out by searching databases. As it turns out (Section 2), only a limited number of works have been found that address themes concerning the link between product design and engineering management and manufacturing management. The second path was to find published case studies that support the critical evaluation of these themes (Flyvbjerg, 2006, p. 203). Where providing more evidence was beneficial, case studies conducted by the authors have been added to present supporting evidence wherever possible. In that spirit, this study combines a literature review with empirical evidence.

The approach adopted makes this paper stand apart from studies that focus more on product design and engineering management itself (e.g. Chang, 2005; Lock, 1993) or the many writings on production or manufacturing management (note that these terms are used interchangeably), for example Caron and Fiore (1995), Hicks et al. (2000) and Little et al. (2000). To that end, the paper starts with a literature review based on selected databases in Section 2; that review leads to themes that are mostly expanded on in the later sections. In Section 3 we complement the outcomes with a generic reference model; this also follows from one of the themes found in the literature review. The other themes in the literature review are then elaborated upon successively in Sections 4–7 where we have attempted to place them in a logical order. A final section concludes, addressing managerial implications and presenting a research agenda for the interface between “product design and engineering” management and manufacturing management.

## 2. Outcomes of initial literature review

To arrive at these implications and to determine an outline for a research agenda, the first step of the study reviews existing literature to address the three questions, informed by the criteria for a systematic approach (Petticrew, 2001; Tranfield et al., 2003). However, it should be noted that the literature about the interface is scattered among a wide variety of outlets. For this reason we used Google Scholar, Science Direct and Scopus using the following Boolean expression:

["new product development" OR "product design" OR "engineering management"] AND ["production management" OR "manufacturing management"].

After selecting relevant publications (exclusively empirical and experimental research), themes have been drawn from the 49 remaining papers in Table 1, following Tranfield et al.’s remark (2003, p. 218) about thematic analysis. All retrieved papers appeared after Riedel and Pawar (1991). These themes have been complemented by additional literature about the interface between “product design and engineering” and manufacturing, which is detailed in the later sections.

As an unexpected outcome, it is possible to infer from the results in Table 1 that the research into this interface is largely confined to just two research methods. The first one concerns survey-based statistical analysis for samples ranging from 48 to 352 responses (e.g. Fynes and De Búrca, 2005). This type of studies reveals that certain factors can co-exist in probability but they do not identify causal relationships (in fact, their analysis might be ignorant to contingencies). This is congruent with remarks that quantitative studies are not applicable to all research questions (Hoskisson et al., 1999, p. 447), tend to lack accuracy (Shah and Corley, 2006, p. 1831) and need to be complemented with inquiries that go into more detail (Hoskisson et al., 1999, p. 447; Shah and Corley, 2006, p. 1831). Hence, the validity of outcomes when using these quantitative research approaches is limited, accounts insufficiently for contingencies or is self-evident. One example of the latter is the work of Antonio et al. (2007, p. 14) when they state that modularity leads to improved reliability of delivery and variant flexibility; were those not the foremost reasons why modular design configurations were introduced? The second dominant type of research method is the singular case study for which a specific approach is developed. Even though some, like Eisenhardt and Graebner (2007), have advocated the use of case studies, if one follows the reasoning by Timpf (1999, p. 131), these might not necessarily lead to sufficient underpinning for abstraction and generalisation. Considering these two extremes of research methods so dominantly present in literature, it is no wonder that Weick (1995, p. 385) declares we are only inching towards theory-building. Therefore, it could be recommended that qualitative modelling applied to multiple cases bridges this gap, a thought we will follow.

Given these two dominant types of research methods in the sample, we have identified six major themes. Please note that the review has served merely as a starting point for the structure of this paper; that is why each reference from Table 1 appears in the more detailed discussions that will follow in Sections 3–7. We arrived at the themes by comparing each paper with the other papers according to topic, outcomes and findings from the critical review (4th and 5th columns of Table 1); the more papers were added, the more distinctive the themes became. This procedure also resulted in relatively little overlap between the themes. Of the six themes, “Enabling through ICT (Information and Communication Technology)” links to the characteristics of the fifth generation in Rothwell’s classification of product development processes (Rothwell, 1994, pp. 12–13) and should be seen as supporting sophisticated innovation management. However, this field is extremely fluid (tools for product design and engineering

Download English Version:

<https://daneshyari.com/en/article/5080480>

Download Persian Version:

<https://daneshyari.com/article/5080480>

[Daneshyari.com](https://daneshyari.com)