Mass Customization and Mass Production: Balancing the Portfolio

Mark W. Hansen & Poul Kyvsgaard Hansen

Author contacts:
Mark W. Hansen, Director of Commerce Customization
LEGO Virtual, LEGO System A/S
Aastvej 1, DK 7190 Billund
Denmark
+45 79506715
m.w.hansen@europe.lego.com

Poul Kyvsgaard Hansen, Associate Professor, Ph.D.
Aalborg University, Center for Industrial Production
Fibigerstraede 16, DK 9220 Aalborg East,
Denmark
+45 96358935
kyvs@iprod.auc.dk
http://iprod.auc.dk/~kyvs

Abstract: To most companies pure Mass Customization is not applicable. On the other hand, to most companies some degree of Mass Customization will be highly valuable from various viewpoints including logistics, production, product development, and marketing. By letting customers try their hand at constructing, developing and building their own, individually customized products companies realize and test realistic future challenges. Consequently, most traditional mass producing companies are facing the challenge of balancing Mass Customization and Mass Production and furthermore, do this in a dynamic perspective. This paper will address this problem based on experiences gained mainly at LEGO Company.
1. Introduction

Mass Customization is not equal to modularization and platforms. However, successful implementation of Mass Customization requires a strong outset in modularization and platform thinking. Whether the main philosophy is Mass Production or Mass Customization the product structure do provide the basis for a systematic effort. Creative and functional products can easily be designed without relations to formal or informal product or production platforms. However, experiences indicate that this will rarely lead to significant commercial success for the company as a whole. Therefore, we believe that some degree of formal existence of platforms and some degree of cross organizational alignment is vital to successful Mass Customization.

Platforms and the extension modular platforms can exist in any part of the company. That is, products, production, processes, technology, markets, supply chain, logistics, etc. The visual and systemic strength combined with the alignment of these platforms are one of the crucial success factors. Each individual company will focus differently and we have based on our experiences from LEGO Company chosen two different viewpoints to be included in this paper. These are:

- A marketing focus including a community building process. This includes the alignment of marketing, product, production, and logistic platforms.
- A product structuring focus. This includes an alignment of product, process and supply chain platforms.

In each case we will illustrate the important questions concerning the balance of Mass Customization and Mass Production focus.

2. Modularization and Platforms

Modularization and platforms in products and services have a significant attention in all kinds of industries. However, though many companies have gained experience there is still a significant confusion about managing the two close related areas. In general, the phenomenon of modularization is not well known. The cause-effect relationships related to modularization and platforms are complex and comprehensive. Though a number of research works have contributed to the study of the phenomena they are still far from clarified.

The idea of product modularization is widely recognized as a major success factor in terms of meeting economic and commercial goals of a product program. Convincing examples can be found in the automobile industry (Baldwin & Clark 2000) and in consumer electronics with Sony, Black and Decker, and Hewlett Packard (Meyer & Lehnerd 1997) as the most outstanding examples.

In many cases the modularization of products is documented or communicated by the product architecture or product platforms. A product can be regarded in both functional and physical terms:
The functional elements of a product are the individual operations and transformations that contribute to the overall performance of a product.

The physical elements of a product are the parts, components, and sub-assemblies which ultimately implement the product’s functions.

Product architecture is defined as the assignment of the functional elements of a product to the physical building block of the product. One of the most important characteristics of a product’s architecture is its modularity. The opposite of a modular architecture is an integral architecture. Hence, modularity is a relative property of product architecture. Products are rarely strictly modular or integral (Ulrich & Eppinger 2000).

Important questions concern if, when, and how the product architecture is made explicit. Often the product architecture emerges informally during the concept development – in sketches, function diagrams, and early prototypes. In many cases the product architecture will emerge but will only be expressed explicitly in fragments.

Some authors argue that both product performance and the majority of effects on the whole supply chain can be determined when the product architecture is designed (Erens & Verhulst 1997). This indicates that the development methods of making product architectures explicit in the early phases of the product development process should have a high priority. Regarding the critical problems of realizing such methods, empirical studies report that the functional aspect of product architectures is generally better understood, studied and documented than the interface aspect.

Several authors refer to the product platform term as a way to document and communicate product architectures. This opens for a platform strategy, which aims at generating product platforms and thereby plans the launch of product families rather than single products. The focus on product platforms originates from the quest for design simplifications in product development in the early 1990's, but it was not until the mid-1990’s that companies in fierce competitive situations were faced with the need to implement a platform strategy. Some of the main benefits gained from a platform strategy include reduced development and manufacturing costs, reduced development time, reduced systemic complexity, better learning across projects, and improved ability to upgrade products (Muffatto 1999).

Organizational barriers or lack of cross organizational understanding are important explanations for the difficulties of managing modularization and platforms initiatives. It is generally recognized that the motivation for modularization and platforms in large has to be sought in other organizational units, for example:

- Product modularity reduces costs in the product life cycle due to the possibilities of economy of scale in production
- Product modularity reduces delivery time due to the possibilities of postponement
- Product modularity enhances speed in the product development process due to the possibilities of distributing the activities and due to the inherent structure supporting the project management
- Product modularity enhances speed in the introduction of new product variants due to the reuse of components and structures
• Product modularity enhances the variety due to the flexibility in configuration of the final product

• Product modularity enhances organizational flexibility due to the ease in communication of the product structure

• Product modularity enhances organizational learning due to the inherent structure for storage of knowledge

• Product modularity reduces risk in product realization process due to the exchangeability of modules

Due to the differences in structure and complexity of both product and supply chain each company need to define or develop their own detailed definition of “platform”. Our empirical experience shows that this company individual platform definition is a highly creative process. Therefore, we will discuss the process of defining platforms and to benefit from this explicitness according to a specific company, LEGO Company.

3. The LEGO Company in short

The history of the LEGO Company begins in 1932 in Billund, Denmark, when Ole Kirk Christiansen started making wooden toys. In the post-war years, many new raw materials were developed. One of these materials was plastic. Ole Kirk Christiansen quickly realized that plastic had great potential. In 1947, he bought the company's first molding machine for injecting plastics. Now the company's product range included both plastic and wooden toys.

In 1949, the LEGO factory introduced the first plastic building bricks under the name "Automatic Binding Bricks" to the Danish market. These bricks had four or eight studs and were hollow. They were the primitive forerunners of the revolutionary LEGO building brick.

From 1950, Ole Kirk Christiansen's son Godtfred Kirk Christiansen was the company's assistant managing director. By this time, the workshop had been replaced by a small factory and the number of employees had risen to 140. Over time, the company has developed a successful business selling LEGO toys to retailers all over Denmark.

In 1954, Godtfred Kirk Christiansen developed the concept further. The LEGO brick became the "LEGO System of Play".

The company's big breakthrough came in 1958, when the new coupling system for the LEGO brick was invented. Tubes were added inside the hollow brick that result in far greater structural stability. This makes the combination possibilities almost infinite. A patent on the new coupling system was applied for and given in the same year.

Ole Kirk Christiansen had the satisfaction of witnessing the invention that crowned his life's work and laid the foundation for the company's future success before he died in 1958. He was replaced as managing director by his son Godtfred Kirk Christiansen.
From 1960, the LEGO Company only produced LEGO bricks. In 1963, Godtfred Kirk Christiansen formulated 10 characteristics for the LEGO Company's play materials. The 10 characteristics are today virtually unchanged and are as follows:

- unlimited play possibilities
- for girls, for boys
- enthusiasm for all ages
- play all year around
- stimulating and absorbing play
- endless hours of play
- imagination, creativity, development
- each new product multiplies the play value
- always topical
- at the forefront for safety and quality.

In 1979, Godtfred Kirk Christiansen became the chairman of the company, with his son Kjeld Kirk Kristiansen taking over as managing director.

By 1995, the year of Godtfred Kirk Christiansen's death, LEGO had achieved world leadership in the production of construction toys. Today LEGO employs around 9,000 people. Production of LEGO products is undertaken at factories in Denmark, Switzerland, the USA, the Czech Republic, China, and Malaysia.

LEGO Company's next milestone comes in 2005 - the year when, according to their strategy, the LEGO brand must be the world's strongest brand among families with children.

4. **Platform at LEGO**

The process of defining and understanding platforms in both products and supply chain at LEGO is an ongoing process. Figure 1 illustrates the current generic platform understanding.
In 1958 when the first essential LEGO bricks were developed there were only two different bricks. The main application being house building quickly raised the need for roof and windows bricks and history brought about numerous needs for additional functionality. Today the variety of LEGO bricks counts in several thousands. What initiated as one building system is today several building systems based on the same basic philosophy. Among the brand names are Bionicle, Clickits, Belville, Mindstorms, 4Juniors, etc.

Following the increase in variety the need for clearly defined platforms has increased and, furthermore, the need for alignment with process and supply chain platforms has increased similarly.

Figure 1 illustrates the different classification related to a specific building system. Within the theoretical solution space for the particular system a main system is defined as the sum of the existing elements. Within the existing element a limited number of elements are identified as platforms elements. Each new launch built partly on the existing platform and the existing elements without the platform. Additionally, a new launch introduce new elements. Some of these can eventually qualify to become platform elements but other elements are feature elements associated with the specific launch, e.g., Harry Potter specific elements.

The identification of platforms elements invites to a number of differentiated supply chain architectures and a number of differentiated process platforms, Fine (1998). The balance and alignment between product, process, and supply chain architecture determine the business success, see figure 2.
The balance of the three perspectives is important in any setup, whether traditional mass production or mass customization. However, when moving towards mass customization the balance becomes even more important. The following two cases will illustrate part of the challenges when the product portfolio moves towards more mass customization.

5. The marketing focus – knowing your customer

The mass customization idea had been puzzling in LEGO Systems in the early 1990’s with small initiatives around the company, but with no real backing or success due to unknown market need and market size. This changed in the late 1990’s with strategic intentions to develop and nurture consumer relationships with LEGO fans and LEGO community groups.

There are several forms of “communities” and definitions. Powazek (2001) in his introduction states “I believe the only relevant context to judge a community is a personnel one. Community is immensely personal. Community can be a major part of an individual’s self image”.

To accomplish the strategic intentions to nurture and develop consumer relationships, dialogue was formed between a number of core toy community enthusiasts already present on the Internet. For example, an enthusiast community, which has significant interests in trains and was very active building and sharing their ideas between their members through the Internet. Customized train concept is an idea to develop the consumer relation.

The concept is to give the consumers the ability to configure their own train based on 4 designs with 80 variations: small train, small train with tender, large train and large train with tender in five colors (blue, green, brown, dark gray and black). With further options to add a 9 volt motor and/or light unit (see figure 3).
The four trains are designed in five colors and are made from a varying combination of seven different modules by use of an Internet configurator. The configurator provides the bill of material for packing and shipping.

This product is based on existing product, process, and supply chain platforms. The variation being mainly in the packaging process and the packaging.

The real challenge lies in the market development. Basically the initiation was driven by identifying an existing community and to communicate with this community. Afterwards new products were being developed or configured for the now well-known community. Today two versions of the once mass customized products are being mass-produced for two large mass markets.

6. The product focus – structuring for mass customization

The Mosaic product is one of LEGO’s first attempts to mass customize products in large scale. The basic idea behind the product is that the customer can have a digital photo transformed to a Mosaic build by 1936 small 1X1 LEGO bricks (see figure 4) on a building plate.

A software – LEGOizer – transforms the digital input to a mosaic. After transformation the mosaic can be adjusted according to brightness and contrast. When the customer accepts the specific design an e-commerce order is downloaded into the production system via an interface server. The final mosaic are broken down to a number of bricks in five colors, white, black, and three scales of gray.

Bricks of the five colors are pre-packed in bags of 100 pieces and these pre-packed bags are packed into a delivery package together with a building plate and various inspiration materials. The package is delivered directly to the customer within two days depending on what delivery service the customer has paid for.

Apart from the e-business setup the LEGO Mosaic product is sold in the LEGO parks.
Figure 4 Transforming and picture to a LEGO Mosaic

From a LEGO viewpoint the product is simple based one existing platform bricks. The efforts already done to optimize the existing product and process platforms do support the optimization of the LEGO Mosaic business process. Production of the bricks are done in very large batches and stocked in a warehouse. The planning of the pre-pack production is initiated by a simple KANBAN system controlling the stock of bags. Pre-packing is done on fully automatic pre-pack lines integrated fully with the mass production products. LEGO Mosaic product requires a high flexibility different from the mass production products only in the final packaging and delivery processes.

The most important challenge lies in designing the interface with the customer and to have this part aligned with the existing platforms in product, process and supply chain.

7. Implications and conclusion

In this paper we have discussed the challenges of balancing the portfolio of mass produced and mass customized products. Though modularization is not the only critical element related hereto it is definitely one of the major features. The existing literature has relevant models to illustrate the comprehensiveness of the challenge – in a technical sense. The work by Charles Fine (1998) provide a strong basis for understanding the technical challenges but when it comes to adding a customer view perspective we need new and better models. Furthermore, it proves difficult to capture the dynamic perspective when the different kinds of technical and customer-oriented platforms are challenged by technological or market changes.
References


Powazek, D., Design for Community, New Riders, 2001