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PLATFORM TEMPLATE

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1 Introduction

Platform is an ambiguous multidisciplinary concept. The philosophy behind is easy to communicate and makes intuitively sense. However, the ease in communication does overshadow the high complexity when the concept is implemented.

The practical industrial platform implementation challenge can be described as being a configuration problem with a high number of variables. These variables are different in nature; they have contradictory influence on the total performance, and, their importance change over time. Overall, the platform implementation challenge has two independent but highly interrelated perspectives: 1) a *structural* perspective that includes the company specific selection and configuration of the particular platform variables to be included, and, 2) a *process* perspective that includes the organizational aspects of the implementation. In this paper we will only include the structural perspective.

The focus of this paper is to establish a first version of a so-called platform template. That is a structured grouping of the different multidisciplinary platform variables that can be included in a company specific platform. In practical usage the platform template can support the configuration of a specific platform effort.

Rather than seeking a uniform definition on platforms we propose to apply the platform template. That is, focusing on a number of distinct dimensions the practical industrial platforms might contain. Thereby, the template serves as a basis for defining and developing industrial platforms.

The related theoretical problem is to associate these variables to the ongoing academic research and thereby facilitate a constructive dialog between academia and industrial practice.

2 Platform Management Challenges

Platform as a management concept is not new. In his reflections upon the setup at Ford Motor Company. Henry Ford made a description of the careful delineation of subsystems inside an automobile and examined new component technologies both inside and outside the company to improve comfort, ease of use, and durability [1]. As stated in the introduction this makes intuitive sense, but due to the high complexity it is extremely challenging to implement platform strategy in an effective and efficient way. The complexity refers to the structural complexity of the platform variables as well as the complexity in the implementing organization and the complexity arising due to dynamic change in technology and markets.

The challenges of managing platforms fits well with the challenges as defined within the area of "general systems theory". Herbert Simon defines complexity as the main problem of handling systems: "Roughly, by a complex system I mean one made up of a large number of parts that interacts in a non-simple way. In such systems the whole is more than the sum of the parts, not in an ultimate, metaphysical sense but in the important pragmatic sense that, given the properties of the parts and the laws of their interaction, it is not a trivial mater to infer the properties of the whole" [2].

When we explore this way of thinking to the best known and the most often cited platform – the A-platform of Volkswagen – we often view the platform as the physical and structural unit including the suspension, rear axel, brakes, engine, gearbox, etc. However, it might be relevant to remember the painted picture of a pipe by the Belgian painter, René Magritte. Magritte named the picture "Cesi n´est pas une pipe" – it is not a pipe it is a model of a pipe!

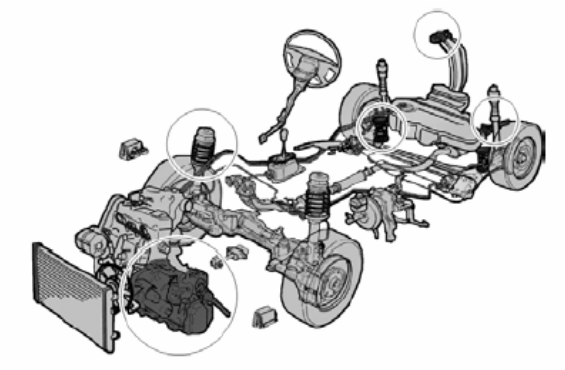

Figure 1. This is not a platform!

The physical representation of the Volkswagen A-platform is not a platform. It is a rather simple visual representation of a number of structural subsystems. Furthermore, we miss the most important issue: the associated supply chain systems or at least their interfaces to the product subsystems. These subsystems and their interfaces are the explanation for the specific physical form, and most important, are the reason why Volkswagen can gain effects in both product development and their supply chains.

The effects are gained in a non-simple interaction between a number of multidisciplinary sub-systems. To select and configure these subsystems and their interaction is, in short, the management challenge of working with platforms.

Due to differences in market dynamics and technologies platforms will be different from company to company. Consequently, there is a need to provide a rich and comprehensive view of platform options to support the company specific work with platforms. We have termed this a platform template.

In our research we have been inspired by similar attempts in quite different areas: strategy formulation and organizational design. Examples of such comprehensive views can be found in Mintzberg et al. *Strategy Safari* [3] and Gareth Morgan's *Images of Organizations* [4].

3 Research Setup

We acknowledge that the theoretical and empirical research have to go in parallel. Due to the lack of theoretical clarification many firms are experimenting with their platform set-up. These experiments are often highly innovative and drive the parallel theoretical research. Our ambition has been to establish a closer relationship between these theoretical and practical activities.

In designing our research set-up we have been inspired by the Extreme Programming methods as applied in software development. Rather than spending a significant amount of resources to generate a fully and comprehensive specification we have identified a meta-structure, termed a platform template. This platform template captures the most important aspects of platforms and serves as a classification structure for the different contributions adding to the knowledge pool.

Our research set-up includes three main types of activities: literature review, case studies in industry, and action research in industry. Between the main types of activities there are a number of mixed types, e.g. conducting workshops in industry. All activities are continuing activities adding to our platform template, as illustrated in Figure 2.

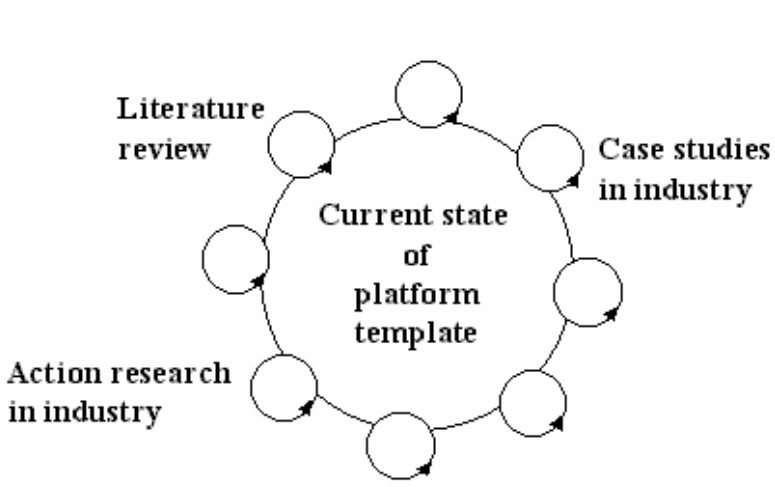

Figure 2. Research setup

Until now we have conducted more than 20 case studies and participated in 4 action research projects (one finished and three on-going). The later typically covers two to four years of close involvement with companies.

One particular action research project has taken place at LEGO Company. Elements of the findings from this study are reported as a case study in this paper.

4 Platform Definition

From a practical viewpoint, platforms reflect common sense of prior experience being rediscovered today by management in various industries. For instance, Cisco describes its

platform as "… the internetworking operation system (IOS), which is based on open Internet communications and networking standards that Cisco did not define alone" [5]. Philips Company, on the other hand, uses the term 'standard design' to denote platform, as the term 'platform' has become overused and thereby lost its power. Furthermore is it also difficult to find descriptions of platform methods applied to non-assembled products [6]. These examples support the notion of platforms and platform management being company specific.

Table 1 lists several generic definitions of platform.

Table 1. Table 1. Definitions of Platform.

Terms	Definition	Author(s)
Platforms	Platforms are components and systems assets shared across a family of products.	Krishnan & Gupta 2001 [7]
Product Platform	A software product platform is both an architecture and an implementation architecture that comprises core subsystems that propel a family of software products or internal corporate applications	Meyer & Seliger 1998 [8]
Product Platform	Product platform is a collection of shared assets (such as components, processes, knowledge, and people and relationships) that are shared by a set of products.	Robertson & Ulrich 1998 [9]
Product Platform	Product platform is a set of subsystems and interfaces that form a common structure from which a stream of derivatives products can be efficiently developed and produced.	Meyer & Lehnerd 1997 [10] Meyer & Dalal 2002 [5]
Product Platform	Product platform is a set of subsystems and interfaces intentionally planned and developed to form a common structure from which a stream of derivative products can be efficiently developed and produced.	Muffatto & Roveda 2000 [11]
Product Platform	Product platform encompasses the design and components shared by a set of products. A robust platform is the heart of a successful product family, serving as the foundation for a series of closely related products.	Meyer & Utterback 1993 [12]

The most widely used definition of product platform is the one provided by Meyer and Lehnerd [10]: "product platform is a set of subsystems and interfaces that form a common structure from which a stream of derivatives products can be efficiently developed and produced." This definition has been extended to provide a focus on shared assets (cf. [7] and [9]). Robertson and Ulrich [9], for instance, define product platform as a collection of shared assets (such as components, processes, knowledge, and people and relationships) that are shared by a set of products.

Muffatto and Roveda [11] identified four concepts that affect product platform strategy: (1) production and logistics processes, (2) development processes; (3) project organizational structure, and (4) knowledge. Various scholars have also linked product platform to the tradeoffs between distinctiveness and commonality (cf. [11], [9], and [13]). Distinctiveness is related to the degree to which a firm is capable of producing products that are differentiable from competitors' products. This is related to the amount of uniqueness that is idiosyncratic to a particular platform. Commonality, on the other hand, deals with the extent to which components or subsystems are shared or reused across platforms in order to create economies

of scale and product variety. Here, standardization of interfaces (be processes or components) become a central issue of concern. The tradeoffs between distinctiveness and commonality are one of the challenges that management face during the platform planning process. As Robertson and Ulrich [9] articulates, "Good platform decisions requires making complex trade-offs in different business areas. Top management should play a strong role in the platform process for three reasons: (1) platform decisions are among the most important a company makes, (2) platform decisions may cut across several product lines or divisional boundaries, and (3) platform decisions frequently require the resolution of cross-functional conflict."

5 Viewpoints of Platform Studies

There are several reasons why firms pursue a product platform strategy. Some of the benefits of product platforms include reduction of fixed costs of developing individual product variants, greater degree of components and subsystems reuse, increased responsiveness, offer higher product variety to customers, reduction of development lead time, and improved customer service. However, implementation of product platform can also be extremely challenging due to coordination problems that may arise due to too much product variety. Customer needs may actually be more difficult to be articulated than expected. The organization itself might exert resistance if the balance between distinctiveness and commonality can not be leveraged to fit the capabilities of the organization.

As explained by Meyer and Dalal [6], platform management is "the integration of the building blocks (the core technologies and processes) with common architectures (the shared subsystems and interfaces), with user requirements aggregated into target market segments towards the end of producing value rich products and systems. Product platform has tremendous implications for a company's product portfolio management, in which set of technologies and products are evaluated in relation to each other [17]. How platform is planned and configured, in terms of technology composition contained in the sub-systems and respective interfaces linking these sub-systems, has significant impact on trade-offs between the degree of standardization and customization of product families and respective end products. The result of that integration should be product families that serve a spectrum of price and performance for one or more market segments." Furthermore, having platform leadership [5] allows a company to drive innovation around a particular platform technology at the broad industry level. Platform leaders, however, face three problems:

1. How to maintain the integrity of the platform (the compatibility with complementary products) in the face of future technological innovation and the independent product strategies of other companies
2. How to let platforms evolve technologically while maintaining compatibility with past complements; and
3. How to maintain platform leadership.

In order to implement a platform strategy, product architecture strategies (which can range from modular to integral) have to be devised. The purpose of devising modular product architecture designs is to create flexibility and changeability [18].

Consequently, the study of platforms is a multi-disciplinary research area.

As described in the introductory part of this paper platforms can be viewed from a structural or a process perspective.

Additional, the engineering perspective emphasizes the product architecture designs in terms of visualization of product structures and associated functionality. This makes modularization and the associated interface problems to a central research focus.

Business perspective, on the other hand, takes a broader view of the company strategies and functional processes, such as marketing, organization, supply chain, etc. In addition to product architectures, this perspective also looks into the notion of knowledge architectures [14], process architectures [15], and supply chain architectures [16].

In order to cope with these multi-disciplinary challenges and in order to facilitate a structured access to updated research results we propose a platform template. In the following we shall present our first version of the product template.

6 Platform Template

Based on the literature review and our on-going research, the following factors are identified as potential elements of a platform template:

- The platform is based on one or more architectures
- It forms a meaningful part of a product or a process
- It includes relevant knowledge at the architectural level
- It serves as a basis for long-term development work
- It serves as a basis for short- and medium-term continuous improvement
- It is based on a partly modular structure (by adopting modular architectures)
- It specifies internal and external interfaces
- It is specific about where to gain effects

In the following we shall elaborate shortly on each element.

6.1 The platform is based on one or more architectures

The notion of architecture seems to be strong at capturing the structure and complexity of a particular system. Traditionally we know the architecture term from product architectures and in particular from building architectures. However, the term and the associated methods apply as well to technology, processes, supply chains, knowledge structures, market structures, etc.

Product architecture is the arrangement of functional elements of a product into several physical building blocks, including the mapping of the functional element to physical components [19]. A product family refers to [13] “a group of related products that share common features, components, and subsystems, and yet satisfy a variety of market niches.” The distinction between “platform” and “architecture” is important when deciding on the focus of analysis and design. In order to implement a platform strategy, product architecture

strategies have to be devised [17]. According to Simon [2], a complex system can be divided into hierarchies (consisting of few less complex stable components, each of these of a few even simpler components, and so on) that can be analyzed into many independent components having relatively many relations among them, so that the behavior of each component depends on the behavior of others. A great number of closed-assembled systems (e.g., automobiles, airplanes, ships, elevators, etc.) are complex systems that can be decomposed into hierarchies (e.g., sub-systems, modules, sub-modules, etc.). All of this can efficiently be captured by architectural methods.

Our empirical studies support that architectures are the revolving concept of platforms. Based upon these studies we propose that the structural definition of platforms and the practical handling of platforms are based on architectures. We propose the following definition:

A platform comprises a number of architectures that are aligned with each other in order to provide the desired balance between commonality and distinctiveness of derivative products.

The critical issue regarding the effectiveness and efficiency of the platform is the strength of the architectures and in particular the alignment between architectures.

The challenge is choose the right architectures and to develop creative ways of communicating them.

6.2 It forms a meaningful part of a product or a process

Platforms are highly strategic and thereby related to the core business of the company. The word “meaningful” refers to the relation to the strategy. What is meaningful in one company might be inferior in another company – or it is simply not defined as the core issue regarding the existing business.

Each company can handle a limited number of platforms and the process of choosing the right number can be considered as a creative process that in the end is very determine about the competitiveness of the company.

The best performing companies all have a special way of interpreting their business opportunities and to systematize this in a form that is possible to communicate and manage.

6.3 It includes relevant knowledge at the architectural level

Platforms do not only include physical structures and rules. The associated knowledge is a part of the platforms. When the platforms rely on highly integrated architectures the knowledge structures tends to be integrated as well. On the other hand, when the platforms rely on modular architectures the knowledge structures tends to be modular as well [20].

In many cases the knowledge structure can limit the strategic possibilities of a company. The company seems to be “captured” in an obsolete knowledge structure and competitors can take advantage of this temporary “blindness”. A number of such cases are reported by Charles Fine [16] and Clayton Christensen [21].

6.4 It serves as a basis for long-term development work

The platforms are informed by the strategy. Since the systemic work with platforms requires additional resources compared to traditional products the effort has to be long-termed in its nature.

There are strong empirical indications that the best performing companies are the ones that can set a long-term agenda by their platforms and develop the ingoing architectures both radically and continuously over long time (depending on particular industry) [22].

6.5 It serves as a basis for short- and medium-term continuous improvement

The competitive advantage has to be gained both from radical and continuous improvements [23]. Successful continuous improvement relies on the involvement of a broader part of the organization [24].

Continuous improvement routines are recognized as contributing to competitive advantage and one important feature is that such routines cannot be simply copied from one context to another; they have to be learned and practiced over a sustained period of time [25]. Thus, for example, the Toyota Production System with its high levels of participation took over 40 years to evolve and become embedded in the culture. [26] Whilst it is easy for Toyota executives to demonstrate this to others, it is not easy to replicate it; the Ford and General Motors needed to go through their own learning processes and come up with their own firm-specific versions of the idea [27].

Routines can begin by the chance recognition of something that worked or as the result of trying a new and different approach. But if they work repeatedly, they gradually get established and eventually formalized into structures and procedures—until finally they are part of the organization's personality.

6.6 It is based on a partly modular structure

Modularity is a crucial part of platform thinking. Even though it has been a part of both the academic and industrial discussion for a long time (cf. the introduction of this paper) there is still no precise understanding of the phenomena.

Gershenson *et al.* [28] note in their literature review that there is no agreement on the definition of modularity. There is some agreement that a "more modular product is one with more modules that are closer to the *ideal* module". But the definition of an ideal module is not agreed upon.

O'Grady [22] defines "hard" and "soft" modules. "Hard" modules are physical modules and "soft" modules have limited physical presence e.g. software, service, financial products, insurance, etc.

Mattson and Magleby divide modularity into three categories: design, manufacturing, and customer modularity [29]. Also Gershenson [28] categorizes modules into the design and manufacturing, as well as the end-of-life modularities.

Another common way of defining a module is a more abstract definition such as that of Otto and Wood [30]: "product modules are defined as integral physical product substructures that have a one-to-one correspondence with a subset of a product's functional model.

Ericsson and Erixon [31] add that in addition to the similarity between the physical and functional architecture of a product, a module should have minimal interaction with other modules or the rest of the system. This strong connectivity within a sub-system and loose connectivity between sub-systems was discussed by Simon [2] quite early. Baldwin and Clark [31] define a module as "a unit whose structural elements are powerfully connected among themselves and relatively weakly connected to elements in other units". Also Suh [32] considers the connectivity of the module to the rest of the system in his definition where a module is a row in his design matrix.

6.7 It specifies internal and external interfaces

At the heart of platform is the organization of modules (or sub-systems) and interfaces making up the product architecture, and the degree of product architecture modularity is dependent on how the components are linked with each other and substitutability of unique components across product families [33].

The internal interfaces of the process chain and the interfaces between the product architecture and process architecture are described through a number of individual industrial cases [20].

The fact that is has been possible to classify products' internal interfaces and not the interfaces related to the implementing organization, is partly an indication of high complexity and partly an indication of the need for companies to address specific tasks related to the platform.

6.8 It is specific about where to gain effects

Finally, it is important to specify where the effects in term of time reductions, cost reductions etc. has to be gained. In this paper we will cope with this dimension only in a qualitative way. This, however, is an acknowledgement of an urgent need to focus on this dimension in future research.

7 Case Study

One of the case companies is LEGO Company. We have been working with the company for three years and will continue for another year. The purpose of the study has been to take part in a platform review and re-design process in an action research process.

Initially, the platforms across the company were identified. The numbers of platforms were large since the idea of platform thinking has been promoted for many years. Due to the modular nature of the LEGO bricks there have been an urge to use this modularity in analogous ways.

However, while the number of different platforms has grown there has been an increasing awareness of the need to redefine the way platforms have been defined and thereby increase the focus and the competitiveness.

The initial study made it clear that the organization in general made no distinction between platforms and architectures. Consequently the first activity was to introduce the notion of architectures and to relate this to platforms. This was done under the following heading:

We must be able to spell
A-R-C-H-I-T-E-C-T-U-R-E
before we can pronounce
PLATFORM

The effort reduced the number of platform from more than 100 to app. 12. At the same time the number of architectures raised to more than 100. These, however, were much sharper defined and the organizational responsibility became much distinct.

To communicate the way of thinking decorated LEGO bricks has been used to illustrate different architectures. In the figure 3 a platform is illustrate as three architectures that are aligned with each other.

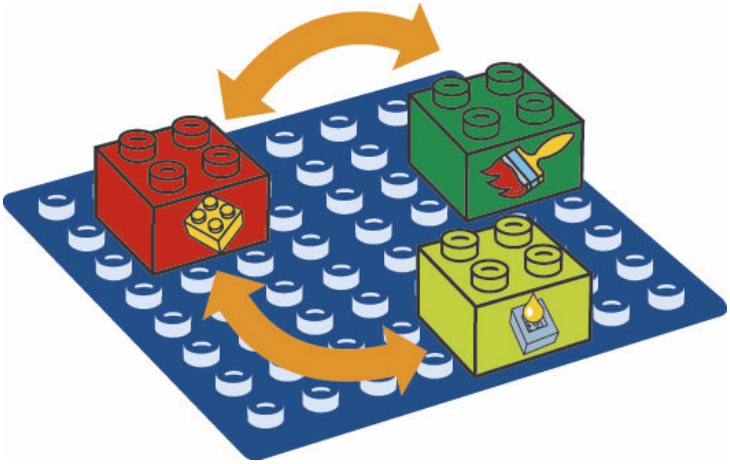

Figure 3 Illustration of a platform at LEGO Company

The 2 by 2 LEGO bricks symbolize different architectures. The following is the internal popular description of the figure:

"A new platform is created when, starting with a building system, we gather all the relevant architectures and align these in relation to each other.
Element architectures, moulding architectures and decoration architectures are examples of architectures that are included in every platform. In the illustration above, the arrows pointing in both directions illustrate that the architectures are aligned.
When aligning architectures the operational task is to become conscious of our possibilities and limitations inherent in our production equipment. The strategic task is to initiate change in and the development of our production equipment to meet the predicted demands of future product launches."

7.1 Implications

The case study above only describes the initial steps of a platform clarification process. According to the platform template this only include the first dimension. This is, however, an

important dimension, that facilitates the communication and defines the agenda for the continuing process. By defining and clarifying the architectures, their structure, and the rules guiding their functionality the development of the challenges of the development of the platforms have been clear.

It has been clear that the platforms are cross-functional. They have to be defined and developed in a cross-organizational setup. At the same time it has been possibly to relate the performance of the platforms to the strategic development. It has been made possible to discuss and initiate a continuous and decentralized development effort.

It has been clear that modularity has to be defined. In a few cases some architectures have been over-modularized and the realization of this has triggered a broader discussion and understanding of modularity.

The process of aligning architectures has sharpened the focus on interfaces and facilitated a broader and more focused discussion.

Finally, it has been made clear that there is an urgent need the come up with new ways of measuring the effects. Traditional economic evaluation methods have proven insufficient.

In general the platform template – as described above – has proven to be a useful guide to point to important focus areas.

8 Conclusion

We have presented the first version of platform template to facilitate the development of company specific platforms. Initial cases have proven that the platform template do support the platform definition process. However, further research is needed, and, furthermore, we need to go deeper into the process of classifying existing research findings according to the template structure. Our intention is to let the literature review go in parallel with further empirical studies.

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