Balancing Commonality and Differentiation: A Case Study of a Development Tool for Enhancing Differentiation of Digitized Products

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Abstract. This paper presents a case study where the balance between product commonality and differentiation in a multi-branded global organization is difficult to attain. In particular, it addresses a software development tool that is intended to achieve differentiation of digitized products with a common architecture. Drawing on innovation management literature, the paper explores problems of realizing the tool's anticipated benefits in a development environment characterized by extensive commonality pressures. The urge for commonality reduces differentiator possibilities even though tools are available to enhance it. I conclude the paper by discussing the balance between differentiation and commonality and what barriers that affect the balance.

Introduction

Differentiation has the intention to enhance variability and add value (Karlsson and Sköld 2007). A product with differentiation possibilities can support individual, regional, cultural and global needs, goals and intentions. The ultimate differentiator adds value without sacrificing efficiency, effectiveness and low cost (Pine II 1993). It is desirable to add, adjust and delete differentiation attributes (Robertson and Ulrich 1998) during the whole development process as well as during usage. This is particularly important for manufacturing companies with long developing cycles. A development cycle of five years is not an uncommon

scenario in the automotive industry. It is therefore important to make adjustments along the way to be able to fulfill the current requirements and needs from the market.

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Common architectures and platforms for product families or brands and its relation to differentiation have been studied from various perspectives (Karlsson and Sköld 2007; Kim and Chhajed 2000; Lundbäck and Karlsson 2005; Martin and Ishii 2002; Sköld and Karlsson 2007; Xuehong et al. 2000). In the automotive industry is it common to use one or few platforms for many models and brands. Examples of this are Toyota Camry and Lexus ES300 or Audi TT, Audi A3, VW Golf, Seat Leon and Skoda Octavia or Volvo S40, Mazda 323 and Ford Focus. They all have common platforms that have been attributed with differentiators to be branded and customized. The focus of that research has mainly been on hardware platforms in conjunction with organizational, technical economical and managerial issues.

Differentiation can be designed into, and communicated via, functions or the HMI (Human Machine Interface) of a product, for example a digital display. Displays and the architecture supporting the display with data are in many products common in multi-branded manufacturing organizations to accomplish economical goals, take full advantage of economies of scale and add flexibility to the products. To be able to take full advantage of what software qualities make possible, development of tools to handle such software efficiently is necessary.

Lundbäck and Karlsson (2005) mention in their paper the possibility to regulate differentiation electrically on common platform. This paper continues on that track looking at how software can be the enabler of differentiation on a common architecture in a traditionally focused hardware manufacturing company. More specifically, an automotive manufacturer has developed a tool for producing HMI software used in a subsystem in a car. The subsystem partly consists of a digital display where the HMI is presented. Hardware commonality in the subsystem is an efficient solution in regards to both cost and development. To use software to enable differentiation was therefore a solution for the manufacturer, therefore was a tool to enable this developed.

Innovation management literature (Karlsson and Sköld 2007; Lundbäck and Karlsson 2005; Sköld and Karlsson 2007), where different managerial aspects on differentiation and commonality aspects are described, together with software product lines literature (Ereño et al. 2006; Pohl and Metzger 2006) form the framework for this paper.

The objective of this paper is to further understand how to achieve a balance between product commonality and differentiation. The research questions are as follows: What are the barriers for realization of differentiation attributes in an environment where the urge for commonality is extensive? Furthermore; What

barriers influence the possibilities to use a tool to its full potential to attain a balance between commonality and differentiation on a digitized product?

The remainder of the paper is structured as follows. The coming section presents previous research relating to commonality and differentiation in relation to architecture and software possibilities. Thereafter are research methodology and the case presented. The paper ends with a discussion on research results and finally conclusions based on the discussion.

Theoretical Background

Exploring counteracting forces of, and the balance between, commonality and differentiation is important since it is the reality for many manufacturing companies of today. The commonality aspect of this case lies not only in the architecture of the product, but also in processes and managerial aspects. To be competitive in the global fast changing market strategies of how families of products should be developed and maintained is important. Architecture and its components, modular or not, is basically the skeleton for any manufactured product and highly influence future opportunities for the manufacturing company. The components included in the architecture can be hardware or software components and they have different qualities in regards to flexibility and differentiation.

Commonality vs. Differentiation

The importance of differentiating products is clear and previous research has confirmed this several times (Aaker 2003; MacMillan and McGrath 1997; Pine II 1993; Robertson and Ulrich 1998). Concerns with product differentiation are cost and development time. If a company has many products with different architecture the differentiation can be realized more easily than with common architecture. But with different architectures the cost is high as well as it demands long development cycles. If, as in this case, the company has many products with common architecture the differentiation possibilities of the architecture is of high importance. When developing multi-branded and synergetic architecture new aspects are introduced compared to other kinds of architecture development (Karlsson and Sköld 2007). Counteracting forces that needs to be managed when multi-branded architecture is developed deals with opposite characteristics connected to commonality and differentiation. In regards to the commonality force, is the force focused on finding a common solution for all brands. The opposite force includes product differentiation that must exist for the different brands. If the differentiation between brands is absent the brands will be cannibalized(Karlsson and Sköld 2007).

The result of implementing differentiation attributes on common architecture can be remaining, and/or improving the market share and keep customers attention (Aaker 2003). It is important for manufacturers of today to remain competitive, by fulfilling customer requirements in regards to branding, customization and personalization in addition to price, since they face an aggressive fast changing global market. Digitalization is a facilitator for fast changes on many products and it enables new possibilities for several players in the global market. To be able to stay competitive is it necessary to continuously develop, adjust and improve the products as well as make them unique in relation to other products in the same segment. This can be accomplished with a flexible common architecture with differentiation attributes that adds value to the end customer.

Contrary to differentiation is commonality, which decreases production cost and reduces the development cycle (Robertson and Ulrich 1998), but also makes the products more indistinguishable from one another. The fact that products are similar to each other due to commonality in architecture and adherent areas can cause a negative revenue effect (Kim and Chhajed 2000). Customers are willing to pay more for the same functionality as long as the products come from the same product segment. It is doubtful that they are willing to pay same price for a low end as for a high end product. If the customer finds out that a low end product or service has the same features as a high end product but for a less price, a high probability for negative revenue appears for the company. Even though commonality reduces cost for the manufacturer in many aspects there is a high risk that it also decreases the perceived image of quality. It is possible to use commonality for different product within same price range. When commonality is used for different price ranged product adversely revenues will appear (Kim and Chhajed 2000).

Software differentiation

As mentioned above, digitalization has opened up new possibilities for new products, solutions and services. Where interaction interfaces before was hardware objects and mechanical solutions, digitalization has taken over an immense part with, for example, digital displays. Another result of digital convergence is differentiation possibilities of graphical interfaces which are vast on digital displays together with its software components. Different software can be developed for the same architecture or common components. A family of related products with common architecture but different software components, or modules, have proven to be an efficient and effective mean to implement a sufficient product variety (Ereño et al. 2006) An example of this is a regular display to a personal computer. Personal computers basically have the same

architecture and components including the display, but infinite number of possible graphical interfaces. This is due to the software application facilitating the graphical interface. Software product lines include methods, tools and techniques for enabling a collection of similar software modules from a shared set of assets. This approach allows for variability and diversity of similar products at low cost with high quality and reduces the development cycle (Pohl and Metzger 2006).

Software is the main enabler of an infinite mass of graphical interfaces on, for example, personal computers as described above. It can be manipulated in late stages of a development cycle and can also be adjusted and manipulated during time of product use. Unlike hardware, software is more adjustable during its lifecycle and can be configured and updated continuously, also when the product is in use at the end-customer. This is an important aspect when the development cycle of a product is long. Another important aspect is that adjustments and adoptions can be done in a late state thanks to software. An issue within the automotive industry is that the hardware and software often is developed in conjunction, which means that they often are adjusted to fit each other's requirement. The automotive industry is traditionally a hardware and mechanical industry where the focus is on physical components. Putting this together result in a development cycle where the hardware is first developed and there after is the software adjusted and adopted to the hardware capabilities. A solution to this obstacle is to separate the longer hardware development cycles from the software development (Simonds 2003).

Software is an enabling technology within the automotive industry. It enables new features, services and functionalities. Hardware is more and more a commodity while software determines the functionality, including graphical interfaces, and consequently becomes the dominant factor (Broy 2006).

Research Methodology

Research setting

The automotive industry is a worldwide manufacturing industry involved in design, development, manufacture, marketing, and sale of motor vehicles. The automotive industries of today include several brands and many of these are incorporated in major multi-branded companies. In the late 20th century a merge of CarCorp into a major automotive multi-branded company, here called Global CarCorp, was complete. To be able to survive the increasingly competitive and aggressive global market the inclusion was necessary.

Over the last years, CarCorp has sold between 80 000 and 120 000 vehicles per year in primarily Europe and the USA. The expectations have been higher which frequently result in tightening up costs and resources. Due to this has, among

other areas, the R&D been re-organized and re-located within the global firm to avoid redundancy. One R&D subdivision located at CarCorps has received global responsibility to develop and improve HMI in the driver environment where infotainment is one part.

Focus on driver environment has evolved during the years much thanks to an awareness of cognitive load and the expansion of the infotainment area. The infotainment area has expanded and evolved immensely in the last couple of years due to digitalization, usage of information and the expanding consumer electronics market. The driver and passengers of a vehicle can today not only be transported from A to B but also receive information and be entertained along the way. Features can include navigation information, news, road condition information, telephone calling, rear seat entertainment (RSE) such as movie watching, karaoke activities and so forth. Due to the fact that features mentioned above are greatly valued by the end-user, has the area of Infotainment become an increasingly important feature in the automotive industry over the years and the importance of how the driver environment and HMI is developed and maintained has increased.

Along with the Infotainment investment goes development of the HMI coupled with the system. HMI is an increasingly important domain in the automotive industry and has a significant role in the development process and is an enabler for differentiation.

A strategy decision has been taken that HMI is core to Global CarCorp and should be handled and controlled within the organization. The in-house development strategy enables continuous development, improvement and implementation within an increasing area of importance. This is beneficial in the aspect of development control, changeability, flexibility, and expectantly cost.

Global CarCorp believes in the possibility to remain competitive over time through continuously developing and refining product differentiation supported by HMI. Since CarCorp aim to develop HMI intended for Global CarCorp, with its range of brands, is it important to be able to differentiate the product.

Research method

This is an interpretive case study (Walsham 1995) where an attempt for an in-depth understanding of problems and possibilities in the areas of differentiation on digitized products are of interest. The interpretive research approach helped to understand human thought and action in the social and organizational context (Klein and Myers 1999) of the tool being used. The research method applied involves a hermeneutic approach where an attempt to understand the situation from the company and its employers point of view is integrated. An effort to use the hermeneutic circle (Gadamer 1975) has been performed to get a better understanding of a complex whole by further investigating its parts and the

relationships in-between the parts (Klein and Myers 1999). The parts in this case include a global multi-branded organization with its employees and its way of managing product development.

Data collection took place during a period of five months and was an iterative process. The iterative process allowed for reflection and further in-depth investigation of areas in focus and further outlines the situation. To be able to get an improved understanding of what difficulties and possibilities the organization is confronted with different ways of collecting data has been applied.

Data sources include meeting notes, semi-structured interviews, workshops and email correspondence. During the first period of the research process attendance to meetings framed the area of concern and the situation was better understood. Five categories; Development methods, Organization, Digital convergence, Differentiation possibilities, Technology and architecture, were evolved after attending project meetings and listening to discussions concerning main areas of interest from the project point of view.

25 semi-structured interviews were thereafter performed on the basis of an interview template. Most respondents were involved in the process of developing, or usage of, the development tool for enhancing differentiation on digitized products. Other respondents have worked with software during a longer period within the company and have an awareness of software that is deficient for many employers at the company. Software, architecture, HMI, ergonomics, design and market are the areas where the respondents have been involved in and worked with within the CarCorp organization. The interview process started with interviewing persons directly involved in the project and thereafter contacting relevant people who indirectly where involved in, or affected by, the project. The period of employment of the respondents varies from 6 months to 13 years. Interviews lasted between 40 minutes to 2 hours.

After completing the interviews the analytical phase started by categorizing statements from the interviews into the five categories. Each statement was thereafter put into one of two timeslots. One slot is the period before CarCorp was fully integrated in Global CarCorp, also called Natural Differentiation under Limited Commonality, and the other slot includes the period when CarCorp and Global CarCorp was fully merged, called Limited Differentiation under Extensive Commonality.

After the categorization of the statements a better understanding of what problems exist in the project and within the organization had increased. The theoretical framework was thereafter established based on prior research within the areas of innovation management and software product lines. Reflection in-between the empirical data and prior research was thereafter performed and is presented later in this paper.

Apart from attending meetings and the semi-structured interviews have also an amount of workshops together with the project team been accomplished. These

workshops have had the attention to present new perspectives of different areas based on prior research, as well as bring in useful terminology not yet introduced to a full extent in the automotive industry. Email correspondence during the five months has also been integrated in the study to further improve the understanding of the case.

Case

The focus of this case is on the dilemma an organizational change can introduce on product differentiation possibilities. More specifically, trying to identify barriers that affect usage of a tool and its potential product. The process and tools used for developing HMI in a flexible and efficient way have changed due to merged organizations. Flexibility is important to car manufacturers in order to handle differentiation requirements, such as adaption to a specific customer segment, region or branding. An efficient development cycle is required to be able to keep up with the fast changing world outside of the automotive setting.

The process included in this paper is divided in two phases and starts in the late 90s. The first phase covers the time before CarCorp organization was completely integrated with its owner, Global CarCorp. The second phase deal with the change from being a more stand alone organization to be merged with Global CarCorp. This phase includes organizational change and new processes were introduced and incorporated.

Phase 1: Natural Differentiation under Limited Commonality

When CarCorps organization was separate from Global CarCorp each developed component, such as radio with its display and buttons, was unique for Carcorp cars compare to other brands. The R&D organization of CarCorp was autonomous and decisions regarding the design and purpose of the HMI were made within the organization. Everyone working with and taking decisions about HMI within CarCorp was located on the same site. The specification and evaluation process of HMI was mainly done on regular office applications by HMI engineers.

> *We made the first concepts in Power Point [...] we did usability test with paper printouts which represented different screens and buttons.*

HMI engineers were employed to create virtual software simulations of HMI to use for decision-making and evaluation purposes, but there was never time or money to do so. The understanding of software development in general was low in the late 90s. An electrical engineer expresses it:

> *In 1998 this company was like a developing country in regards to software.*

Development of HMI was not prioritized and often was the development of HMI the last step in the product development process. As one HMI developer said:

> *We called it "reviewing engineering" and got so frustrated each time. [They told us]" Here are the functions you are suppose to do and here are the buttons you are suppose to use and it looks like this. There you go - do something." It was like working with both hands tied.*

When the HMI specification, made by the HMI engineers within CarCorp, was completed it was sent to the chosen supplier who implemented the HMI and manufactured the system. Due to the tools used and limitation of time some requirements needed to be explained further or added after the specification had been sent to the supplier. Sometimes CarCorp employees went to the supplier to secure that the implementation was correctly done.

> *We had close contact with the supplier and went to them to get things done.*

When the product was manufactured and completed by the supplier it was sent to CarCorp for integration in car. Integration, test and verification were then conducted at CarCorp before released to customer.

Phase 2: Limited Differentiation under Extensive Commonality

When the integration of CarCorp increased in Global CarCorp a strategic decision was taken that HMI should be considered as core competence in the organization. The cost for developing HMI had been an issue, especially with many brands to keep track of and configure. Translations of languages and customization adjustments are expensive procedures and needs to be implemented regularly which mean a lot of updates of small software modules. A way to improve the situation was to take full control of the HMI from the start of development to the end of implementation. An awareness of the importance of HMI as a way to communicate differentiation towards customer was another reason. The decision signifies an organizational and process change for Global CarCorp.

To be able to cope with the new requirements regarding differentiation on common architecture a tool was developed to handle HMI. The purpose of the tool is to achieve flexible and efficient development and implementation of product differentiation, communicated via HMI on digitized products.

The tool was developed to handle not only the different variants of languages included in a system, but also different HMI families of a digitized product. The foundation of the tool is a database where different parameters can be adjusted in an efficient way. New parameters can easily be added to the database.

After the companies merged, development of HMI included both commonality and differentiation features between different brands and models. An organizational change was put into operation where everyone worked across

different brands. People who worked with HMI for one brand in the old organizations were supposed to cooperate with people from other brands and develop several variants for each brand. Some features were also told to be the same across all brands. As one of the developers of the tools said:

I don't work for CarCorp, I work for Global CarCorp. I am supposed to find the common parts, how the functions can be global.

Even though CarCorp had implemented brand unique features when they were a standalone organization, the importance of brand uniqueness was more obvious after the complete integration to Global CarCorp. Now products were developed in conjunction with the other brands within Global CarCorp and the relevance of keeping, and emphasize, brand specific features got more central. At the same time information regarding commonality is communicated to the developers. As much as possible should be common across all brands.

It is a challenge to develop an HMI that will work for different brands for only one function.

The current tool has a purpose of realizing an interface that looks like it is designed for a specific market or language or culture even though there is one common engine.

Global CarCorp want to standardize as much as possible.

The HMI tool can handle an immense amount of variants which is beneficial to Global CarCorp. It is now possible to fast develop interfaces for evaluation or decision making or to make rapid changes and then implementing the outcome directly instead of handing over to a supplier. Before the tool, required changes were always sent to the supplier who implemented them, and that was costly.

Traditionally do suppliers sell the component to a low price and then do the profit on the changes. And these changes often turned out to be simple HMI changes.

[With this tool] we can try out different solutions and develop what is brand unique. If a supplier will make one product for 15 different brands - of course they will fight for each variant, especially when it [the brand issue] was not included when sourcing was done.

The realization of implementing HMI SW in-house, and not handing over a specification to a supplier, required new people in the organization with new assignments. Today a few people at one site within Global CarCorp implements HMI for all brands within Global CarCorp. At another site the specification is developed and at yet other sites the design is decided. Changes and adjustments to the HMI are discussed in global forums within Global CarCorp where consensus is reached before implementation. The discussions can handle what colors to use or what symbols are best suited for a specific purpose. This can of course cause some issues as different engineers explain:

It was difficult when we were only CarCorp and only had to care about ourselves. Now when in Global CarCorp there are so many more tradeoffs and it is very difficult to change ingrained opinions and roles.

It is great fun to work globally but it is not easy to please everyone.

Except for the HMI SW are the majority of components required for the product purchased from same supplier for all brands within Global CarCorp. The commonality within the product architecture and components between the different brands has therefore increased. It is a challenge to be cost efficient and use available resources in an optimal manner for the Global CarCorp. The commonality aspect is important to be able to fulfill set economical goals. Commonality in development processes, tools and purchase of components are factors considered when optimizing the resources available in Global CarCorp.

Discussion

Previous research (Karlsson and Sköld 2007; Lundbäck and Karlsson 2005; Robertson and Ulrich 1998; Sköld and Karlsson 2007) describes important management and strategy issues and its relation to commonality and differentiation. This paper attempts to understand if there are still other issues to consider in regards to this. More specifically, this paper focuses on trying to identify what barriers exist for enhancing differentiation in an environment where the urge for commonality is extensive. In particular, what barriers influence the possibilities to use a tool to its full potential to attain a balance between commonality and differentiation on digitized products? Barriers identified are cognitive, organizational and process barriers. These three will be further explained in the following text.

First, there exist a cognitive barrier to overcome in relation to the tool and development of software. The traditional focus within the automotive industry is hardware and mechanical engineering. This is changing which this paper is proof of. There are new aspects that need to be considered when the awareness of software possibilities increases.

One reason for not using the tool to its full potential can be the unconscious unwillingness of change. There are continuously changes today, for example organizational and process oriented. Not always are the right changes accomplished and for understandable reasons might some people get tired of changes. To yet one more time adjust and comprehend to a new tool might include some resistance, unconscious or not.

Another cognitive barrier can be that the knowledge of the tool is minimal within the organization and therefore cannot be understood or used fully. Even though the people working with the tool have a complete understanding, the surrounding organization and processes connected to development, marketing, design and other parts of the organization don’t. Due to this, suitable processes and organizational changes are not incorporated and executed. It is apparently not enough that an awareness of the importance of differentiation exist and a tool is developed to enhance it. The awareness of what organizational and process changes that is necessary, in combination with the introduction of the tool is

necessary as well. In this case has the implementation of organizational and process changes connected to the tool been delayed which have an effect on how much the tool can be used to its full potential.

Secondly, as mentioned above, organizational barriers exist in relation to the cognitive barrier regarding the awareness and knowledge within the organization. The organization needs to be developed and adjusted in conjunction with the development of the tool just as Sköld and Karlsson describes (2007). Resources with new assignments might be required, while some resources might be superfluous. Also, the urge for organizational commonality have an effect on how the tool can and will be used (Lundbäck and Karlsson 2005).

To get full economical effect out of the tool, organizational adjustments and changes are necessary to consider from the beginning of the development tool. As Lundbäck and Karlsson (2005) point out should more time be spent in the earlier phases of development when there is an extra need for reaching the required common understanding of what is to be done and how. In this case have the tool been developed in remoteness to the organization and the organizational changes are happening after the tool already is in use. This makes it difficult for the developers and other people affected by HMI development. Organizational links between involved sections does not yet exist.

Lastly, process barriers are related to both cognitive and organizational barriers. To be able to use the tool for realizing differentiation, suitable processes are necessary. In this case has focus been on developing a tool for enhancing differentiation. In what process the tool should be incorporated in and what kind of organizational structure is needed has not been considered to a full extent. The tool itself is not a process, only one part of a development process. The tool can make certain things possible, but if there are no processes supporting the tool, what it requires from the organization and supplies into the organization, the full effect out of the tool will fade away.

Traditionally have automotive manufacturers been focused on developing hardware and mechanical solutions. Introducing software into this environment is an immense change in regards to organization and processes, especially in an area that not have been in the center of automotive development – the driver environment. The rate of software growth in cars is proportional to the state of growth especially, in the driver environment where consumer electronics drive evolution. Engineering of software in combination with organization and processes is in its infancy the automotive industry.

As other manufacturers, has Global CarCorp goals concerning flexibility, economy of scale, cost efficiency and reduction of development time. Executions of organizational merge and unite processes within the global organization, together with finding a commonality strategy, such as common hardware architecture within the driver environment, increase the chances to fulfill the set goals. The commonality is essential for the factors mentioned above, and the

differentiation is required so the brands, and variants within the brands, still can be attractive and sellable within different segments. The necessary organizational and process change is an ongoing course within the organization which seems to always follow the technical requirements and development some steps behind.

A lot of focus has been, and still is, on commonality in architectures, components, resources and tools. Also when tools are developed for enhancing or enable a vision of differentiation, much focus is on the tool and not the environment and circumstances surrounding the tool. If organizational and process changes are done after introduction of the tool, the full effect of the tool will be delayed and the advantage might be lost.

In the urge for commonality and effectiveness the tool ended up as a tool that is flexible and can enhance differentiation to certain degree due to cognitive barriers, slow organizational and processes changes and adoptions.

Conclusions

Global CarCorp has tried to be proactive in avoiding the negative effects of commonality with this tool. Although, it seems like a thorough plan of how to handle the differentiation possibilities in regards to organization and processes is deficient. The urge for commonality is too strong at the moment. A complete understanding and awareness of what the tool is and can produce, and how to take care of this, also lacks. This is valid for all new tools introduced in an organization, but it might be even more apparent in a global organization working with common architecture for different brands, variants and models.

As mentioned, HMI design is an increasingly important means to differentiate products for different market segments, brands and individuals. It is a high risk that common architecture and tools, in conjunction with merged multi-branded organization and supplier strategies for global multi-branded organization, will watered down differentiation possibilities. This in combination with the automotive infancy of software engineering and what it requires from organizational and processes aspects is significant.

In short, I would say that there are cognitive, organizational and process barriers to overcome to enable differentiation with the software tool. An awareness of how to use software for differentiation attributing is improving and increasing. A challenge is to incorporate it fully, from start, throughout the organization and its processes. If this happens a balance between commonality and differentiation might appear.

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