Platform Development to Support Multiple Brands

By
Agus Sudjianto
Ph.D., Industrial Engineering (1996)
Wayne State University

Submitted to the System Design & Management Program
In Partial Fulfillment of the Requirement for the Degree of
Master of Science in Engineering & Management

at the
Massachusetts Institute of Technology
February 2001

Signature of Author _____
System Design & Management
December 16, 2000

Certified by _____
Thesis Supervisor: Kevin N. Otto
Associate Professor of Mechanical Engineering

Certified by _____
Thesis Supervisor: Drazen Prelec
Associate Professor of Management

Certified by _____
Corporate Sponsor: John Krafcik
Chief Program Engineer, Ford Motor Company

Accepted by _____
LFM/SDM Co-Director: Paul A. Lagace
Professor of Aeronautics & Astronautics and Engineering Systems

Accepted by _____
LFM/SDM Co-Director: Stephen P. Graves
Abraham Siegel Professor of Management

DEDICATION

To my family—Christine, Ashley, and Alexis—for their love and support.

ACKNOWLEDGEMENT

There are many people, knowingly and unknowingly, contributed to this thesis. I could only acknowledge a few, but I am very indebted to all who help along the way.

I would like to thank my thesis advisors: Professor Kevin Otto of Mechanical Engineering and Professor Drazen Prelec of Sloan School of management. Their assistances, countless opinions, and enthusiasm made all the works in this thesis possible and, most of all, fun.

I thank John Krafcik and Chris Magee who generously shared their busy and valuable time on this thesis, my System Design & Management (SDM) education, and career advice.

I owe a great debt to my current and former management at Ford Motor Company—Dennie Holyoak, Karen Stewart, Hunter Tiernan, Larry Ward, and Doug Whitney—for their supports to my SDM education. I would like to specially thank Mahesh Vora for his continuous and fearless support to my career development since he hired me as a Ford Motor Company employee.

I have had the best help and support from numerous people at Ford Motor Company, especially my Ford fellow students of MIT SDM Program.

I am grateful for the transformational experience provided by all SDM staffs and faculties. Especially, I am indebted to all my SDM fellows for the unmatched experiences. I will miss you all.

Finally, I thank my family—Christine, Ashley, and Alexis—for their enduring patient and support during my SDM education. As small recompense for the joy they bring me, I dedicate this thesis to them.

ABSTRACT

Modular product portfolio architecture to maximize shared systems/components among products is increasingly popular in product development for reasons of economy of scale and scope. Product development is no longer sufficient to consider only a single product. Instead, it must also consider the needs of a brand family or portfolio. One of the main challenges in designing multiple brands from the same product platform is the ability to create a group of distinctive product variants to support their individual brand images while maximizing system/component commonality among them. Making a proper decision of product platform and necessary differentiation is, indeed, a complex and crucial task. A systematic approach for designing a modular product portfolio architecture to support multiple brands—to maximize brand differentiations as well as product commonization—is still largely unexplored. This is evident by the facts that different companies are employing disparate and inconsistent platform development approach.

The development of a practical, useful, and sound framework on how to develop a modular product architecture in the context of brand portfolio is the unique and original contribution of this thesis. This includes the creation of a set of platform and modular architecture principles (i.e., dominant theme of product functions and aesthetic forms, brand signature, and platform rules) and tools, such as the brand function structure and modularity matrix to complement the existing modular product portfolio architecture approach. The framework was developed based on applicable research on consumer responses to product characteristics, functional architecture methodology to define possible product platforms, and an empirical "listening to customers" automotive case study to understand necessary brand differentiation and acceptable brand parity. The integrative framework, combining brand portfolio management and product portfolio architecture development, proposed in this thesis is essential to deliberately engineer necessary product differentiation to deliver unique brand identity in the mind of customers, while taking advantage of the economy of scale of a product platform commonization. The applicability of the methodology was evaluated using several cases where multiple brands were developed from common product platform.

Table of Contents

Chapter 1. Introduction

1.1. Motivation

Modular product portfolio architecture to maximize shared systems/components among products is increasingly popular in product development for reasons of economy of scale and scope.

> *Ford Motor Company has made great strides in providing quality vehicles that capture the imagination of our consumers. To increase brand loyalty and yield the highest returns, we must work constantly to provide the best quality at the lowest total cost. Our goal is to streamline the vehicle production process and strengthen Ford's individual brand identities through the use of common platforms and parts. Commonization across product lines will increase productivity, reduce expenditures and allow us to create unique branded parts. This new strategy will provide the flexibility we need to respond quickly and creatively to the demands of the consumer.*
>
> *Jim Padilla – Group Vice President Manufacturing. Ford Motor Company*

Product development is no longer sufficient to consider only a single product. Instead, it must also consider the needs of a product or brand portfolio. One of the main challenges in designing multiple brands from the same product platform is the ability to create a group of distinctive product variants to support their individual brand images while maximizing system/component commonality among them. As a brand portfolio is derived from the same platform, each brand in the portfolio must provide a distinctive value proposition consistent with its brand positioning. Making a proper decision of acceptable product commonization (i.e., product platform) and necessary differentiation is, indeed, a complex and crucial task. In the automotive industry, the complexity is even greater when multiple brands in the product family are developed with different target markets and positioning intention to avoid brand dilution, where each product must contain distinctive product attributes to provide not only unique functional benefits but also unique emotional benefits (Aaker, 1996). An example of this situation is the well known DEW98 platform of Ford Motor Company, where the platform is shared among various brands and sub brands such as Jaguar S-Type, Lincoln LS, Ford Mustang, and Ford Thunderbird.

1.2. Challenges of Maximum Differentiation and Parity

There are growing literatures in both brand management (Aaker, 1996; Aaker 2000) and product platform (Wheelright and Clark, 1992; Meyer and Lehnerd, 1997; Meyer et al., 1997; Stone, 1997; Cusumano and Nobeoka, 1998; Moore et al., 1999; Wood and Otto, 2000; Baldwin and Clark,

2000). Nevertheless, a systematic approach to designing modular product portfolio architecture to establish a platform for a portfolio—to maximize brand differentiations and product commonization—is still largely unexplored. This is evident, for example, in the automotive industry where different companies employ different strategies in defining platform and commonization (Bremmer, 1999a, 1999b, 2000).

To achieve the goal of designing a platform for a product portfolio to support multiple brand differentiations, one must truly understand what are the necessary brand differentiations and acceptable parities so that a product platform can be developed to prevent brand dilution. Finding answers to the following fundamental questions is critical:

- *Brand parity*: What systems/components can be commonized among multiple brands without being noticed by their customers? What systems/components can be commonized among brands so that even when customers do notice the similarity, they do not have any objection? This point of parity then can be used as the building blocks of product platform.
- *Brand differentiation*: What systems/components must be unique in every brand so that brands developed from a common platform are perceived with different identities as intended by their brand positioning?

Finding proper differentiation and commonization without overdoing either one of them is obviously a difficult decision, yet it is very fundamental in developing a modular product portfolio architecture to support multiple brands.

1.3. Approach of the Study

The nature of the study in this thesis requires an integrative view of marketing disciplines (e.g., consumer behavior and brand management) as well as the "art" of designing a product portfolio architecture. Because the areas of brand management and product architecture are traditionally disconnected, literature searches were conducted to investigate the state-of-the-art of both disciplines so that an integrative framework could be developed. Chapter 2 discusses the importance of brand identity in a brand portfolio with a focus of product differentiations, especially the elements of product aesthetics. This thesis is not about brand management at large; instead, it focuses on an approach to develop product architecture to support brand differentiation. Therefore, a product-centric point of view is kept as a focus. After all, products are what give customers reason to believe what a brand promises as presented by its marketing. Chapter 3 provides a background of product portfolio architecture including some current research results on

how to develop it. The approach emphasizes the use of functional architecture methodology to define possible module commonization to define a product platform. Chapter 4 presents a consumer insight study to understand necessary brand differentiation and parity. This study involved "listening to customers" to gather their perceptions about product variants of different brands developed from the same product platform. The outcome of the study is a generic set of "voice of customers" about brand differentiation, which is very useful to guide a development of the set of heuristics for deliberately designing modular product portfolio architectures to support brand differentiation. These heuristics are the results of combining the findings from the empirical consumer insight study with related research results in the area of consumer behavior and product development. In Chapter 5, the heuristics are formally stated and then evaluated using multiple brands that are developed from a common product platform (e.g., Black & Decker® cordless drills/drivers). Conclusion and opportunities for future study are presented in Chapter 6.

1.4. Focus and Contribution

As previously mentioned, this thesis takes a product-centric view on how to develop a modular product portfolio architecture to support brand differentiation. Other aspects of brand development in the marketing mix (i.e., price, promotion, and placement) are not part of this thesis. The main contribution of this study is the development of a practical, useful, and sound framework on how to develop a modular product portfolio architecture in the context of brand portfolio. This includes the development of a set of heuristics to complement existing modular product portfolio architecture approach (Stone, 1997; Baldwin and Clark, 2000; Otto and Wood, 2000). This framework is crucial to bridge gaps between brand management and product portfolio architecture development, i.e., to maximize synergies across brands in the product development while preventing products to be perceived as being too much alike by their customers. The set of "principles" and framework proposed in this thesis is evaluated using several consumer products employing a common platform for distinct brands.

Chapter 2. Differentiation and Parity in Brand Portfolio

2.1. Introduction

The main focus of this thesis is the creation of necessary product differentiation to deliver unique brand identity in the mind of customers, while taking advantage of economy of scale generated by product development synergies among brands in the portfolio; to simultaneously design necessary differentiation among brands in the portfolio and utilize acceptable brand parity as a common product platform. In this Section, particular interest is paid on understanding the needs of brand differentiations within brand portfolio and how to develop them.

Brand differentiation development starts with market segmentation and brand positioning, as discussed in Section 2.2. Because most companies manage multiple brands in their portfolio, it is important to understand brand positioning in the context of a complete brand portfolio instead of a single brand. Section 2.3 explores the roles of a brand and its relationships with other brands in a portfolio that ultimately lead to the development of distinct brand identity in a portfolio. Section 2.4 presents product differentiation and the role of product functions and product forms to deliver customers' functional and emotional benefits. In particular, the roles of product aesthetic forms for differentiation are discussed in greater detail in this section. The theory discussed in this chapter is used as a basis for the consumer insight study presented in Chapter 4.

2.2. Brand Positioning

Brand positioning is about creating customer perceptions of a particular brand among other brands (including competitors and other brands in the portfolio). To avoid product positioning overlap and brand dilution, this thesis is interested in developing a product platform to support distinct positioning of multiple brands within a company's brand portfolio, especially multiple brands delivering similar utilitarian attributes but different brand beliefs (e.g., various brands of cars offered by Ford Motor company, various cordless drills offered by Black & Decker®). The process of brand positioning starts with market segmentation: dividing the market into sub-categories and pursuing a different strategy or product offering for each category. The underlying belief for market segmentation is that customer preferences are heterogeneous: Tastes and preferences differ among people. The basis for segmentation can be the following:

1. *Geographic*: segmentation on the basis of cultural differences among customers living in different locations

2. *Demographic*: segmentation on the basis of gender, age, education, occupation, income, ethnic background, marital status, or household size
3. *Psychographic*: segmentation on the basis of attitudes, beliefs, lifestyle, or personality
4. *Behavioral*: segmentation on the basis of usage situation or frequency

The last two segmentation bases provide rich brand positioning opportunities by taking advantage of unique product attributes/benefits and product forms. Although all elements in the marketing mix (product, price, promotion, and placement) are crucial for successful brand positioning, this thesis focuses on product attributes (see Section 2.4 in this Chapter). Product attributes create tangible and intangible product differences that can be used as a fundamental building block of brand positioning to ensure that the chosen differences occupy distinct and important positions in the minds of customers. Distinct brand positioning is commonly accomplished by exploiting distinct emphasis on product characteristics to meet various segments of customers who ascribe to different weights of importances of benefit dimensions (Urban and Hauser, 1993).

Brand positioning typically uses techniques that make use of abstract attributes, including techniques such as perceptual mapping and multidimensional (Urban and Hauser, 1993; Kaul and Rao, 1995). To design a product portfolio architecture, however, the abstract attributes must be translated into more concrete attributes. The approach of designing product platform and attribute differentiation to support positioning of multiple brands is discussed in greater detail in Chapter 5.

2.3. Brand Portfolio

Development of a strong brand is of primary importance; however, with a more segmented market there is strong pressure for brand proliferation to cover more market segments. As a result, most companies must manage a portfolio of brands instead of a single brand. Over time, brand contexts become more complex because of brand extensions both horizontally and vertically, wider use of brand extensions, or acquisition of outside established brands. For example, the Ford Motor Company brand umbrella includes Jaguar, Volvo, Mazda, etc. (see Figure 2.3.1). To effectively manage a brand portfolio, relationships among brands and the role of each brand must be well understood and designed so that distinct brand identities can be developed and maintained.

Figure 2.3.1. Ford Motor Company umbrella brands.

2.3.1. Brand Portfolio Relationship

Aaker (2000) describes four major relationship categories among brands in a brand portfolio:

1. *House of brands* contains independent and unconnected brands for which each independent brand maximizes its own impact on a market. Each brand is managed independently, thus it lacks the economy of scale of brand synergies. However, this strategy allows companies to clearly position brands to customers, and compromises do not have to be made among brands.
2. *Sub-brands under a master brand* (or parent, umbrella, or range brand) where a primary reference brand is stretched by several sub-brands to serve different segments (e.g., Ford Taurus®, Ford Mustang®, Black & Decker® Firestorm®) or descriptive sub-brands (e.g., Ford trucks, Ford cars). Sub-brands provide an important way to convey product distinction that otherwise must be represented by a different brands. Sub-brands are tightly linked to the master brand; therefore, sub-brands have a strong association effect to the master brand, and vice versa. Either master brand or sub-brand can act as the primary driver (i.e., the one that has a higher degree of relationship with its customers). For example, when asked what car do you own, the answer will often be the sub-brand that acts as the primary driver (e.g., Mustang® instead of Ford).

3. *Branded house*: where the master brand plays the dominant role and the sub-brands play little or no role at all. The branded house maximizes clarity, synergy, and leverage of the portfolio. A branded house, such as BMW, sends a clear message to its customer what it stands for. The company benefits from the single dominant brand communication message to its customers.
4. *Endorsed brands* are independent brands but they are also endorsed by an organizational brand. The primary use of endorsement is to provide additional credibility to the endorsed brand as an assurance to the customers. A study by Saunders and Fu (1997) suggested that endorsement from a company with credibility in the product class helps the endorsed product. In the automotive industry, co-branding is often used to enhance product differentiation and value propositions. An example of this is Ford Explorer and Expedition Eddie Bauer editions, which are used to enhance the outdoor image of the vehicle through the discriminating taste and style of Eddie Bauer.

Rather than employing a single strategy among the aforementioned four strategies, companies with numerous brands in their portfolios often employ a combination of those strategies.

2.3.2. Roles of Brands in the Portfolio

In managing a portfolio of brands, it is important to understand the role of each brand in the portfolio so that resources and synergies can be optimized across brands. Aaker (2000) defined the brands role into four categories: Strategic, Linchpin, Silver bullet, and Cash Cow brands. A brand could be simultaneously falls into multiple categories.

1. *Strategic brand* is a brand that represents significant future sales and profit even though it may not be currently a dominant brand in the portfolio; however, it is projected that this brand will grow into a dominant brand in the future. Jaguar brand in the Ford Motor Company portfolio is an example of a strategic brand as the luxury segment is projected to have the highest growth.
2. *Linchpin brand* is a leverage brand that has no direct influence in the business but is important to the future vision of the company by providing a basis for customer loyalty. Service provider brands such as Ford Credit and Quality Care are examples of linchpin brands in the Ford Motor Company portfolio.
3. *Silver bullet brand* is a brand that has a strong influence on the image of other brands in the portfolio by creating, changing, or maintaining brand image. Lincoln LS® is an example of a silver bullet brand for the Lincoln brand in the Ford Motor Company portfolio.

4. *Cash Cow brand* is a brand that is currently providing the most significant customer base that does not require as much investment as other types of brands in the portfolio. The role of this brand is to generate profit that can be invested in strategic, linchpin, and silver bullet brands which, in turn, will provide future growth to the company. Ford Truck is an example of a cash cow brand in the Ford Motor Company portfolio.

The business decision of common basis as a platform shared among brands often affected by the role of each brand in a portfolio.

2.3.3. Brand Identity

In the past, brand management encouraged existing brands in the portfolio to compete with each other because different market segments were covered and competition among the brands within the company was considered to be healthy. This approach forces each brand to have different positioning by offering its own set of unique functional benefits that are relevant to its customers. The increasingly muddled market and the pressure of product development efficiency, however, causes a host of brands within a company to drift into a confused set of offering and it becomes more difficult to remain distinct from each other. Thus, realizing the objective to manage brand portfolio such that all brands work together to create strong synergies to maximize product development efficiency and market effectiveness, it is crucial to successfully establish a product development process that will best support multiple brands. Because product is one of the most important aspects of brand identity[1], the challenge for product development is how to deliver products with distinctive identities that will best differentiate brands and appeal to different target segments. Aaker (2000) argues that creating elements of brand identity includes two dimensions: (1) the ability to create sustainable differentiation and (2) the ability to resonate with its customers by delivering its value proposition--functional benefits, emotional benefits, and self-expressive benefits.

Functional benefits are provided by functions performed by the product. Because functional benefits directly relate to the utility values of the product, leadership in functional benefits is very critical to the success of a brand. The challenge, however, is to select the most valued customers' functional benefits for a given limited resource. On many occasions, functional benefits often fail to deliver differentiation and product functionalities become more alike because of competitive pressure and are relatively easy to copy.

---

[1] According to Aaker (1996), brand identity includes brand as product, organization, person, and symbol.

Emotional benefits add richness and depth to the experience of owning a product beyond practical usage considerations (see discussion in Section 2.4.1). Emotional benefits are positive feelings that a brand provides to its customers (Aaker, 1996). Emotional benefits are the consequences of achievement of functional benefits and product aesthetic forms.

While a product's emotional benefits provide positive feelings to its customers, self-expressive benefits provide a way for its customers to express their self-image among brands among brands—how they perceived themselves or how they would like to be perceived by others by using or owning a brand (Aaker, 1996). For example, Jaguar S-Type® has a self-expression of spirit, style, and glamour. Product attributes (e.g., function and aesthetics) can be exploited to support self-expressive benefits.

2.4. Product Differentiation

Because product implementation plays a significant role in creating brand identity, establishing product differentiation that resonates to its customers is very crucial. Product distinction can be implemented through its *function* as well as its *form*. Product *function* refers to the utilitarian benefits or attributes of a product. Product *form* refers to the physical implementation or packaging, including the aesthetics of a product. Aesthetic forms have a strong influence on its emotional and self–expressive benefits because of unique intangible sensory experiences that customers can see, hear, touch, feel, or smell. Therefore, aesthetic forms can be used to create product differentiation when function becoming parity. In the following sections, a model of consumer responses toward a product developed by Bloch (1995) is presented as a basic theory to understand the fundamental of brand differentiation. Thereafter, more concrete product characteristics, in particular its aesthetic forms, are discussed to develop product differentiation.

2.4.1. Model of Consumer Responses to Products

Bloch's (1995) study of consumer reactions to products suggested that product properties have strong influences to consumers' cognitive and affective responses which, in turn, affect behavioral responses (see Figure 2.4.1). Product form is the embodiment of a concept selected by the design team during the product development activity. Product form consists of a number of elements blended together into a whole product to achieve the design goals and constraints. In addition to delivering functional performance, product form must also achieve particular sensory effects by its aesthetic form. Because product functions directly provide benefits sought by customers, creating product function differentiation is fundamental for overall product

differentiation. There are two types of product function differentiation: the product functions (e.g., features) themselves and the "quality" level of how well the product delivers functions.

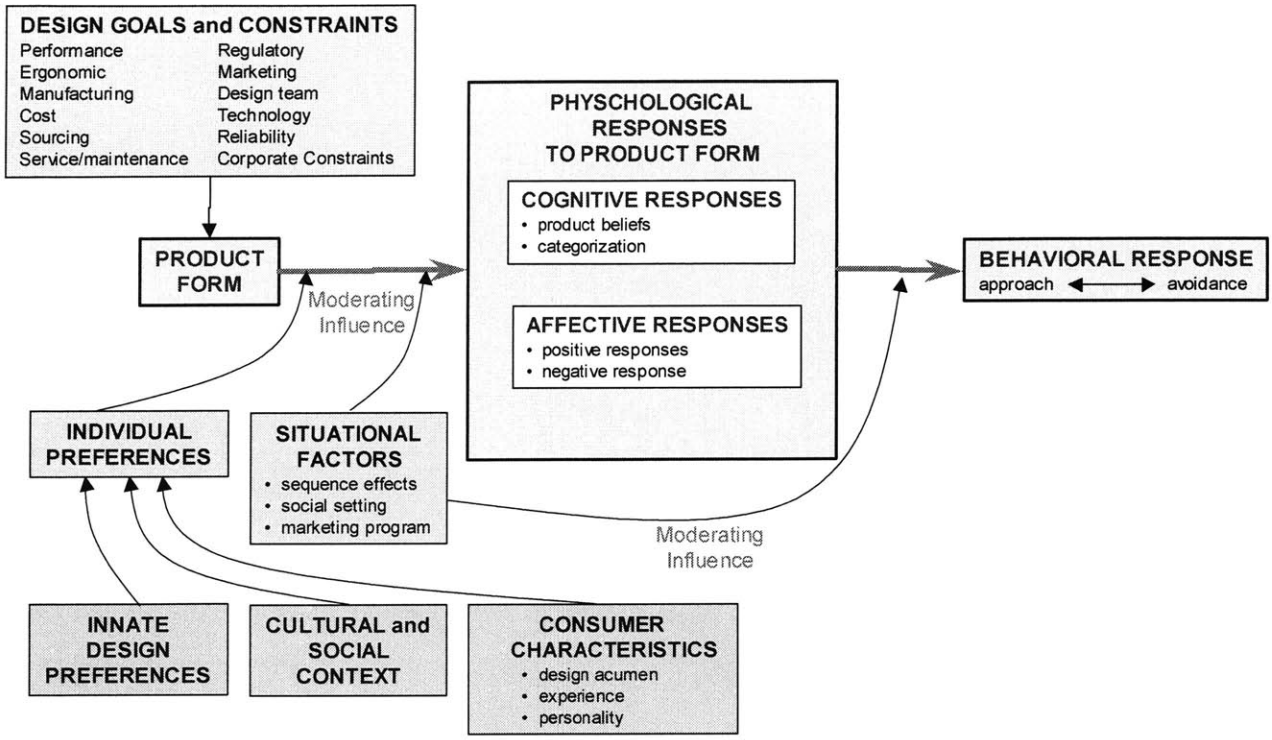


Figure 2.4.1. A model of consumer responses to product form adopted from Bloch (1995)

Bloch argues that the functions and aesthetic forms of a product strongly influences customers' psychological responses include both cognitive and affective components. Cognitive responses about a product are the results of product functional and aesthetic properties. Consumers' cognitive responses toward a product include:

1. *Product-related beliefs.* Product forms affect customer beliefs about a product and associated brand characteristics such as durability, power, sophistication, masculinity, and elegance (see discussion in Chapter 4). To create product differentiation, multiple brands derived from the same platform must employ distinctive forms, functionalities, or different levels of functionality to create different product-related beliefs. The Jaguar S-Type® and Lincoln LS® case discussed in Chapter 4 illustrates the effective use of product-related belief distinction.
2. *Categorization.* Based on the perceived similarity between a given product and its surrounding exemplars of product categories, customers perform the cognitive process of product

categorization. Rather than leaving categorization to chance, multiple brands derived from the same product platform must strive to achieve perceptible product differentiation so that consumers will categorize them differently.

Consumers' *affective responses* include aesthetic and other positive (or negative) responses. Product form evokes various degrees of affective responses from its consumers. This is particularly important for products where designs create very strong emotional responses among consumers due to their aesthetics, such as the automobile. When Apple iMac™ "*turned its form into something you want to touch instead of something you ought to dust,*" (Hamilton, 1999) it started a new trend in the computer industry to pay more attention to aesthetics. Holbrook and Zirlin (1985) define aesthetic response as:

> *"Deeply felt experience that is enjoyed purely for its own sake without regard for other more practical considerations"*

Aesthetic responses are the result of sensory properties of a product rather than its utilitarian (functional) attributes (Bloch, 1995; Schmitt and Simonson, 1997). To create brand differentiation, every brand in a portfolio must exploit distinctive dimensions of positive responses by employing different product aesthetic forms.

Psychological responses to product aesthetic form lead to behavioral responses: approach-avoidance behavior that reflects attraction and desire for deeper exposure. Approaching behavior is engaging activities such as exploring, touching, taking care of, or even a tendency to display the product to others, while avoiding behavior is just the opposite.

2.4.2. Elements of Product Aesthetic Form

Product aesthetic forms are composed of four primary elements: visual, auditory, olfactory, and tactile. These elements come together to create multi-sensory experiences when customers purchase and/or consume products. Product form is one of the critical elements and, when it is not done right, will result in failed product differentiation. Therefore, careful design consideration must be taken when establishing necessary products differentiation and parity (i.e., product platform). Though the utilization benefits[2] of product form (i.e., its ergonomics) may also be used as product

[2] One may argue that all products try to fulfill ergonomic needs therefore sooner or later products cannot be differentiated from their ergonomic benefits.

differentiation, this section pays particular attention to aesthetics. Schmitt and Simonson (1997) in "Marketing Aesthetics" described the elements of form[3] as follows:

Form: The Visual Element

The visual element is the most prevalent element in the eye of customers. From a product point of view, the major visual elements consist of *shapes* and *colors*. While shape can be very complex, there are four basic elements of shape:

1. *Size*. Large, tall, or wide shapes are often associated with power and strength, but may also be perceived as awkward, unwieldy, unsophisticated, or unintelligent. Small, short, or thin are associated with delicate, orderly, and sharp, but it also be associated with weakness.
2. *Angularity*. Angular form contains angle (e.g., triangle, rectangle, and square) while a rounded form has no sharp corners. Angularity and straight shapes are often associated with dynamism, sharpness, and masculinity while roundness or curved shapes suggests the opposite, e.g., harmony, softness, continuity, and femininity.
3. *Symmetry*. Symmetry reflects balance, order, and relief of tension, while asymmetry evokes the opposite impression, such as agitation and tension. Symmetry with a stroke of asymmetry breaks monotonicity and often isused to create a sense of balance with excitement.
4. *Proportion*. Long and short angular shapes create different sensations. The former extends the field of vision and captures more area, thus creating a bold and dominant impression, while the later is more timid and modest.

A combination of the above elements is often blended to create a preferred sensation, e.g., a circular shape appears to be less powerful than oblong shape, but it generates a perception of harmony, softness, and perfection.

Shapes can be used to create a product identity by repeating the shape over time. When the shapes are repeated across products in a brand family, then the shapes can be considered as part of brand identity. In the automotive industry, a particular shape and design cue is commonly used as a brand identity. This shape is maintained across products in the same brand and over time, e.g., the front grill shape of the Lincoln is unique to the brand and has been preserved over time as part of Lincoln brand identity (see Figure below).

[3] Schmitt and Simonson refer form as *style*

Lincoln Continental®

Lincoln LS®

Lincoln Towncar®

Lincoln Navigator®

Figure 2.4.2.1. Front grill shape as a part of Lincoln's brand identity.

A color in a product can be used to carry an association and experience through the effective use of a mix of the three basic elements of color: saturation (chromatic purity or dilution with white), brightness (intensity or energy level), and hue (wavelength or the particular shade). Saturated color makes an object appears more dynamic. Brighter color creates an impression that an object appears closer that reality. Hues around red, orange, and yellow create an impression of energy and extroversion, while hues around green, blue, and purple are the opposite. The following are examples of color association (Schmitt and Simonson, 1997):

Red: adventurous, sociable, exciting, powerful, protective

Yellow: cheerful, jovial, exciting, affectionate, impulsive

Green and blue: calm, restful, soothing

White: sunny, happy, active, and pure

Black: dark, mysterious, evil

Metallic (gold or silver): quality, brightness, luxury, elegance

When a specific color or a palette of colors is used consistently, it can be used as a part of identity. When a color is repeated across a variety of products in the company then the color can become part of a company's identity. To support brand identity and differentiation, a color can be repeated across products in the brand family as effectively used by Black & Decker®, e.g., yellow for DeWalt®, orange for Firestorm®, blue for Black & Decker®, and green for Quantum®.

DeWalt Firestorm Black & Decker Quantum

Figure 2.4.2.2. Brand identity using colors in Black & Decker's brands.

Form: The Tactile Element

Tactile is the feel of "touch." Material and texture of material create a certain feel and sensation for a product because they carry a strong association with strength, warmth, and naturalness. Organic materials such as wood and leather are perceived as warm, luxurious, relaxed, natural, and soft, while inorganic materials such as metals and glass are perceived as strong, cold and hard. Rough-textured materials are associated with strength and the outdoors, while polished materials are associated with refinement and indoors.

Form: The Auditory Element

Sound, characterized by intensity (or loudness) and frequency, triggers very sensitive reactions of customers. Sound can create an impression of quality. A soft clicking sound may provide an impression of refinement and quality, while loud sound may provide an impression of strength and power. Therefore, sound can be used to enhance product identity, e.g., the sound of engine noise in a performance car such as Mustang® is far different from the engine sound of a family sedan such as Taurus®.

Form: The Olfactory Element

Odor can evoke a strong memory and create desired perceptions and feelings that can be used to enhance identity. Automotive companies pay significant attention to the smell of a new car and its leather interior. Females and males have different reactions to smell. Scents have a subtle advantage that while they may not draw attention, they can be used to enhance product identity.

Form: The Unity and Congruity of Aesthetic

Integration of the four primary senses (shape, color, sound, touch, and smell) is important to create overall system attributes that express product differentiation and, thus, identity. Though each element of aesthetic form is important in its own right, overall system results created by a proper integration is a key to creating a holistic perception. Gestalt psychologists argue that objects are perceived as a whole rather than individually (Kohler, 1947). The whole is more than the sum of the elements; however, slight changes in the elements, because of interactions, may have a significant impact on the whole system impression. Schmitt and Simonson (1997) called "synesthesia," the art of combining multiple sensory attributes to create a holistic perception—a style.

Chapter 3. Product Platform

3.1. Introduction

The approach of using a product platform as a building block for developing a product family has received much attention in recent research. Wheelright and Clark (1992) define product platform as "*a product that embeds an architecture for the system solution to be provided to customers.*" They suggest that the following characteristics must exist in a product platform: (1) A platform must have performance targeted to a core group of customers, (2) A platform must support an entire product generation, and (3) A platform must provide a migration path for the customers from the previous to the next generation. Because of these characteristics, a platform must provide multi-dimensional excellence of total solution as opposed to a product derivative that typically provides improvements only in one or two dimensions. Meyer and Lehnerd (1997) define a product platform as "*a set of subsystems and interfaces that form a common structure from which a stream of derivative products can be efficiently developed and produced.*" Meyer, et al. (1997) define a platform as a "*physical implementation of technical design that serve as the base architecture for a series of derivative products.*" That is, a platform development approach is characterized by the existence of common components in the product variants derived from the platform. As a result, a platform enables a company to create greater product variety and bring them to the market more rapidly at lower costs (Henderson and Clark, 1990; Smith and Reinertsen, 1992; Sanderson and Uzumeri, 1995; Meyer and Lehnerd, 1997; Sanchez, 1999).

With the proliferation of multiple brands in a company's portfolio, it is becoming more common that product variants marketed with different brands are developed from the same product platform. Volkswagen is famous in the automotive industry for using a shared product platform extensively to develop products for various brands, e.g., A4 platform for total of 7 products including the VW Golf®, VW Beetle®, VW Jetta®/Bora®, Audi A3®, Audi TT®, Skoda Octavia®, Seat Toledo®, and Seat Leon® with a combined volume of 1.9 million vehicles (Bremmer, 1999a, 1999b, Bremmer, 2000). A platform can be stretched "horizontally" to develop multiple brands in the same price range, such as the case of Ford Escape® and Mazda Tribute®, or it can be stretched "vertically" to develop multiple brands in a different price category, as in the case of Lincoln LS® and Jaguar S-Type®. Existing research in product platforms (Henderson and Clark, 1990; Smith and Reinertsen, 1992; Sanderson and Uzumeri, 1995; Meyer and Lehnerd, 1997; Sanchez, 1999; Zamirowski and Otto, 1999; Dahmus et al., 2000; Otto and Wood, 2000; Baldwin

and Clark, 2000) do not sufficiently address the aspects of platform development to support multiple brands. Indeed, a sharing product platform to support multiple brands imposes significantly different challenges not encountered in those of platforms for a single brand to support multiple product generations or mass customization. This thesis attempts to specifically address the needs of designing a platform sharing to support multiple brands. Prior to accomplishing such a goal, this chapter reviews related methodologies to develop platform architecture proposed by existing research. Applicable portfolio architecture classifications are presented in Section 3.2. as a prelude to portfolio architecture to support multiple brands. Section 3.3 discusses the functional architecture approach to develop a product family. Section 3.4 reviews modular product architecture and modularity heuristics to support platform development. The materials presented in this chapter, along with those in Chapter 2, will be used as the foundation to establish principles and framework to architect platform sharing to support multiple brands presented in Chapter 5.

3.2. Product Portfolio Architecture Classification

Otto and Wood (2000) define product portfolio architecture as a "*system strategy for laying out component and systems on multiple products to best satisfy current and future market needs.*" Product portfolio architecture can be categorized into three general classes (Otto and Wood, 2000):

1. *Fixed unsharing architecture.* Each product in the portfolio employs unique components or systems and no commonality is used among products in the portfolio. Fixed unsharing architecture is a typical architecture for a very high volume product where economy of scale of a single product justifies the approach. With fixed unsharing strategy, each brand in the portfolio is developed independently and no economy of scale synergies among brands in the portfolio is pursued.
2. *Platform portfolio architecture.* Variants of products can be efficiently derived from a platform to meet market need variety. A product platform enables a company to offer product families with greater variety at lower cost and quicker to market. When product variants are offered through multiple brands, this architecture can be used to create economy of scale synergies among brands in the portfolio. There are several significant categories of platform portfolio architectures identified (Otto and Wood, 2000) that can be used to support brand portfolio as follows.
    2.1. *Modular Product Family.* In a modular product family, a set of derivative products, which may be marketed with different brands, is supported by a common platform at any given time. The modular family architecture may be employed for the reason of extending product lines

or supporting distinct brands with different value propositions, which may include a cost-reduced derivative for a low cost brand, or enhanced-product derivatives for premium brands (see also Cutherell, 1996). As examples, Black & Decker® employs a modular product family for its cordless drills marketed under Black & Decker® basic for the low cost brand and Firestorm® for the high performance brand.

2.2. *Modular Product Generation.* Modular product generation support multiple products by sharing common modular elements over the time. Modular product generations are common in the automotive industry where periodic product freshening is incrementally performed to satisfy a changing market while maintaining low cost product development and manufacturing investment. The modular product generation approach may be employed to support a brand as well as multiple brands.

2.3. *Consumable Platform.* Consumable platform architecture is used to isolate components that are consumed at a faster rate than the rest of the components.

2.4. *Standard Platform.* Standard platform is a subset of systems in the product portfolio that conform to industry standards or a dominant supplier.

2.5. *Scalable Platform.* In scalable platform there is no share component, but all are the same except for size (Conner, et al., 1999; Simpson, et al., 1999). What is common among product variants is that all variants employ the same functions and concepts—so that production or development activities are common. Yet, to achieve different performance levels, the components themselves are all different size and material.

3. *Mass customization architecture.* This architecture allows the offering of greater product tailoring to each customer by varying the basic product platform with ease, i.e., no significant increase of costs or process complexity to meet the requested product variations (Pine, 1992; Anderson, 1997). Product variations in mass customization typically do not create dramatically distinctive product offerings that justify the creation of multiple brands. Therefore, mass customization is usually minor product variations within a brand. Examples of mass customization may include (Pine, 1992; Anderson, 1997; Otto and Wood, 2000) the following:

3.1. *Adjustable for purchase*, where manufacturers provide a very large variety for some subsystems to meet different customer wants

3.2. *Fabricate to fit*, where customers may order using exact specification

3.3. *Adjustable for use*, where customers may dynamically adjust the setting of a product at any point in time during use

This thesis extends the scope of platform portfolio architecture to also include modular brand family, i.e., modular architecture to support developments of product variety with different brand identities.

3.3. Functional Architecture of Product Portfolio

Otto and Wood (2000) and Dahmus et al. (2000) introduced functional architecting of product family by developing possible function structures for each product variant and merged them into a common function structure. The result is a family function structure that highlights *shared functions* among variants in a product family. Subsequently, a collection of these shared functions is used as a platform for a product family. Dahmus et al. (2000) demonstrate the use of family function structure complemented with a modularity matrix to redesign the Black & Decker® VersaPak® product family. This technique will be used extensively to aid the development of product platform to support multiple brands as presented in Chapter 5. The discussion below provides a short background of function structure development as given in Pahl and Beitz (1996) and refined by Otto and Wood (2000).

3.3.1. Function Structure

Function structure is an abstract representation of a product by decomposition of its functions and their relationships in terms of *information*, *energy*, and *material* flows to achieve its overall task (Pahl and Beitz, 1996). The main constructs of a function structure are:

1. *Functions.* A function is a statement of what a system does as opposed to what the product is (Otto and Wood, 2000). A function is generally associated with a system, but not necessarily on a one-to-one basis. Indeed, in an integral architecture, a system delivers multiple functions while systems in modular architecture have one-to-one relationships with the functions (Ulrich and Tung, 1991). Functions are generally stated in terms of quantifiable performance using a verbal description of an active *verb* and *noun* phrase such as "accept electricity" and "convert torque." Little, et al. (1997) provided a generic list of product function statements.
2. *Flows.* Flows represent interactions among functions in a function structure in terms of input and output, to and from functions. Pahl and Beitz (1996) categorize flows into three categories: *information*, *material*, and *energy* (see also Otto and Wood, 2000).

A function structure is schematically represented as a network weaving all identified functions and flows of information, material, and energy associated with them. A function structure of a Hamilton Beach® electric can opener is shown in the following figure. There are functions such as "Convert electricity to motion" which is an abstract representation of an electric motor. The flow associated with this function includes electrical energy as an input coming from the "Switch Power" function and kinetic rotational energy (motion) as an output to the "Convert Speed/Torque" function. Using this function structure representation, a series of modularity rules have been proposed to architect modular products (Stone et al., 1997) and modular product families (Zamirowski and Otto, 1999; Otto and Wood, 2000).

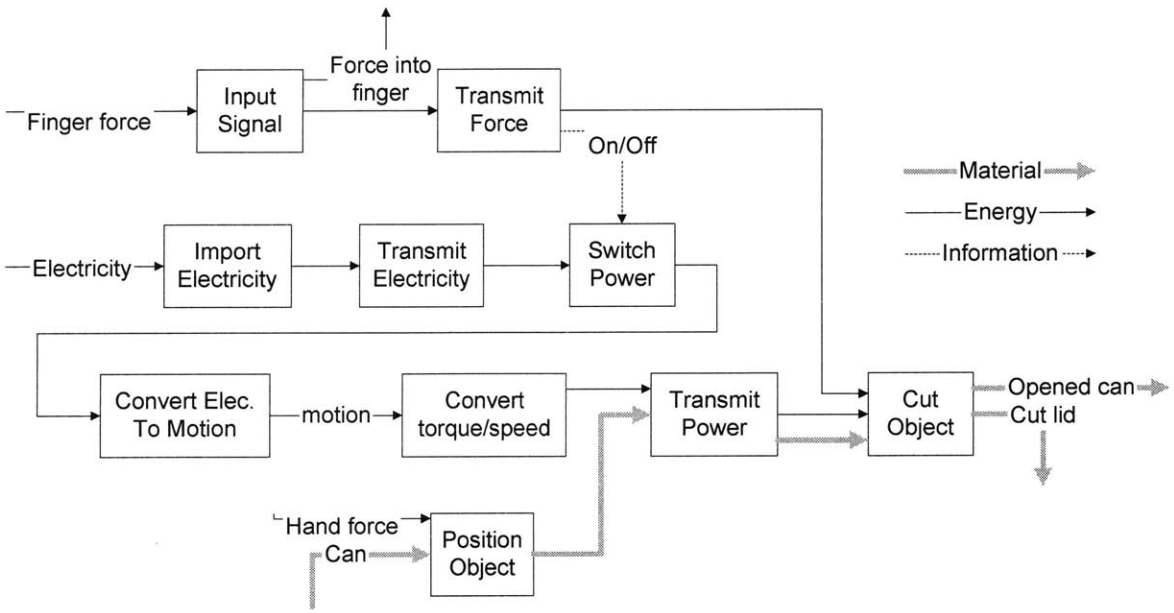


Figure 3.3.1. Function structure of an electric can opener.

3.3.2. Product Family Function Structure

A function structure for multiple products in a product family can be constructed by overlaying individual product function structures into a single function structure (Zamirowski and Otto, 1999; Otto and Wood, 2000; Dahmus, et al., 1999). The union of all product variant function structures is a single diagram of product family function structure that has every function in every product variant including all the flows. A product family function structure is useful to investigate

opportunity for possible commonality among product variants to develop a product platform as a building block foundation for a product family. The family function structure in Figure 3.3.2 illustrates how it is done on a Hamilton Beach® electric can opener and mixer. The intersection between mixer and can opener function structures are shown in unshaded boxes. Otto and Wood (2000) suggest that these common functions are candidates (at least theoretically) to be modularized and used as a common platform that appears between the two products. Unique functions in product variants should also be grouped to isolate variety, which will be helpful to improve product development efficiency. This approach resembles the concept of delaying product differentiation in design for variety, as coined by Martin and Ishii (1997).

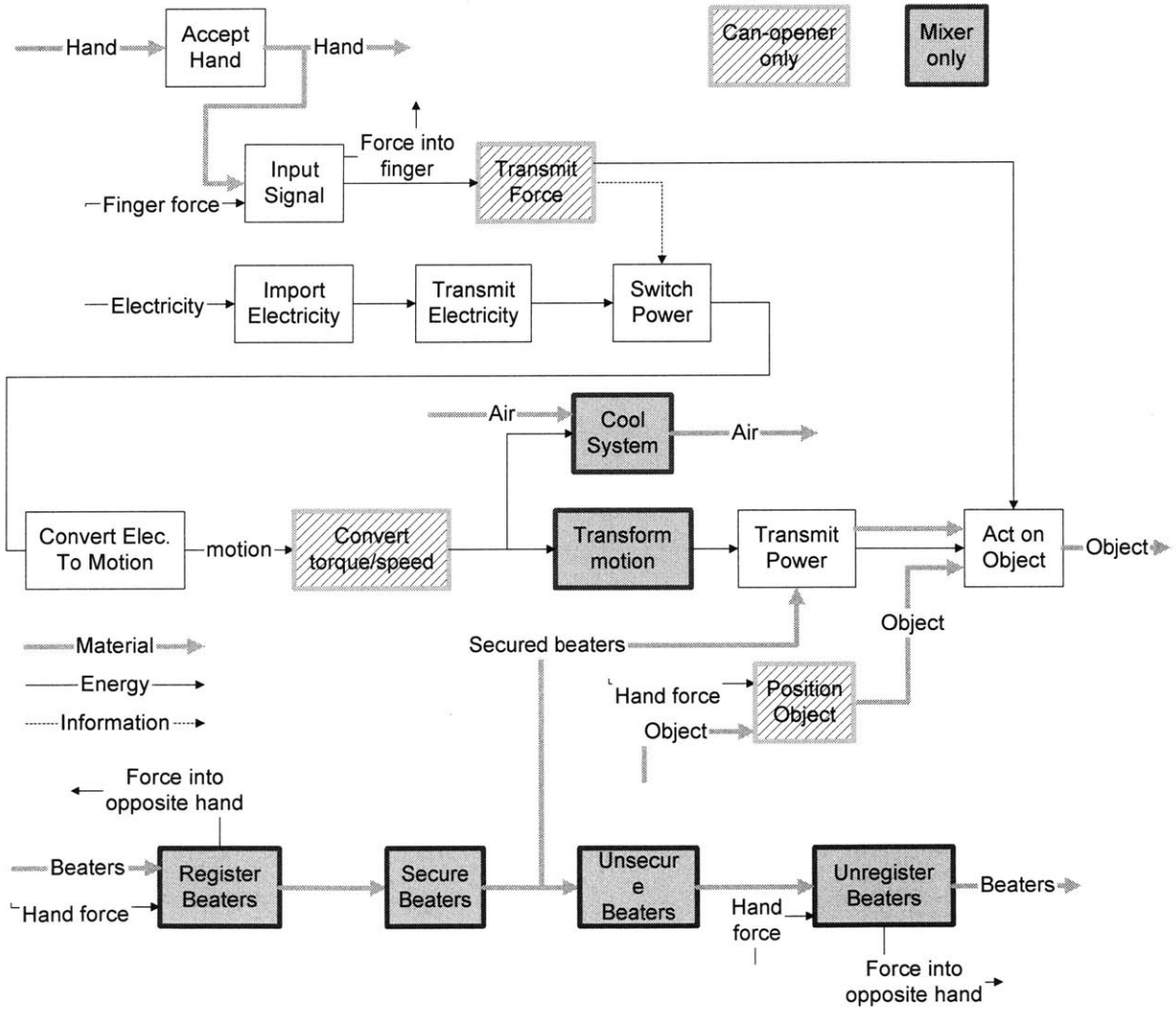


Figure 3.3.2. Family function structure of Hamilton Beach® mixer and can opener.

3.4. Modular Product Architecture

While product portfolio architecture deals with multiple products in a product family, product architecture deals with a single product and how to map its overall product functionalities--as demanded by its customers--into a product form including its functional components and their interfaces (Otto and Wood, 2000; Sanchez, 1999). Modular architecture is created when the interfaces among its elements are standardized such that it allows product reconfiguration by substitution of its components with a range of variations without requiring changes in the design of other components (Otto and Wood, 2000; Sanchez, 1999). This condition is achieved because the elements in the product (i.e., modules) have a one-to-one relationship with the product's functions (Ulrich and Tung, 1991; Cutherell, 1996).

3.4.1. Modular Architecture Classification

There are two major perspectives of modularity that can be used to classify modular architecture (Otto and Wood, 2000):

1. *Device-based modularity* with an emphasis on intrinsic product functionality. There can be several classifications of device-based modularity (Ulrich and Tung, 1991; Otto and Wood, 2000).
   1.1. *Component-sharing modularity* where the same components are used across many different products. Product interfaces and components are standardized so that component-sharing among products in the family is permitted.
   1.2. *Component-swapping modularity* as a complementary view to component sharing modularity. Here, the product interfaces are able to accept a range of component variations. These components can be inserted to reconfigure the product to accomplish different tasks.
   1.3. *Bus modularity* is where the main product has *multiple identical standard interfaces* that accept a number of combinations of different functioning modules. Functionalities of a product are improved or enhanced by accepting additional modules in the bus interfaces.
   1.4. *Sectional modularity* where a collection of modules builds a functioning product. The product can grow (i.e., scale up or down) by chaining interconnections among modules through standard interfaces.
2. *Manufacturing-based modularity* is employed to facilitate manufacturing or assembly process. This type of modularity can be classified as follows (Otto and Wood, 2000):
   2.1. *Assembly modularity*, where a collection of components form a module to increase assembly ease

2.2. *Sizeable modularity*, where components are exactly the same except for their physical dimensions

2.3. *Conceptual modularity*, where the same functions are implemented with different physical embodiments. This module requires a change in manufacturing or assembly process without significant changes in the rest of the product elements

3.4.2. Modular Architecture Rules

Modular architecture is characterized by standardized interfaces among its modules to create loosely coupled modules so that variety can be created with relatively isolated (i.e., local) changes. A module in a modular architecture is a collection of elements that has strong internal connections but has relatively weak external connections with other elements (Baldwin and Clark, 2000). A module may be identified by cluster among functions that have strong dependencies or interfaces among each other as identified by information, energy, or material flows in the product function structure. A dependency mapping representation such as Design Structure Matrix (Steward, 1981; Ulrich and Eppinger, 1999) is useful to identify clusters as possible modules (Pimmler and Eppinger, 1994; Baldwin and Clark, 2000). While Design Structure Matrix seeks module identification by means of numerical representation using a clustering algorithm (Eppinger, 1991, 1997; Eppinger, et al., 1994; Pimmler and Eppinger, 1994; Smith and Eppinger, 1997), Stone (1997) proposed a set of heuristics to construct modules by identifying flows (information, energy, and materials) in a product function structure as follows (see also Otto and Wood, 2000).

M1. Dominant Flow Rule. A module can be formed by grouping a set of functions for which a flow passes through them from the start to the exit of the flow in the system.

M2. Branching Flow Rule. Modules can be formed by grouping sets of functions that make up branches in the function structure. All modules (one per branch) must interface at the last function before the flow branches.

M3. Conversion-Transmission Rule. A module can be formed by grouping a pair of functions that performs a conversion of the flow (information, energy, or material) from one type to another, and the transmission of the flow.

Figure 3.4.1 illustrates the application of Dominant Flow, Branching Flow, and Conversion-Transmission Rules in a function structure.

For a product family, as discussed in Section 3.3, modularity rules can be extended to include a product platform shared by multiple products in the family as follows (Zamirowski and Otto, 1999; Otto and Wood 2000):

M4. Function Sharing Rule. A platform module can be constructed from a set of functions that are shared among variants in a product family. This rule can be applied to the maximal extent of common functions in the product family function structure or sub-systems within a complete set of shared functions. The application of this rule is illustrated using the Hamilton Beach® can opener and mixer, presented in Figure 3.3.2.

M5. Unique Function Rule. Conversely to the function sharing modularity, a module may be formed from a set of functions that is unique to a single product variant. Because unique sets of functions are applicable to a single product, it is logical to combine them into a module to ease assembly efficiency as intended by manufacturing-based modularity, as discussed in Section 3.3. The application of this rule is illustrated using the Hamilton Beach® can opener and mixer presented in Figure 3.3.2.

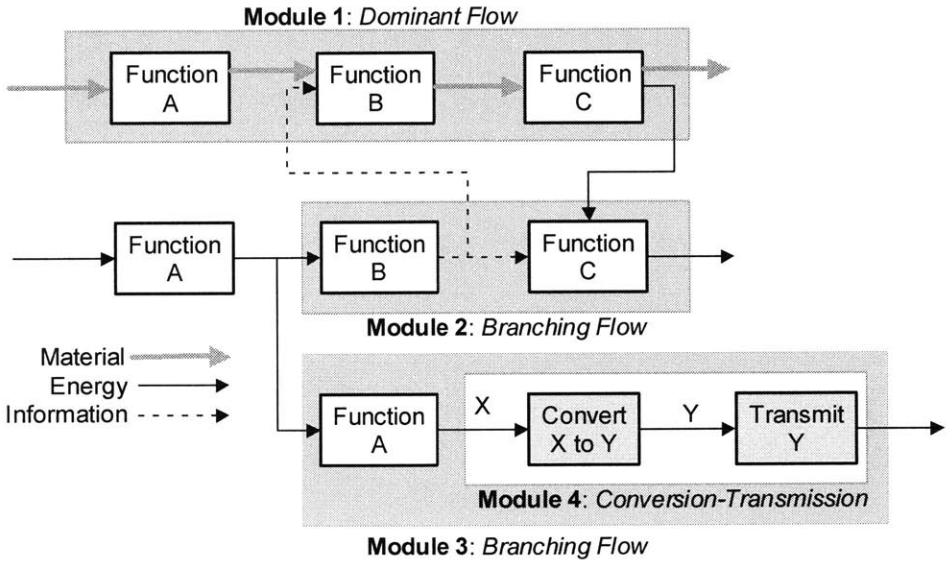


Figure 3.4.1. Product modularity rule illustration: Dominant Flow, Branching Flow, and Conversion-Transmission.

The aforementioned modularity rules will be further developed in Chapter 5 to address the need to modularize product architecture to support multiple brands.

Chapter 4. Brand Differentiation Consumer Insight Study: Automotive Case

4.1. Introduction

The goal of the study in this chapter is to get better understanding and insight of consumer responses to brand differentiations and similarities for products that are developed from a common product platform. The intended outcome of this study is a set of empirical extractions of brand differentiation nuances that eventually lead to the development of general principles to deliberately engineer product differentiations in a brand portfolio. These empirical observations will be combined with the brand differentiation principles discussed in Chapter 2 and platform architecture principles presented in Chapter 3, to formulate a set of principles to develop a platform for multiple brands presented in Chapter 5. Consistent with the overall thesis theme, the study limits its focus on product-related aspects (i.e., other marketing-mix elements are not considered in the study) that support brand differentiations. A qualitative approach for the study was selected due to the following considerations:

- Hirschman (1983) argues that customers do not make rational choices. Instead, they are quite emotional and, therefore, feeling may be more appropriate as a dependent variable.
- Many researchers believe that perceptions of products are inherently unified configurative gestalt in nature rather than individual discrete element evaluations (Veryzer, 1993; Bloch, 1995; Veryzer and Hutchinson, 1998).

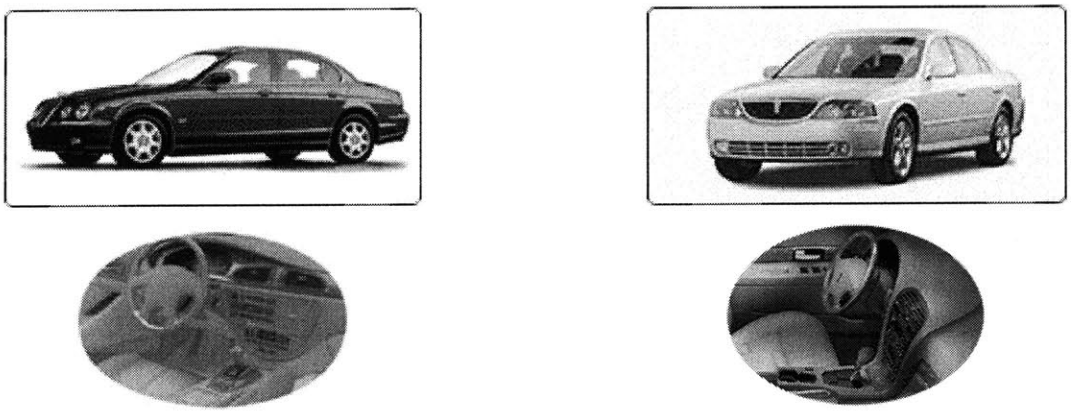
Considering the above, it is more advantageous to study consumer responses qualitatively through personal interviews to encourage customers to express their holistic perceptions about a particular set of brands. To acquire an assemblage of rich responses that include both functional utilization and emotional (i.e., aesthetic) benefits, complex products of automotive interiors were selected. In particular, Jaguar S-Type® and Lincoln LS® (see Figure 4.1.1) were selected because those two brands share a common product platform, yet they are perceived as very different products.

> *When Ford built two luxury sport sedans off the same platform, no one expected the result to be two highly individual and foreign-feeling cars. Unbelievably, the Ford Motor Co. has managed to build both at once—the Jaguar S-Type® and the Lincoln LS. Because the two luxury sport sedans share genes (Ford's new DEW platform and 40% of parts), I feared they would be too similar, but quite the opposite is true.* (Zesiger, 1998)

> *Given the new Jag's sensual shape and exhilarating power, it's hard to believe it shares a heart and skeleton with the Lincoln LS. Underpinning the S-Type and the LS is a mechanical platform*

engineered by Ford—the first to support both a Jag and a Lincoln. And each borrows the other's engine... The LS is not the same car as the S-Type. The Lincoln is made in America; the Jaguar in Britain. Each feels, drives, and looks like a different car. The Jag is elegantly curvy, while the LS's rakish styling seems equal parts BMW and Lexus. (Naughton, 1999)

The Jaguar S-Type® and Lincoln LS ® case is especially interesting because Jaguar is known to have a very strong brand image and identification, while Lincoln LS® is a new "silver bullet" brand (see discussion in Chapter 2) to capture younger markets, and it departs significantly from its traditional Lincoln roots.



Jaguar S-Type

Lincoln LS

Figure 4.1.1. Jaguar S-Type® and Lincoln LS® and their interiors.

4.2. Voice of Customer Acquisition Strategy and Approach

This study followed a methodology developed by Griffin and Hauser (1993) and refined by Burchil and Hepner-Brodie (1997) that includes the following steps:

Develop Interview Scenario

Eight subjects to represent four Jaguar S-Type® and four Lincoln LS® owners were selected in this study. The study intent was to capture two types of customer responses:

1. *Stimulus-based responses.* The stimulus-based responses attempt to capture short-term memory responses from direct experience of sensory such as sight, sound, touch, and smell. Here, customers are provided with experiences of driving both Jaguar S-Type® and Lincoln LS® for a short period of time (e.g., about 15 minutes for each vehicle). A related study by Carpenter et al. (1994) indicates that customers tend to mention even trivial differences to

compare the brands. However, in general, customers are expected to focus on important differentiation and similarity attributes, while unimportant differentiation and similarity attributes are considered only after the important attributes have been exhausted (Kardes, 1999).

2. *Memory-based responses.* While the stimulus-based attempts to capture customers' perceptions of brand differentiation and similarity from individual product elements, the memory-based responses attempt to capture more holistic and projective responses, including attitudes and beliefs. A follow-up interview was conducted with each customer one week after the direct experience interview. Kodak MAX® cameras were distributed to the customers at the end of direct experience interview, and each customer was asked to take pictures (any picture other than car pictures) that reminded them of Jaguar S-Type® and Lincoln LS® interiors. The pictures were used to stimulate projective responses during the follow-up interviews.

To acquire rich responses, a full factorial of a designed experiment setup was used to assign the interviews as shown in the following table.

Table 4.2.1. Design of experiment setup for the interviews.

Subject #	Driving Sequence	Stimulus-Based Interview Focus	Memory-Based Interview Focus
1	Jaguar, Lincoln	Jaguar	Jaguar
2	Jaguar, Lincoln	Jaguar	Lincoln
3	Jaguar, Lincoln	Lincoln	Jaguar
4	Jaguar, Lincoln	Lincoln	Lincoln
5	Lincoln, Jaguar	Jaguar	Jaguar
6	Lincoln, Jaguar	Jaguar	Lincoln
7	Lincoln, Jaguar	Lincoln	Jaguar
8	Lincoln, Jaguar	Lincoln	Lincoln

For example, subject #1 was asked to drive a Jaguar S-Type® prior to driving a Lincoln LS. The interviewer probed for perceived differences and similarities between the two brands while the subject sat in the second vehicle. At the end of the interview, the subject was given a disposable

camera for one week and was asked to take pictures as assigned in the above table. The pictures were used to stimulate customers' projective view during the follow-up interview.

Create Interview Guide

The interview guide was created to ensure that the interview covered important issues consistently and stayed on track with subjects relevant to the objective of the study. The interview guide was constructed in an outline format that would provide enough freedom during the interview, yet maintain the consistency, sequence, and priority of the topic, to avoid inadvertent omission of important information. The interview guide had two main sections:

1. Stimulus-based, direct experience, detailed interview directly related to the Jaguar S-Type® and Lincoln LS® product attribute differences and similarities.
2. Memory-based (picture interview) to better uncover customers' holistic and projective perceptions.

Select Customers for Interview

Consistent with the objective of the study, eight customers were selected to represent Jaguar S-Type® and Lincoln LS® owners or prospective owners. The customers were asked to drive both vehicles for a short period of time according to the assignment in Table 4.2.1. After the interview, the selected customers were told to take 6-12 non-automotive pictures that would remind them their experiences with a Jaguar S-Type® or Lincoln LS®. These pictures were used during the follow-up interview.

Conduct Customer Interview

The execution of the customer interview, according to the interview guide, involved both direct driving experience and picture interviews. The stimulus-based direct experience interviews lasted about 75 minutes, including 30-minute test drive of both vehicles, while the picture interview lasted about 30 minutes for each customer. All interviews were tape recorded to maximize data capture. During the direct experience interview, customers were requested to drive the vehicles and interviews were conducted while the customers sat in the second vehicle (see Table 4.2.1). Both holistic and detailed observations were encouraged during the interviews. During the in-vehicle interviews customers typically made comments about various details and features in the vehicle

while the picture interviews were much more holistic and projective expressing their attitude and recalled impressions about the vehicles.

Transcribe Customer Interviews

Each of the recorded interviews was transcribed verbatim with minimal grammatical editing.

Identify Key Voice of Customers (VOC)

The process of identifying the VOC included the identification of relevant statements in the transcripts. These statements were highlighted and copied onto cards without editing. The cards were arranged to find natural groupings among the statements. Twenty-two natural groups emerged from this exercise to identify the key VOC. The strongest and most representative statement was selected in each group and was placed on top of the card stack.

Scrub VOC to Extract Customer Requirements

For each group of VOC statements, key ideas were identified, and customer requirement statements were constructed to represent the theme of the groupings. The customer requirements were constructed using the following guidelines:

- Identify complete statements expressing brand differentiations and similarities and extract the key ideas.
- Capture both practical considerations (e.g., steering wheel) as well as abstract or vague statements (e.g., elegant).
- Whenever possible, search for physical or functional characteristics (e.g., shapes) that relate to abstract statements (e.g., elegant).
- Phrase the statement in a positive sentence by avoiding the use of the word "not" and to highlight its relevancy to brand differentiations.
- Ensure that the statement is consistent with the VOC from which it was constructed.

As a result of this step, 22 customer requirements were identified for brand differentiations.

Create Affinity Diagram Group Customer Requirements

Obviously, it would be quite overwhelming to address all 22 customer requirements simultaneously. Therefore, 22 requirements were further grouped using affinity diagrams to create

fewer *strongest* requirements. As a result of this step, 11 *Level-1* groupings emerged. Further high level grouping resulted in 4 *Level-2* requirements (see the grouping results in the Affinity Diagrams in Figures 4.3.1-4.3.4 in Section 4.3).

Qualitative Analysis

A qualitative analysis of the requirements was conducted based on the topic suggested by the result of the affinity diagram. A detailed analysis was conducted for each of the requirements identified in the previous steps. This qualitative analysis is discussed in Section 4.3.

4.3. Qualitative Analysis of Voice of Customers

The voices of customers are grouped into four main categories: (1) Visual appearance, (2) Utilitarian attributes, (3) Brand identity, and (4) Brand personality as shown in the affinity diagrams below.

4.3.1. Aesthetic Form

Aesthetic forms of product provide users enjoyment experiences beyond practical considerations and generate strong attention. In these customer interviews, four strong categories emerged: visual appearance, material, workmanship, and sound quality.

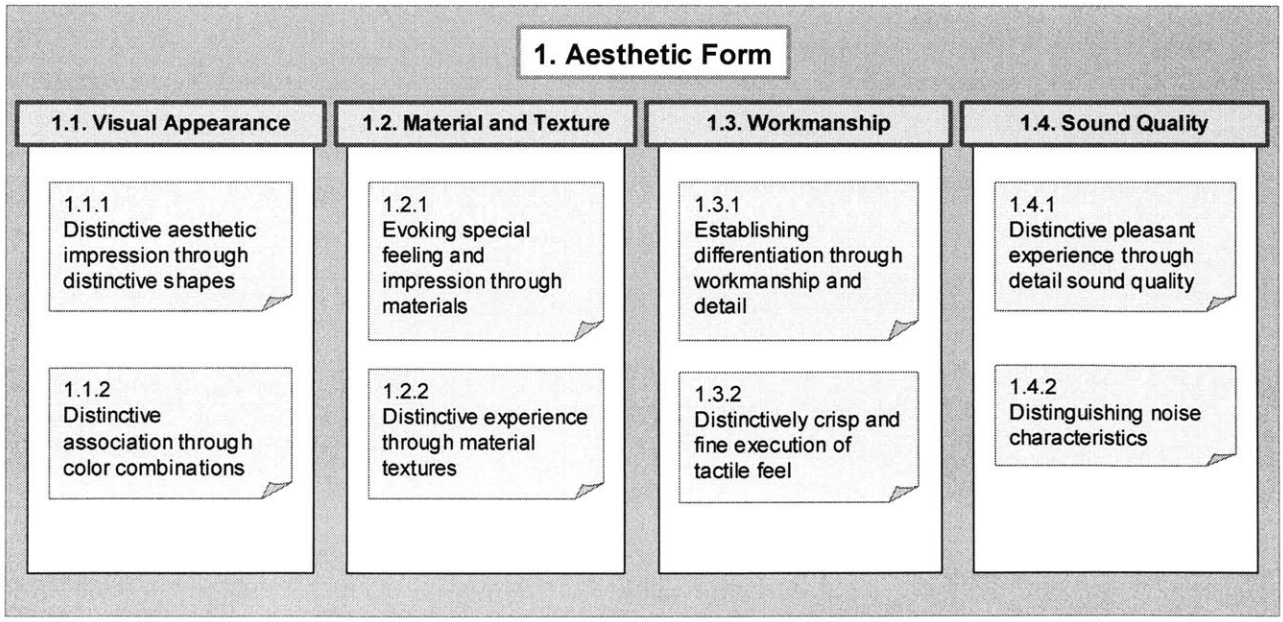


Figure 4.3.1. Affinity diagram for the aesthetic form.

Distinctive aesthetic impression through distinctive shapes

Customers engaged in different levels of emotional responses toward Jaguar S-Type® and Lincoln LS® such as "*This one (LS) is cleaner, solid, and masculine while Jaguar is more luxury and comfort.*" Differences in the dominant shapes of the interiors between the two vehicles, in particular, draw a strong distinction between the products and generate various impressions as follows:

> *"The boxy style (of LS) and the edges kind of have a masculine look: an extension of power and finesse"*
>
> *"Jaguar feels very smooth while LS has hard edges which is still nice but it is less elegant than Jaguar."*
>
> *"The Jaguar dash is more blended-in and curvy and softer type of appearance"*
>
> *"The Jaguar is aesthetically pleasing"*

Distinctive association through color combinations

Colors and color combinations in the products trigger distinct associations and experiences. In particular, responses from Lincoln LS® owners differ significantly from those of Jaguar S-Type® because the LS generally uses darker color combinations (dark wood with dark vinyl in the interior) than that of the Jaguar:

> *"The material, color combination, and strong lines… is elegant yet durable. It makes a statement but not pretentious or ostentatious"*
>
> *"The whole color theme and the strong lines and the masculine color"*
>
> *"I do not know why the black, the gray, and deeper colors seem to remind me of LS… everything about strength and dark colors is kind of what I get when I see the LS interior"*

Evoking special feeling and impression through materials

Because of tactile feel, material creates a certain feel, sensation, and strong associations with the product such as strength, warmth, and naturalness. Organic materials, such as wood and leather, are perceived as warm, luxurious, elegant, traditional, natural, and soft while, inorganic materials such as metal, glass, and chrome are perceived as a luxury associated with strength. Woods, in particular, have a strong association with Jaguar such as stated by some customers.

"The overall luxurious feel of wood and leather in the instrument panel and steering wheel of Jaguar, the rich wood trims, Jaguar has to have that"

"I love the wood, it's good, solid, and pretty"

"It's the way they use the wood. It's difficult to put it in words, but Jaguar is more stylish and elegant"

Distinctive experience through material textures

Similarly, the texture of materials also carries strong tactile and visual sensations, especially the naturalness of the wood texture.

"The texture and the grain of the wood is being natural and foresty-looking gives me the impression of quality and pleasing"

"When you touch the wood, it has a relaxing and luxurious feel"

Differences in textures and quality feel of the textures between materials in Lincoln LS® and Jaguar S-Type® separate user experiences of the two products:

"The wood on the dash panel is rougher and not as refined as in Jaguar, but this one looks more durable"

"The feeling that I have about the wood in the Jaguar gives a little bit nicer feel, better texture, and more visual appeal"

Establishing differentiation through workmanship and detail

The workmanship and the execution of the design also have an impact on the product differentiation. Workmanship encompasses design aspects envisioned by the designer:

"The Jaguar has a lot more attention to details and feels..."

"All the elements in Jaguar are just refined"

Additionally, workmanship includes the quality of manufacturing and assembly processes, i.e., it includes not only finely designed elements in the interior, such as the rich woods and the elegant of the design but also the imperfections as a result of manufacturing and assembly processes.

"Everything seems to fit and finish real well"

"The common theme is that all of these are done with precision and hand made artistic looks even though they're not"

Distinctively crisp and fine execution of tactile feel

Similar to workmanship, which includes fit and finish, the fine execution of product elements that affect touch and tactile feel create a strong impression and confidence about the product. Strong negative reactions are common when they are not done right.

"I don't like the tactile feel of it. It feels loose and doesn't feel tight. It's cheap"

"The control kind of sticks and is difficult to work with. It's not crisp and clean"

"It takes quite a bit more pressure. It doesn't feel as good as in the Jaguar"

"This car is kind of clunky"

On the other hand, a fine execution is a delight to customers. Therefore, touch quality may be used as significant brand differentiators.

"The smoothness of the switches ... the way the controls operate is almost a feather touch"

"The quality of the feel really defines a Jaguar"

Distinctive pleasant experience through detail sound quality

Sound evokes very sensitive reactions from customers because it creates an impression of quality. A soft clicking sound from switches and controls provide positive impression because of its refined and quality characteristic as expressed by some customers in the interviews:

"I like the sound when you click the buttons"

"When you click it, it doesn't sound cheap"

"It does have a pleasant sound when you use the turn signal"

"I like the little beeping that you get on the temperature control when you change the setting"

As sound creates impression of quality, premium brands can be differentiated from the rest by using sound quality.

"I feel like all the functions are the same but how this is designed, including the clicking sound, is different"

"The click just doesn't sound the same. Things that you hear are very much different and it does give you different impression"

Distinguishing noise characteristics

On the other hand, unintended sound, or noise, creates strong negative responses such as "*The engine sounds a little bit harsher in terms of noise, more outside noise comes in.*" When unintended noises commonly encountered in similar products are eliminated, delight reactions happened.

"The sound doesn't sound like screaming. It is a very pleasant hum"

"It's solid. When you drive it, the road noise is limited. It feels solid, where as other vehicles have squeaks and rattles"

Clearly, both types of sounds (pleasant sound feedback as well as noise) can be manipulated to create brand differentiation as suggested by the voice of customers.

4.3.2. Utilitarian Attributes

Utilitarian attributes are benefits directly provided by the functions of the products. These benefits have direct links to customer experiences. Excelling in utilitarian attributes is crucial for product differentiation. The challenge is to select where it must show attribute leadership to support differentiation from other brands in the portfolio as well as its competitors.

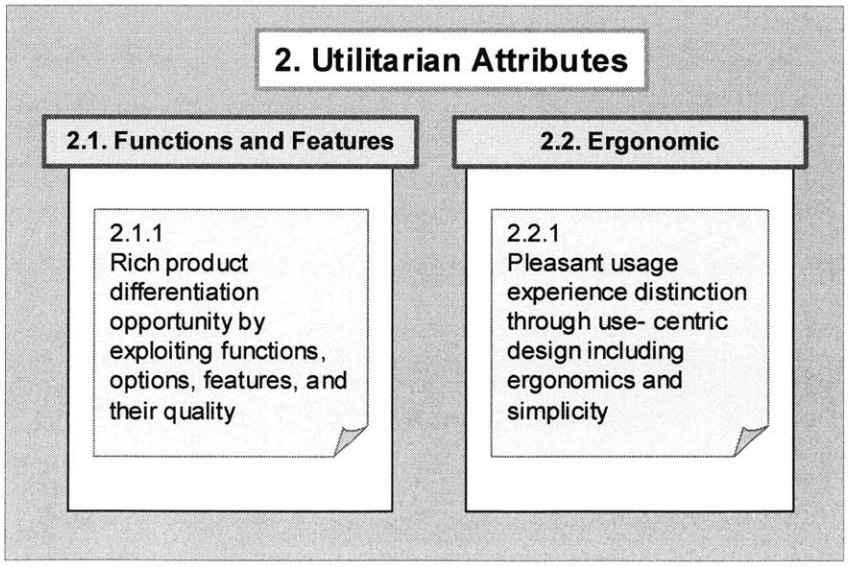


Figure 4.3.2. Affinity diagram of utilitarian attributes.

Rich product differentiation opportunity by exploiting functions, options, features, and their quality

Function is what the product does. Function provides utilitarian benefits that are relevant to customers. Functional differentiations for products with the same utility are quite difficult because the products typically offer the same functionalities. For example, a customer made a statement about the navigation system in the Jaguar S-Type: "*It's a big distinction. This one has a navigation system.*" However, when she was asked whether she would have had any objection if Lincoln LS® had a similar navigation system feature, she replied: "*I think navigation system is a way of the future. Every car would eventually have navigation system.*" Therefore, when customers voice the following wants it may be difficult to use them as points of differentiation among brands.

"The heated seat is a very nice option"

"It has the same memory setting feature for the seat..."

"It would be nice to have a dual lighter"

"I like the option of controlling the stereo from the steering wheel..."

"The dual climate control is nice"

"I like the homelink where you can program it for your garage door and others..."

Nevertheless, because product functions directly provide benefits sought by customers, then creating product function differentiations is fundamental for overall product differentiation. One way to make a distinction is to deliberately not provide some of the functionalities in the sister brands consistent with their brand positioning. Another way is to provide similar functions but with a different degree or quality of achieving the functions as part of the overall design theme as exemplified by the Jaguar.

"The Jaguar did a couple of things differently such as the defrost function looks different, sharp, and does different things for you"

"They put more thought where they put the overall function"

Pleasant usage experience distinction through user-centric design including ergonomics and simplicity

Ergonomics involve providing customer wants to maximize ease of use and comfort to support product functionality.

"It's ergonomically placed and you can easily reach everything right from the driver's seat without having to stretch or lean"

"It's very well thought out and placed. The buttons are large and plenty of extra spaces. The controls are very simple and usable"

"Everything seems to be in a good area. I like the way the cockpit is laid out and the opening on the steering wheel as you drive you can see everything clearly"

"The seat is very comfortable as you spend most of your time driving"

"The layout of the cluster is very easy to see and easy to get through"

"When I sat in LS everything is cluttered. The way they put it is just there because they need to put it somewhere"

"I feel there is a separation between the car and me. I don't feel one with the overall instrument panel"

While the degree of ergonomics satisfaction can be used as point of differentiation, a more interesting opportunity to highlight differentiation occurs when trade-offs between ergonomics and product aesthetic must be made. That is, the most aesthetically pleasing product may not be the most ergonomic product and vice versa as voiced by customers during interviews:

"It's functional ergonomically but the way it wraps around makes me feel a little bit tight... styling-wise, it is really great but I felt a little bit constrained in this vehicle."

"The way the line is executed in LS is a little more functional than Jaguar. The Jaguar sacrifices some of the functions to the style such as the less space for legroom."

"I think the Jaguar does a very good job in presenting the integrated theme in the interior and I do not mind to have it less functional to get the elegant styling."

4.3.3. Brand Identity

Brand identity provides purpose, direction, meaning, and significance of the brand (Aaker, 1996) and how it wants to be perceived by its customers. Because brand identity consists of unique brand associations that link the brand and the customers, it is very important to establish brand differentiators to support the intended brand identity. The following discussion details some important aspects of brands that must be differentiated. It is worth noting Aaker's (1996) warning of the caveat of brand identity due to product-attribute fixation traps, in which strategic and tactical decision for the brand is solely based on product attributes. Aaker (1996) argued that a brand is

more than a product and when product attributes are used as the sole basis for brand identity, they often fail to create differentiation, easy to copy, assume that customers obey rational decision-making process (which may not be the case), and limit the flexibility of the brand.

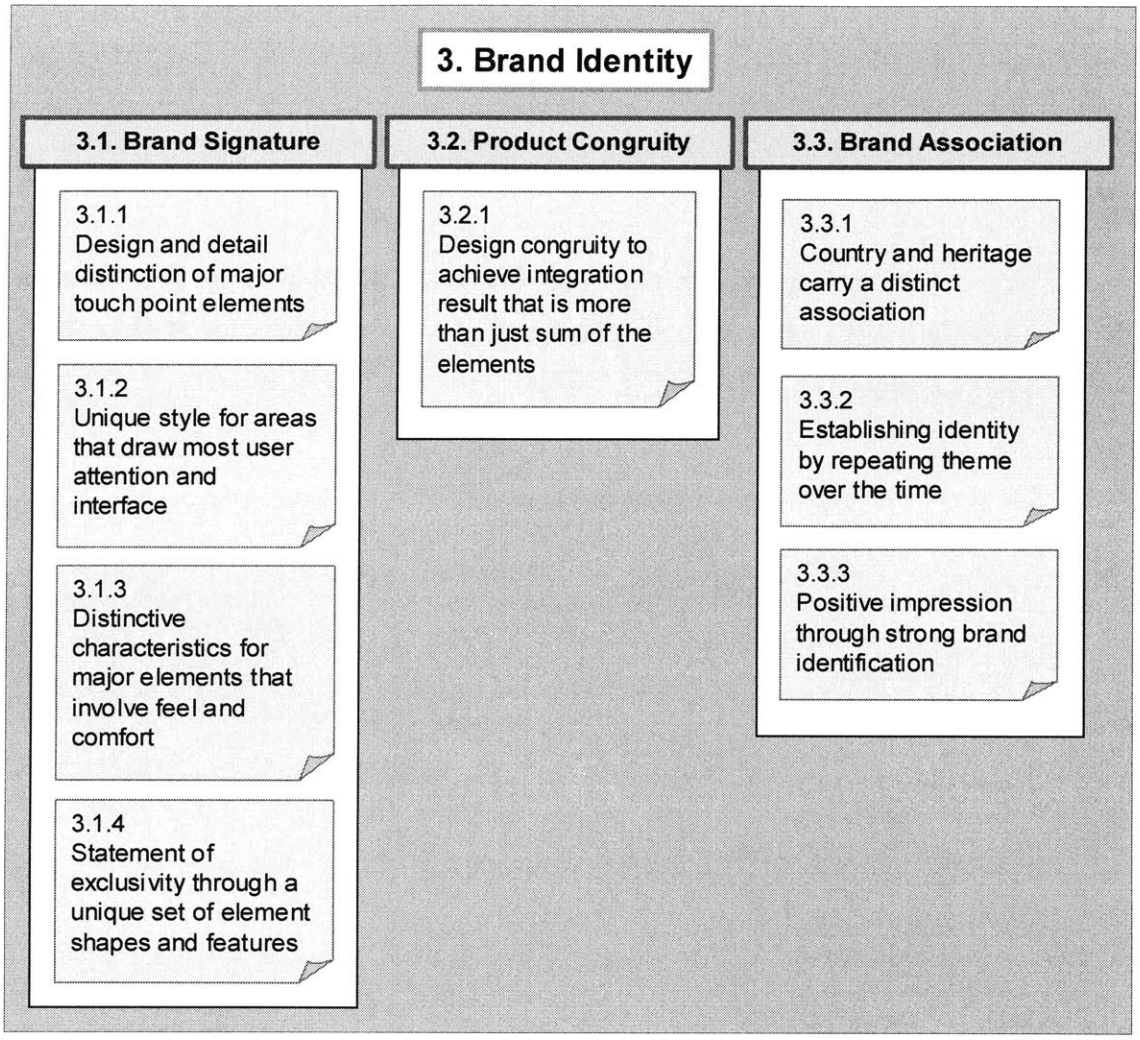


Figure 4.3.3. Affinity diagram of brand identity

Design and detail distinction of major touch point elements

As previously discussed, aesthetic form plays a major role in product distinction, in particular, the aesthetic form of major touch point elements. In the Jaguar S-Type® and Lincoln LS® case, steering wheel aesthetics is one of the most critical elements that the two products must have for strong aesthetic and detail design differentiations.

"The steering wheel, because you touch and feel it. Because you always touch it, it reminds you that I've got something special here"

"The steering is a big difference. It's a major touch point"

A major interface component for both touch and visual appearances (e.g., steering wheel) may trigger strong reactions as one of the Jaguar S-Type® owners said: "*As I sit in the car I feel that I sit in a luxury just by the steering wheel alone.*" Similar opinions appeared for the Lincoln LS.

"This one (LS) has a wood steering wheel also but the Jaguar feels much better"

"As I step in LS, seems like it's a common steering wheel that goes with other Ford cars"

"The steering wheel is typical of Ford or Lincoln."

"They could have done a little better on the design of the steering wheel to make it different from a mid-priced car... to give some kinds of luxury in terms of the detail"

When deliberate and conscious differentiations are made, a major touch point can be used as a central differentiation point.

Unique style for areas that draw most user attention and interface

Complementary to the previous statement, unique design styles should also be incorporated in areas that draw most user attention or that are frequent interfaces, such as the instrument panel and the center stack, where the audio and climate controls are located: "*The center is where I focus the most. That's the area that draws most of the attention: integrated console, center stack, audio.*" Customers frequently commented on the differences between the Jaguar S-Type® and the Lincoln LS® interiors.

"The biggest differences are the instrument panel brow and the cluster. The cluster might be the same but the brow in the instrument panel and how it goes over the center console are quite unique and very different"

"The stereo in the center stack is very well laid out. Very clean and understated but it's still nice enough for a luxury car"

"The climate controls seem to have similar features with dual zone, but the Jaguar did a couple of things differently..."

Distinctive characteristics for major elements that involve feel and comfort

While products may have similar functionality and design, product differentiation can be created by providing distinguishing characteristics of feel and comfort. These characteristics are

different from the practical ergonomic considerations. The products can be ergonomically similar but they provide different experiences as illustrated in the Jaguar S-Type® and Lincoln LS® seats.

"The other seat is more luxurious but this one is more for hard driving and a racer feel"

"At least for me the seat cushion feels the same, but the contour of this seat has more of a racing feel as opposed to luxurious"

"The seat is not as plush... more compact yet it's comfortable"

"I am thinking softness and fluffiness of comfort especially when you sit in a Jaguar..."

Statement of exclusivity through a unique set of element shapes and features

While the previous three categories address major elements in the product that need to be differentiated, there are also some less important elements in the product that may be made unique and eye-grabbing to signify brand signatures. Jaguar S-Type® employs this approach very well, as stated in the interviews:

"The Jaguar has a distinctive J-shape (transmission) shifter"

"I like the very distinctive gearshift here in the Jaguar. It's an important characteristic"

"Jaguar is always Jaguar ... the J-shape control should be exclusive"

"It definitely has a lot nicer and distinct features, especially the wood, the J-shape shifter ... They are different enough to make a real distinction"

"The J-shape shifter is different and I like it because it gives a sportier edge over the LS"

An automatic transmission shifter is not a major element that draws attention, yet the uniqueness of its shape supports the overall presentation of Jaguar and reinforces its distinction.

Design congruity to achieve an integration result that is more than just the sum of the elements

A product is a blend of numerous elements into a whole to create an overall statement. The congruity and unity of the product theme is more than the sum of the individual elements. The interviews indicate that for complex products (e.g., car interior), consumers observed the "Gestalt law" of proportion and unity (Veryzer and Hutchinson, 1998) as well as linear processing of individual elements (Durgee, 1988). That is, consumers performed both holistic evaluation and individual element evaluations and how they fit together.

"It's not really so much any one element that is or isn't right in the Jaguar, but the whole; how everything comes together and gives you that feeling"

"How the overall shape and how everything comes together is just very well done… smooth and flowing and no sharp edges"

"All the elements in Jaguar come and play together really well"

"The appearance and display is not a big deal, both (LS and Jaguar) are acceptable. It comes into how they come together, how they flow together, and how they perform and feel"

"Just the way the whole thing together is very nice compared to LS"

"I think Jaguar does a very good job in presenting an integrated theme in the interior"

"Overall is very crisp presentation and indicative of luxury and sporty"

"The mixture of the wood grain is more integrated where it belongs with the accent of the wheel and shift lever"

"The harmony of it in LS has to go a little further while the Jaguar seems doing much better"

"Here is kind of a little bit disjointed between the black trim and the gray trim. It does not seem to come together well"

"The appearance makes me feel very comfortable. Everything is very well done. The colors are very well matched"

Country and heritage carry a distinct association

The country of origin, or heritage, signifies brand identity and association (Haubl and Elrod, 1999). It generates a strong point of differentiation through quality and the personality associated with it—"*For the Jaguar, I would buy more because of the history while the LS is more the contemporary.*" A strong association with product heritages was frequently mentioned during the interviews.

"Jaguar is British luxury and what that means"

"It shows a strong English heritage… reminds you that you're being pampered"

"This has a more European look, although LS is more European than other Ford vehicles"

"Comfort and sophistication, integrating American tradition with a modern world"

"It reminds me of an American root of Lincoln as opposed to European"

"Someone thinks that the car is trying to be like German cars, but I think it's important to maintain the root of an American tradition"

Establishing identity by repeating theme over the time

Brand identity can be created by repeating consistent design cues, such as shape or color across products in the same brand or over time. This repetition makes brand identity easier to understand, to remember, and to link to the brand and thus positive associations are enhanced. The challenge is how to manage consistency of design cues while avoiding customers' boredom of identity. The need for creating identity through repetition appeared frequently during the Jaguar S-Type® interviews.

"It gives you the sense of classy, a timeless classic"

"Just kind of having a classic kind of look and style"

"Jaguar hangs on to the classic look with the wood and the leather flowing together"

"The Jaguar has a strong theme that is carried over from the past"

"The classic look is exclusive to Jaguar. The styling of Jaguar hasn't changed dramatically in many years"

"Jaguar seems to preserve a classical image from the past"

"To me, Jaguar is more deserving and has an antique impression"

This identity creation, through consistency repetition, is a challenge for Lincoln LS® where it tries to depart from its traditional Lincoln identity.

"The LS is adding to the tradition of American sporty feel ... kind of integrating the experience of driving Mustang and Continental"

"... doing traditional Lincoln while appealing to a younger crowd"

"... kind of contemporary art deco type of appearance, which is a blend of traditional and modern looks..."

Positive impression through strong brand identification

Brand identity is a unique set of brand associations (Aaker, 1996). These associations represent the promise of the brand and what the brand stands for. Part of the brand identity is the execution of product attributes (both functional and aesthetic forms). As brand identity helps to establish a relationship between the brand and the customers, lack of brand identity obviously put the brand into a disadvantage position as apparent in contrasting the Lincoln LS® and the Jaguar S-Type.

"To see a Jaguar you know that it's a Jaguar"

"The LS is not as apparent as to what vehicle maker it is"

"It's difficult to say what defines an LS"

"The LS buttons seem very similar to other Ford vehicles while Jaguar is very unique"

"It almost seems the look and the components are almost like any other car"

"Sitting in Jaguar you know what you're sitting in"

4.3.4. Brand Personality

Brand personality includes characteristics associated with a given brand. These characteristics support the fulfillment of emotional experience and self-expression of the user. Emotional experience provides positive-feeling benefits that enrich the experience of using or owning the brand beyond its practical considerations. Self-expression provides a way for the user or owner of the brand to communicate his or her self-image. The brand personality is a result of functional benefits and design aesthetics that are consistently built in the brand.

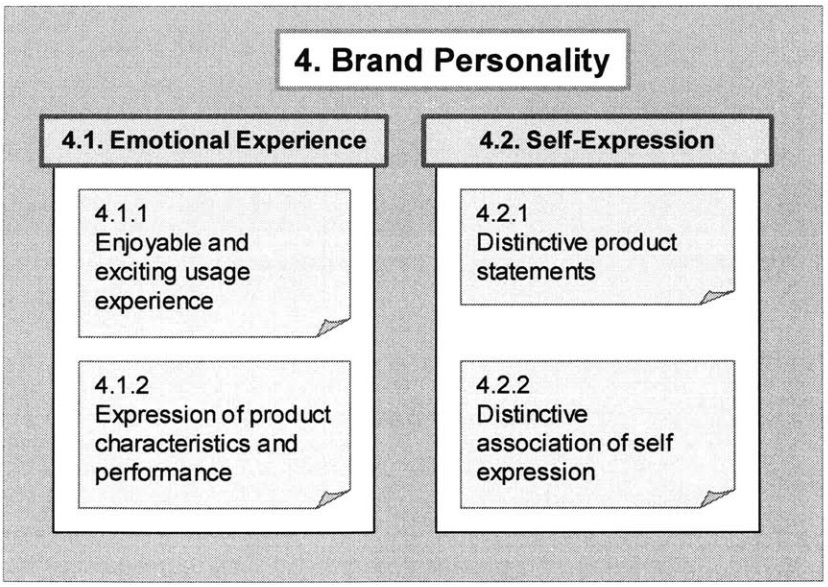


Figure 4.3.4. Brand personality affinity diagram.

Enjoyable and exciting usage experience

Distinctive product characteristics create special usage experiences as expressed by Lincoln LS® owners.

"I was thinking about the endurance in the long run"

"It represents enjoyment, exciting to drive and a nice long ride"

"This car makes me feel that I want to get in and drive it..."

"... more of city car, sophisticated as opposed to a car that you take on a country road"

Expression of product characteristics and performance

Product-related characteristics and performance articulate distinct emotional benefits. For example, Lincoln LS® owners mentioned the following attributes:

"The wind in the trees... I can feel myself flying with my LS"

"Power, speed, and mobility"

"You feel that the LS is more rugged, durable, and masculine than the Jaguar"

"It is fast and swift yet powerful but it's also beautiful"

"You feel that this is more hard-hitting while Jaguar is smoother"

"Something that is strong, powerful, well made, rugged, long-lastong, and outdoorsy"

"The car is more performance luxury while the Jaguar is more luxury performance"

On the other hand, the Jaguar owners expressed the following:

"The Jaguar takes the sporty feel one step further and also more appealing and sexier"

"They definitely convey the impression of sporty while it is a luxury car"

Distinctive product statements

People make statements through the product or brand they use or own. Self-expressive benefits reinforce the connection between the product and the owner. Product characteristics make statements as suggested by a Lincoln LS® owner: "*Simple, elegant not ostentatious. It's grounded and firm. LS should be understated and not trying too much.*" The Jaguar S-Type® owners express the following:

"It gives a smooth and elegant impression"

"It's something above and beyond the average thing, something that someone with taste would appreciate. It's about prestige"

"You feel that you need to take care of a Jaguar and pamper it while with an LS you just throw yourself in and let it go"

Distinctive association of self expression

For some customers, brands are used as a medium to express their self-identity or idealized self-identity. For a strong brand, product characteristics are important to support the self-expression needs of its users, as mentioned by many Jaguar S-Type® owners during the interviews.

"The common theme is luxury. I want the vehicle to be rich and luxurious"

"I would like the cars to be designed for me... I would like the sense of exclusiveness"

"It gives you a sense of special and unique"

"You feel like you're special and treated as someone special"

"It is being pampered and spoiled"

"Someone who has money and belongs to a nice country club and would show it off"

"It's fun and glamorous"

"It reminds me of a movie star with a glamorous feeling"

4.4. Brand Differentiation and Commonization Summary

Ford Motor Company developed Lincoln LS® and Jaguar S-Type® using a shared common platform, yet they remain distinctive and consistent to their respective brand characteristics. While Lincoln LS® and the Jaguar S-Type® share many basic components, they have unique elements in the areas that consumers see, touch, and feel. While there are some minor feature and functionality differences, the major differentiation between the two brands are accomplished by product aesthetic forms and the degree to which they perform these functions. Overall, many drivers never perceive the cars' common underpinnings, even though the two vehicles were developed from the same product platform for the following reasons:

1. A clear distinction of dominant themes exists between the two brands. The dominant theme follows the Gestalt law, i.e., the whole (product congruity and unity) is more than the sum of the individual elements. The unique dominant theme was created from the integration of distinct customer perceived functional characteristics (i.e., features or quality of functional performance)

and product aesthetic forms. The establishment of dominant theme started with an abstract brand personality, or image, such as those shown in the following table:

Table 4.4.1. Jaguar S-Type® and Lincoln LS® brand personalities (images).

Jaguar S-Type	Lincoln LS
Elegant, Sensuous, Harmonious, British Heritage	Ambitious, Independent, Powerful, American Luxury

These abstract images were translated into a dominant theme for each brand in terms of product characteristics such as those shown in the following table:

Table 4.4.2. Jaguar S-Type® and Lincoln LS® product characteristic dominant theme.

Jaguar S-Type	Lincoln LS
Distinctive dramatic styling, Rich crafted interior, World class quality	Sporty, timeless design, Driving comfort, Dynamic performance, Relaxing and driver oriented interior

The product characteristic dominant themes were embodied by gestalt integration of product features, functionalities, and aesthetic forms as shown in the following table:

Table 4.4.3. Examples of dominant theme interior elements of Jaguar S-Type® and Lincoln LS® product functionalities and aesthetic forms.

	Jaguar S-Type	Lincoln LS
Instrument panel shape	Smooth and curvy	Angular and hard edges
Instrument panel touch materials	Fine wood	Imitation wood
Steering wheel	Wooded	Leather wrap
Button/switches	Soft touch	Hard touch
Seat	Plush	Sporty

Note that when the differentiation of functional characteristics is almost indistinguishable, dominant themes were established using product aesthetic forms of the most frequent product-user interfaces or usage areas using the integration of visual (shape and color) and tactile elements supported with auditory elements consistent with product aesthetic form discussed in Chapter 2.

2. Brand signature elements are established to support dominant theme. A select few design elements, either functional characteristics or aesthetic forms were exclusively repeated across

products and over time (i.e., product generations) within a brand. This repetition establishes brand identity. The brand signatures are especially strong in Jaguar S-Type® as exemplified by the J-shape transmission shifter, fine wood accents in the interior, and Jaguar design cues. These brand signatures are repeated across Jaguar brands and over time.

3. Elements that neither part of dominant theme nor brand signatures can be commonized.

The utilization of a dominant theme, brand signature, and commonization[4] in Jaguar S-Type® and Lincoln LS® is illustrated using a portion of the function structure of the interior, including seating, steering, instrument panel, and restraints as shown in Figure 4.4.1.

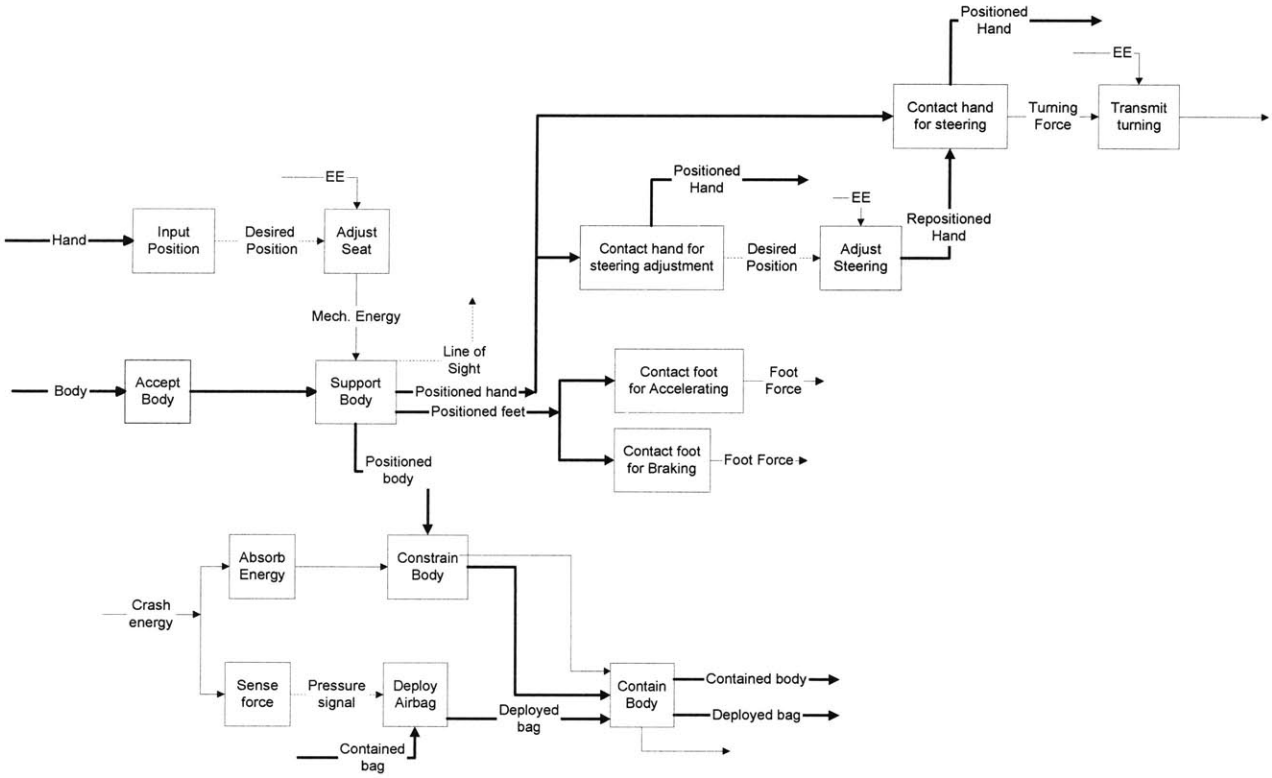
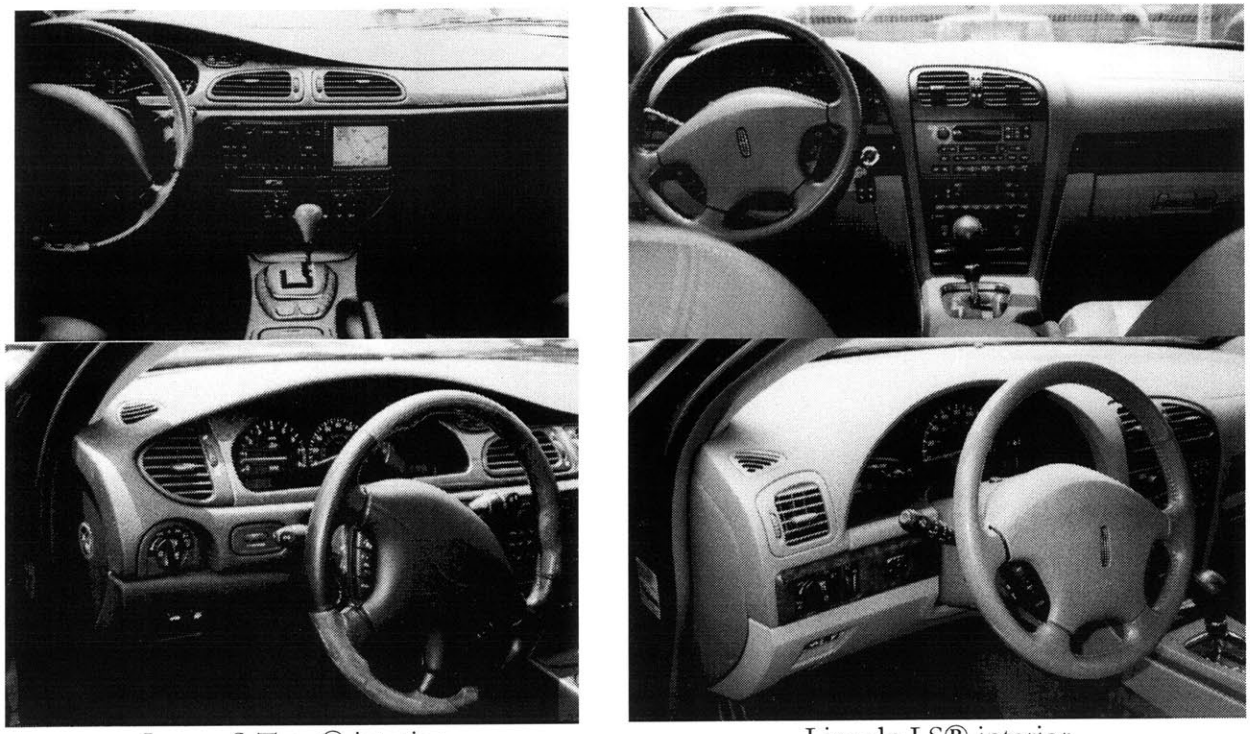


Figure 4.4.1. Partial function structure of vehicle interior.

The product aesthetic differentiations between the Jaguar S-Type® and the Lincoln LS® interiors are shown in Figure 4.4.2, where Table 4.4.4 summarizes the utilization of a dominant theme, brand signature, and commonization concepts.

[4] A more detailed treatment of this concept is provided in Chapter 5.



Jaguar S-Type® interior

Lincoln LS® interior

Figure 4.4.2. Jaguar S-Type® and Lincoln LS® interiors.

Table 4.4.4. Matrix of dominant theme, brand signature, and platforming.

Functions	Forms	Type
Input position	Switch	Dominant theme
Adjust seat position	Power module	Common
Accept body	Cushion	Dominant theme
Support body	Seat frame	Common
Contact hand for steering adjustment	Button	Dominant theme
Adjust steering position	Tilt/telescoping	Common
Contact hand for steering	Steering	Dominant theme, brand signature
Transmit turning	Steering column	Common
Contact foot for acceleration	Pedal	Common
Contact foot for braking	Pedal	Common
Absorb energy	IP structure	Common
Restraint body	Seat belt	Common
Sense force	Crash sensor	Common
Deploy airbag	Inflator	Common
Contain body	Air bag	Common
Encase	IP substrate	Dominant theme

Chapter 5. Merging Multiple Brands To A Platform

5.1. Principles of Brand Differentiation and Commonization

This chapter attempts to unify the concepts discussed in Chapters 2 and 3 along with the empirical findings in Chapter 4 to establish principles to develop a platform to support multiple brands. In particular, the findings in Chapter 4 are formally defined into brand modularity rules (Dominant theme, Brand Signatures, and Platform rules) to supplement modularity rules described in Chapter 3. The brand modularity rules are especially important to establish a product platform to support multiple brands. Special attention is paid to how to develop brand differentiation using a gestalt product dominant theme. This is the overall integration of aesthetics and functionalities that a brand is to have. Family function structure and brand modularity matrix methodologies are proposed to aid in the application of the brand modularity rules to architect a product platform. Jointly, the rules and the modularity matrix can be used as a framework to analyze and synthesize a product platform to support multiple products and multiple brands. The framework will be evaluated and demonstrated using several consumer products.

5.1.1. Brand Differentiation and Platform Decision

Brand differentiation entails product variety with its complexity of costs for product development, manufacturing, marketing, and sales, as well as post-sale maintenance. On the other hand, product commonization may cause a loss of profit opportunity as products become too similar and weaken profitable brands. As brand differentiation is important in generating profits by creating a premium price while product commonization is important in generating profits by creating a lower development cost, the decision to create brand differentiation or commonization through product platform can be summarized in Table 5.1.1, as follows:

1. *Platform component.* When a component is not important for brand differentiation, and the difficulty or cost to create variety is high, then the component is a candidate to be included in a product platform. The decision to select a platform often requires a trade-off between cost of the variety and "giveaway"/"loss of opportunity" costs. Giveaway cost is a cost due to the use of a higher end platform in a lower end product to satisfy high end product requirements while the loss of opportunity cost is the opposite condition.

2. *Brand-specific component.* When a component is important for brand differentiation or identity, and the difficulty (or cost) to provide variety is low, then the component should be made brand-specific.
3. *Does not matter component.* When a component is not important for brand differentiation, and the cost or difficulty to provide variety is low, then it does not matter for either brand differentiation or commonization. There are two ways to take advantage of this component: (1) Make the component a part of the product platform or (2) Find a way to use component variety to enhance brand differentiation, i.e., one should always change "does not matter" components into either platform components or brand-specific components.
4. *Analyze and decide component.* When a component is important for brand differentiation, but the cost to provide variety is too high, then one must analyze and decide whether the component should be included as part of the product platform or made brand-specific. In this situation, modular architecture (see Chapter 3) may be considered so that brand differentiation can be made while maintaining a low difficulty or cost condition, i.e., one should change the product architecture to make a component in the *"Analyze and Decide"* quadrant to fall into the *"Offer brand-specific"* quadrant.

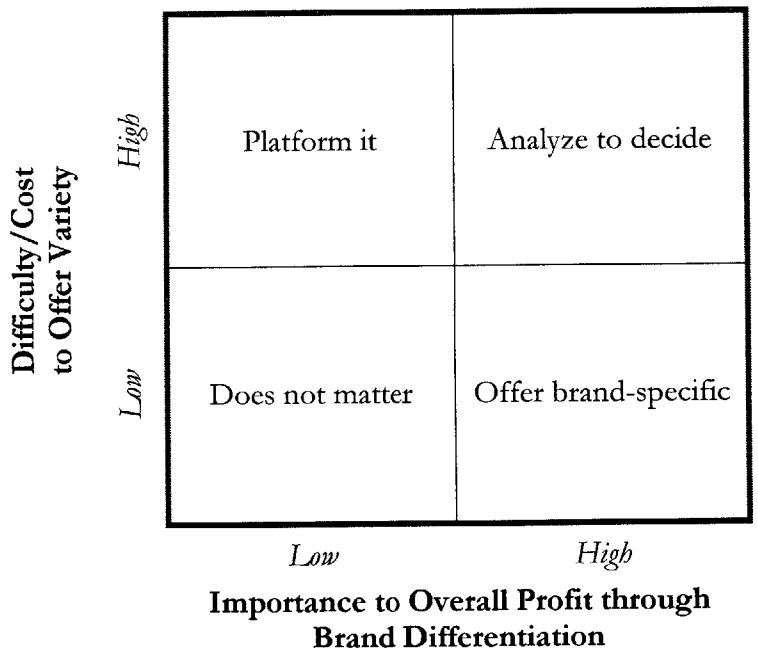


Figure 5.1.1. Decision table for brand differentiation and commonization.

For example, Black & Decker® uses a product modularization strategy to create brand variety, as illustrated in the Black & Decker® and Firestorm® cordless drills, as shown in Figure 5.1.2. A *component-swapping* modularity approach is employed to separate the housing of the drill to enable Firestorm, the high performance brand, to offer a dual-speed transmission for high speed/high torque capability not available on the basic brand.

(a) Black & Decker® cordless drill housing (b) Firestorm® dual speed gearbox

Figure 5.1.2. Component-swapping modularity in Black & Decker® cordless drill housing. The separation of the top section of the housing allows Black & Decker® to use the same housing for both Firestorm® and basic Black & Decker® products.

The decision table shown in Figure 5.1.1, however, does not provide guidelines whether a component is important or not for brand differentiation profitability. The next section presents answers to this question.

5.1.2. Brand Differentiation Rules

One of the most difficult question to answer in developing a platform to support multiple brands is what should be differentiated among brands and what can be made the same so that customers perceive multiple brands developed from the same platform as distinct products consistent with their individual brand positioning. From the model of customer responses presented in Chapter 2, there are several principles that must be followed:

- *Distinct product-related beliefs.* Products derived from the same platform must generate different belief characteristics, as indicated by distinctive brand personalities (see Chapter 2).

- *Distinct categorization.* Multiple brands derived from the same platform must be classified into different product categories (i.e., segments) by their consumers.

For designing a product platform architecture, however, this high level principle of customer responses must be made more concrete into product related characteristics. The following rules attempt to formally state the brand differentiation and commonization from a product-characteristics viewpoint:

Dominant Theme

R1: *Dominant theme rule.* Brands derived from the same platform must have a distinctive dominant theme. A dominant theme follows the Gestalt law, i.e., the whole (product congruity and unity) is more than the summation of the individual elements.

R1.1: A dominant theme must be created from an integration of distinct customer-perceived functional characteristics (i.e., features or quality of functional performance) or product aesthetic forms (see Sections 2.4.2 and 4.3.3).

The basic Black & Decker® and high performance Firestorm® drill/driver illustrate the dominant theme based on functional characteristic distinction as shown in the following figure. Note that Black & Decker® chose not to use a product aesthetic form (e.g., shape) as part of dominant theme differentiation.

Black & Decker® features include:
Dual-speed switch: 350/700 RPM
6 slip-clutch levels

Firestorm® features include:
Continuous-speed switch
24 slip-clutch level
High speed/high torque selection

Figure 5.1.3. A dominant theme differentiation between Basic Black & Decker® and high performance Firestorm® drills/drivers using feature combinations.

R1.2: When differentiation of functional characteristics are almost indistinguishable, a dominant theme must be made from product aesthetic forms of the most frequent product-user interface or usage areas (see Section 4.3.3) using the integration of visual (shape and color) and tactile elements supported with auditory and olfactory elements (see Section 2.4 and 4.3.1).

Berkowitz (1987) demonstrated that product shape exploitation creates effective differentiation. This case is illustrated by the differentiation between Firestorm® and DeWalt® drills/drivers, as shown in Figure 5.1.4. Both Firestorm® and DeWalt® have exactly the same product features. To create a distinctive dominant theme, Firestorm® and DeWalt® share no common aesthetic forms.

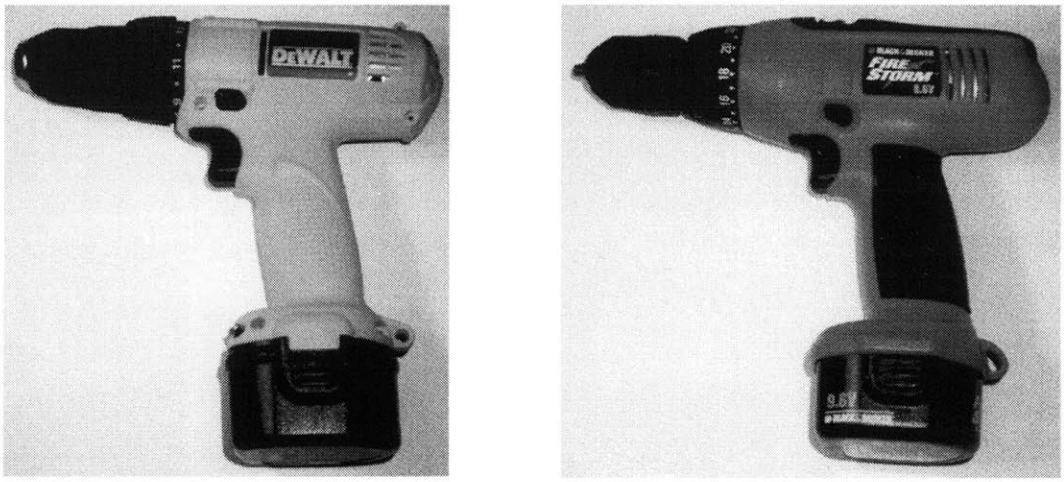


Figure 5.1.4. Distinctive aesthetic presentations of DeWalt® and Firestorm® drills/drivers are used to enhance brand differentiation due to similar brand features: continuous speed, fine grid clutch slip, and high speed/high torque features.

Stated succinctly, a dominant theme is the overall aesthetics and functionalities that a brand is to have. A set of elements defining the dominant theme may be considered as a "module" for brand-specific products. This modularization view resembles the "*Unique Function Modularity Rule*" (see Section 3.4.2) introduced by Zamirowski and Otto (1999).

Brand Signature

R.2: *Brand signature rule.* A selected few design elements, either functional characteristics or aesthetic forms, should be repeated exclusively across products and over time (i.e., product generations) only within a brand. This repetition of brand signature establishes memorable brand identity.

R2.1: Unique product forms, or cues, should be employed, maintained exclusively, and shared among products only within a brand.

For example, Firestorm® power tools use an orange and black color combination, Black & Decker® VersaPak® uses a blue and orange color combination, while DeWalt® uses yellow and black as their brand signatures, as shown in the following figure:

Brand Signatures				
	Color	Blue	Red	Yellow
	Touch Color	Orange	Black	Black
	Battery Pack	VersaPak®	7.2, 9.6, 14.4, 18	7.2, 9.6, 14.4, 18
	Selections	None	Many	Adequate
	Quality	Household	Good	Outstanding
	Power	Low	High	High

Figure 5.1.5. Brand signatures for Firestorm® and VersaPak® power tools.

All Firestorm® products uses orange and black colors, whereas all VersaPak® products use blue and orange colors and no other brand uses those brand signatures. Brand signature elements may be considered as "modules" defining a platform for all products in a brand.

Platform

R3: *Brand Platform rule.* Any element that is neither part of a dominant theme nor part of a brand signature may be commonized into a product platform. This rule resembles "*Function-Sharing Modularity Rule*" (see Section 3.4.2) proposed by Zamirowski and Otto (1999).

The case for the Platform rule is illustrated by commonization between Black & Decker® and Firestorm® drills/drivers as shown in the following figure:

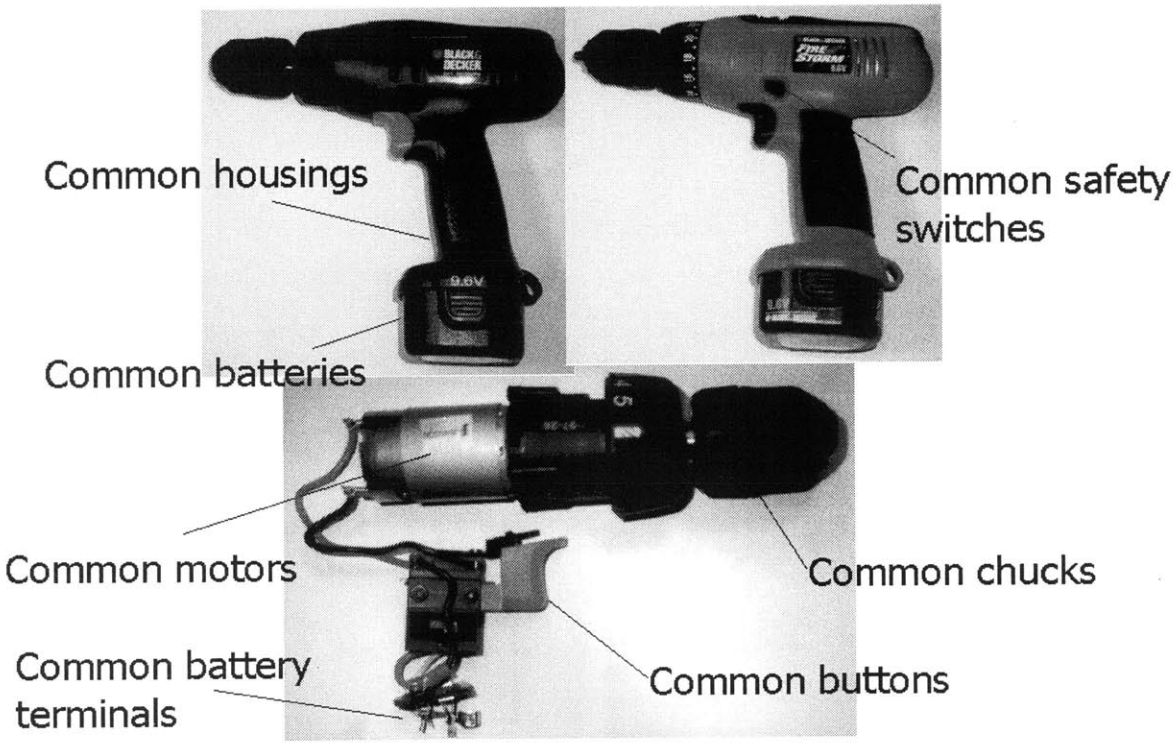


Figure 5.1.6. Common parts in Black & Decker® and Firestorm® drills/drivers.

5.1.3. Scoping Dominant Theme

A dominant theme is constructed with both functional and aesthetic characteristics. The question that remains is what are the concrete constructs of the dominant theme? What elements should be included and not included in the dominant theme that is significant for brand differentiation? There are two opposing views of this problem:

- *Atomistic view.* Most products consist of easily identifiable parts and each part is perceived independently by consumers. Therefore, the effects of the product elements to brand

differentiation are additive. If this is the case, techniques that ignore interactions among product attributes, such as conjoint analysis, where consumers are asked to rank their preferences of product attributes (Green and Srinivasan, 1990; Moore, et al., 1999) may suffice to identify elements that must be included in the dominant theme.

- *Gestalt view.* Congruity among elements, how they relate to each other, beyond mere chance that brought them together and, as a result, brand constructs interact with each other and create superadditive effects (Veryzer and Hutchinson, 1998).

An atomistic view is appropriate when the goal is to establish a product platform to create product variety for the purpose of mass customization (see Chapter 3), but where the products are still contained within a single brand. However, the reason to establish a brand portfolio is that each brand must have distinct associations and offerings reflected by each brand identity. Therefore, one may argue that a gestalt view is more appropriate to create a dominant theme. Bloch (1995) argues that both gestalt and atomistic processing occur simultaneously when consumers evaluate products. The brand is perceived initially as a whole and then, when product characteristics trigger further processing, individual elements will become more important. Consequently, a concept of design unity, as described by Veryzer and Hutchinson (1998), which includes gestalt perspective, should be employed during the construction of the dominant theme.

The gestalt view of brand differentiation has a significant practical implication on how to establish a minimum set of constructs for a dominant theme. Because of the interactions among elements in a product, a conjoint analysis approach to define a product platform as proposed by Moore, et al. (1999) may not be the appropriate method of choice to support multiple brands. The alternative, however, to employ a factorial designed experiment to include at least 2-level interactions is beyond practical considerations for a moderately complex product. For example, for a product with 100 components as a candidate for brand differentiation, there are 4,950 possible two-way interactions, and thus an exhaustive evaluation of interactions is a virtually impossible task. On the other hand, analyzing one factor at a time, based on a common product platform to identify whether a product feature can be used to carry brand differentiation, may not be warranted because it may not capture the gestalt and thus fail to lead to a proper establishment of a dominant theme. This case can be illustrated using product features in Black & Decker® and Firestorm® cordless drills/drivers as follows. Consider the case of establishing a dominant theme differentiation between the Black & Decker® and Firestorm® brands (e.g., basic and high performance brands) using speed switch, torque clutch, and high speed/torque features:

- Speed switch: dual-speed or continuous variable speed.
- Torque clutch: 6 steps or 24 steps.
- With and without high speed or torque capability

Customers may judge that none of the individual features is sufficient to create brand differentiation. However, a combination of two features, continuous variable speed and one other feature, was sufficient to create significant product differentiation, as illustrated in the Table 5.1.1 and the interaction plot in Figure 5.1.7.

Table 5.1.1. Cordless drill/driver categorization based on speed switch, torque clutch, and high speed/torque features.

ID	Speed Switch	Torque Clutch	High Speed/Torque	Product Category
1	Dual	6 Steps	Without	Basic
2	Dual	6 Steps	With	Basic
3	Dual	24 Steps	Without	Basic
4	Dual	24 Steps	With	Basic
5	Variable	6 Steps	Without	Basic
6	Variable	6 Steps	With	High
7	Variable	24 Steps	Without	High
8	Variable	24 Steps	With	High

The interaction plot, Figure 5.1.7, shows that a single individual feature alone did not make a product be categorized as a high performance product, but a combination of variable speed and 24-step clutch, or variable speed with a high speed/torque feature did make the product distinctive from the basic brand.

When such gestalt interaction effects occur, starting from a common product platform and analyzing one feature at a time to create brand differentiation, generally, will not be successful. Instead, one must start with distinctive product elements to maximize brand differentiation and then merge them to create a product platform using a "*subtract and analyze*" approach. That is, instead of started from a common product platform to create brand differentiation, one should start from distinctive products and perform a one-at-a-time element commonization approach, ensuring that one maintains brand differentiation. An element is included in the platform (i.e., not part of the dominant theme) when commonization of this element does not reduce brand differentiation. A

product platform is the result of the common elements identified by such an iterative "subtract and analyze" process. The remaining brand differentiation carrying features set up a dominant theme and brand signatures.

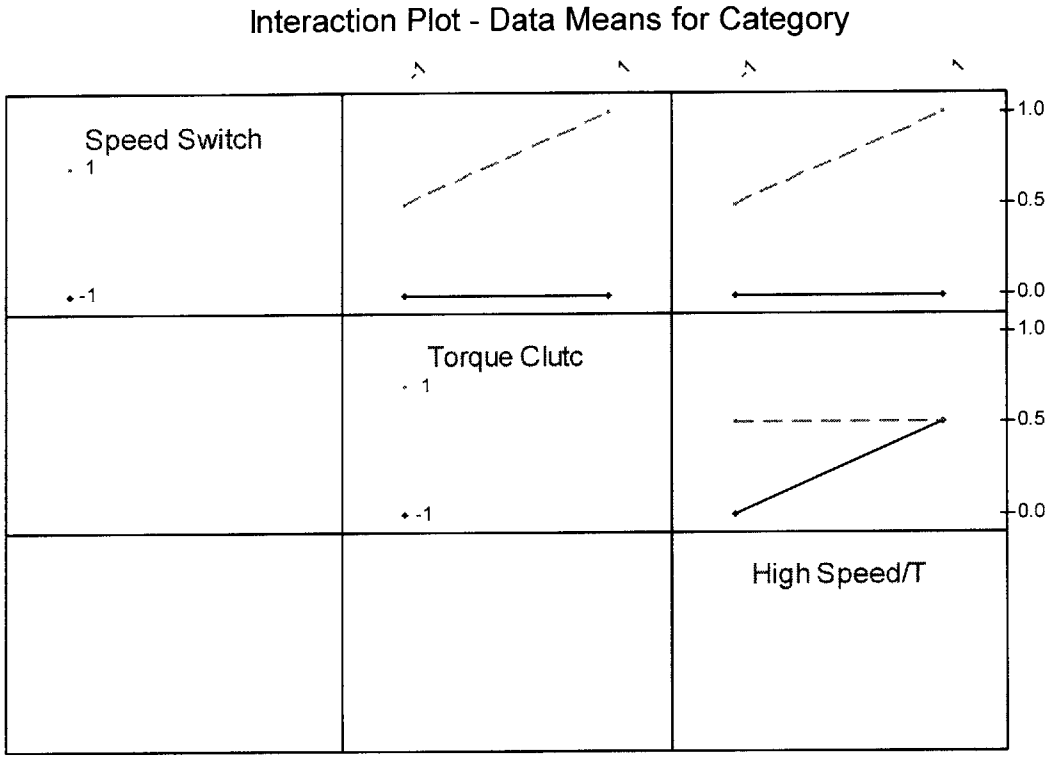


Figure 5.1.7. Interaction plots of speed switch (-1: dual speed +1: variable speed), torque clutch (-1: 6 steps, +1: 24 steps), and high speed/torque (-1: without, +1: with) features to product categorization (0: basic, +1: high performance).

5.2. Gestalt Characteristics of A Dominant Theme: Empirical Experimentation

Again, gestalt characteristics of a dominant theme imply that customers' responses to overall product attributes are greater than the sum of individual element evaluations. Therefore, gestalt characteristics suggest that interactions among elements in a product create "super additive" effects to overall product characteristics. To evaluate the existence of gestalt (i.e., interactions), an experiment was conducted using the dominant theme construction of Black & Decker® and Firestorm® cordless drills/drivers. Black & Decker® is the basic (low end) brand while Firestorm® is the high performance brand. Both of these products are developed from a common platform, as evidenced by component-sharing between the two brands (see Section 5.3 and Figure 5.1.2.).

5.2.1. Experiment Method

Five design factors, each with two levels, were selected in the experiment, as summarized in Table 5.2.1 (see also Figure 5.2.1). There are $2^5 = 32$ possible combinations of the above factors. A half-fractional factorial of 16 drill combinations were used in the study for the above factors, as summarized in Table 5.2.2. The 16 combinations of functional drills were made from the Black & Decker® and Firestorm® drills by interchanging their components to create the combinations in Table 5.2.2.

Table 5.2.1. Factors in the Black & Decker/Firestorm® experiment.

Factors	Level 1	Level 2
Speed Switch (Control)	Dual	Continuous Variable
Torque Clutch	6 Steps	24 Steps
High Speed/Torque	None	Yes
Color	Blue	Orange
Grip Pad	None	Yes

Thirty customers (15 engineers and 15 non-engineers) were asked to categorize the 16 combination drills into two categories: low (basic) or high performance based on the 5 product features. Each feature was explained to customers before asking them to categorize the drills into two categories. Customers had an opportunity to physically explore and use of all features included in the study.

Figure 5.2.1. Factors included in the experiment.

Table 5.2.2. Fractional factorial designed of experiment setting.

ID	Speed Switch	Torque Clutch	High Speed/ Torque	Color	Grip Pad
1	Dual	6 Steps	None	Blue	Yes
2	Variable	6 Steps	None	Blue	None
3	Dual	6 Steps	None	Orange	None
4	Variable	6 Steps	None	Orange	Yes
5	Dual	6 Steps	Yes	Blue	None
6	Variable	6 Steps	Yes	Blue	Yes
7	Dual	6 Steps	Yes	Orange	Yes
8	Variable	6 Steps	Yes	Orange	None
9	Dual	24 Steps	None	Blue	None
10	Variable	24 Steps	None	Blue	Yes
11	Dual	24 Steps	None	Orange	Yes
12	Variable	24 Steps	None	Orange	None
13	Dual	24 Steps	Yes	Blue	Yes
14	Variable	24 Steps	Yes	Blue	None
15	Dual	24 Steps	Yes	Orange	None
16	Variable	24 Steps	Yes	Orange	Yes

5.2.2. Experiment Result

The data from all customers were combined and presented as a six-dimensional contingency table (Speed switch, Torque clutch, High speed/torque, Color, Grip pad, and Category) where each cell in the table containing the count (frequency) of responses (Agresti, 1990). The data suggested that 3 factors—speed switch, torque clutch, and high speed/torque—were the significant variables. A log-linear model with a Poisson link function (Agresti, 1990) was used to analyze the data using the S-Plus statistical package (Venables and Ripley, 1994). The result of analysis of variance (ANOVA) is summarized in the following table.

Table 5.2.3. ANOVA of cordless drill product categorization

Factors	Coefficient	t value
Category	-0.1739	-2.3789
Speed:Category	0.5504	7.5305
Clutch:Category	0.5420	7.4149
Speed:Clutch:Category	0.0966	1.3210
High Speed/Torque:Category	0.3194	4.3690
Speed:High Speed/Torque:Category	0.0957	1.3099
Clutch:High Speed/Torque:Category	0.0873	1.1943
Speed:Clutch:Speed/Torque:Category	0.1661	2.2730

The ANOVA suggests that the Speed Switch, Torque Clutch, and High Speed/Torque are the dominant factors. Additionally, the three-way interaction among those three variables was also significant (t-value = 2.27). The four-way contingency table for the significant variables is shown as follows[5]:

Table 5.2.4. Four-way contingency table of categorization of 16 drills.

			Product Category (Count)		Product Category (Probability)		
Speed Switch	Torque Clutch	High Speed/ Torque	Low Performance	High Performance	Low Performance	High Performance	Odds of High Performance
2 Steps	6 Steps	No	57	3	0.1188	0.0063	0.0526
		Yes	51	9	0.1063	0.0188	0.1765
	24 Steps	No	42	18	0.0875	0.0375	0.4286
		Yes	34	26	0.0708	0.0542	0.7647
Variable	6 Steps	No	42	18	0.0875	0.0375	0.4286
		Yes	33	27	0.0688	0.0563	0.8182
	24 Steps	No	20	40	0.0417	0.0833	2.0000
		Yes	2	58	0.0042	0.1208	29.0000

The entries in the product category are count number of responses for low (basic) and high performance categories. For example, there were 57 responses that categorized drills with a 2-step switch, 6-step clutch, and no high speed/torque in the low performance category. The entries in the probability columns are the joint probabilities, π_{ijkl} (i = dual speed, variable speed; j = 6-step clutch, 24-step clutch; k = without high speed/torque, with high speed/torque; and l = low performance, high performance), which were calculated from the counts divided by $16 \times 30 = 480$ total number of responses. The *odds* that the response for row r (i.e., a given design combination ijk) is in the high performance category instead of the low performance category is defined as (Agresti, 1990),

$$\Omega_r = \frac{\pi_{r,\text{high}}}{\pi_{r,\text{low}}} \qquad 5.1$$

where $\pi_{r,\text{high}}$ is the probability that the design combination in row r is categorized as high performance and $\pi_{r,\text{low}}$ is the probability of design combination in row r is categorized as low

[5] Responses for drill colors and grip pads are combined because they are insignificant.

performance. With a value greater than 1 when a response is more likely to be categorized as high performance than low performance. For example, $\Omega_7 = 2$, then the 7th row response (variable speed, 24-step clutch, without high speed/torque) was twice as likely to be categorized as high performance than low performance.

The marginal distributions for all the features are obtained by summing the joint distributions as follows:

Marginal distribution of speed switch i: $\pi_{i+++} = \sum_j \sum_k \sum_l \pi_{ijkl}$

Marginal distribution of torque clutch j: $\pi_{+j++} = \sum_i \sum_k \sum_l \pi_{ijkl}$

Marginal distribution of high speed/torque k: $\pi_{++k+} = \sum_i \sum_j \sum_l \pi_{ijkl}$

Marginal distribution of category l: $\pi_{+++l} = \sum_i \sum_j \sum_k \pi_{ijkl}$

The joint probability of design factors and the categories are summarized in the following table.

Table 5.2.5. Joint probability of main factors and product categories.

		Product Category (Probability)		
		Low Performance	High Performance	Odds of High Performance
Speed Switch	2 Steps	0.3833	0.1167	0.3043
	Variable	0.2021	0.2979	1.4742
Torque Clutch	6 Steps	0.3813	0.1188	0.3115
	24 Steps	0.2042	0.2958	1.4490
High Speed/Torque	No	0.3354	0.1646	0.4907
	Yes	0.2500	0.2500	1.0000

Note that a product with variable speed and 24-step clutch has an *odd* greater than 1 (1.47 for variable speed and 1.45 for 24-step clutch) to be classified as a high performance product category than as a low performance category. Interestingly, a product with high speed/torque has equal odds with that of a product without high speed/torque to be classified as high performance. This suggests that the high speed/torque feature is not part of the brand differentiation carrying features (i.e., the dominant theme). However, one should take caution in interpreting the results in Table 5.2.5, which averaged main effects of the factors. Table 5.2.4 suggests that a product with variable speed and a 24-step clutch (which carries odds of 2 to be classified as a high performance product) when added with the high speed/torque feature has its odds of classification as a high performance product increasing dramatically, to 29 times. This situation indicates a superadditive effect of high

speed/torque when it is used in combination with variable speed and a 24-step clutch, a strong interaction, or gestalt effect. The interaction effect of high speed/torque can be calculated using the odds ratio between having and not having high speed/torque, given variable speed and a 24-step clutch:

$$\theta = \frac{\Omega_8}{\Omega_7} = \frac{\pi_{8,high} / \pi_{8,low}}{\pi_{7,high} / \pi_{7,low}} = 14.5 \qquad 5.2$$

The odds ratio is much larger than 1, and thus the high speed/torque has a strong interaction with variable speed and a 24-step clutch to create a high performance category even though high speed/torque alone does not have sufficient effect to make a product to be categorized as high performance.

The Black & Decker® and Firestorm® case provides an example of gestalt processing of customers toward product categorization. Therefore, an individual element evaluation to create a dominant theme may not be warranted, as some elements may have strong interactive effects with other elements where individual element evaluation may fail to suggest the inclusion of the element in the dominant theme definition.

5.3. Modularization for Brands: Function Structure and Modularity Matrix Representation

In this section, the modularization approach discussed in Chapter 3 is expanded to include brand considerations. While the approach discussed in Chapter 3 focuses mainly on product functions as the basis for modularization, this section will include product aesthetic forms, as both functions and aesthetic forms define brand dominant theme differentiation.

The modular product architecture discussed in Chapter 3 (e.g., device-based modularity) considers product modularity solely from its functionality point of view. Modularization of a product family, as discussed in Section 3.2.2, is also strictly function-based, as indicated by the inclusive use of family function structure to construct possible modules (Zamirowski and Otto, 1999; Otto and Wood, 2000; Dahmus et al., 1999). While all of these modularization approaches are applicable, the approach is incomplete because it does not address the need of brand differentiation to support multiple brands. Because both product functions and aesthetic forms are crucial ingredients to develop a platform to support brand differentiation, brand modularization must address both of these elements. That is, brand identity or differentiation should be created using a minimum set of combinations of product functions and aesthetic forms constituting a dominant theme while other, less brand-sensitive elements, may be used to develop a platform for all brands.

To concisely represent a product family architecture's function and form, family function structure and a modularity matrix is employed.

A family function structure for multiple brands is constructed from the union of all brands' function structures and then merged into a single diagram of product family function structure that has every function in every brand, including all the flows. As an example, the following figure shows the family function structure for Black & Decker® and Firestorm® cordless drills/drivers. All functions depicted by unshaded boxes are shared between the two brands, and functions denoted by shaded boxes are exclusive to Firestorm® only.

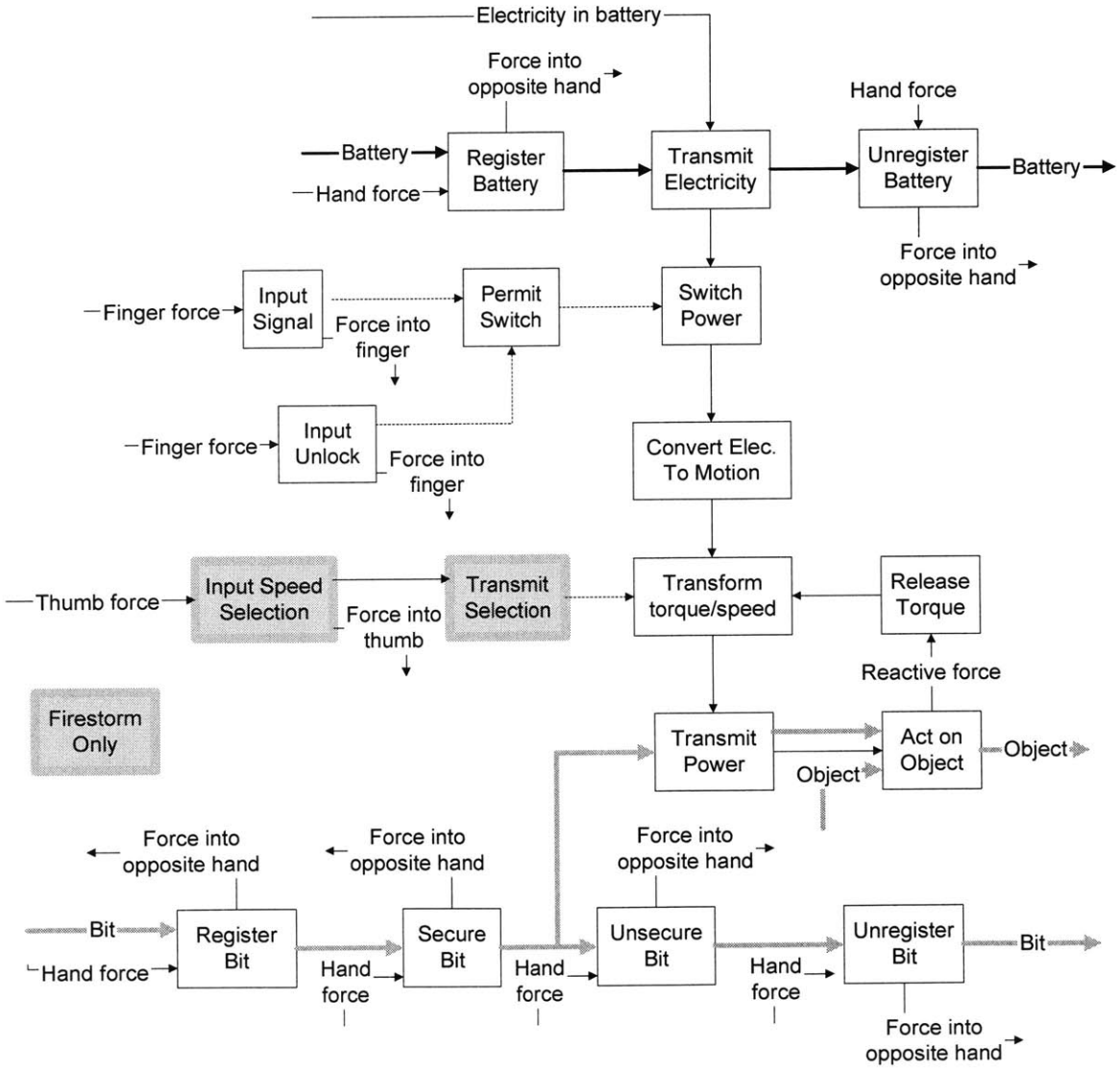


Figure 5.3.1. Family function structure for Black & Decker® and Firestorm® cordless drills/drivers.

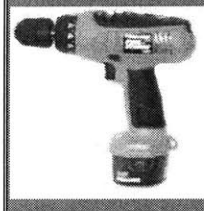
A family function structure is an effective tool to visually identify interactions of functions by tracing the flows and thus lead to candidates for modular partitions, as discussed in Chapter 3. However, it is difficult to simultaneously visualize partitions of modules in a product family using a function structure. Additionally, as functions are achieved and delivered at different quality levels or embodied differently for different brands, a family function structure is not capable of capturing all of this information concisely. To deal with this complexity, Dahmus et al. (1999) proposed a modularity matrix to aid in the application of modularity rules. A modularity matrix lists all functions in a family function structure as rows in the matrix, and lists all possible products from a product family, as columns. Each entry in the matrix contains required function specification levels. To apply this approach for brand differentiation, additional entries of brand identifications are added to describe specific brand attribute information in terms of product aesthetic forms, such as shapes and colors (see Chapter 2).

The specification values and brand differentiation attributes entered in each matrix represent targets for functions and their associated brand identity for each product. These various values establish the architecting space that will define a product portfolio architecture to support multiple brands. The design team must select specification values for the functions and necessary attributes that are likely to carry (or not to carry) brand differentiation. The extent to which a product specification and attributes is compatible defines how well the individual product will work and possess a distinct dominant theme. The extent to which a function has the same targets established across brands defines how well the function can be shared across brands in the family. That is, when the function does not carry brand differentiation attributes, this function can be shared for all brands as a part of the elements in the product family platform. The degree to which multiple products and multiple brands can be satisfied define how well the functions can be shared across products and brands.

Laying out this information in a matrix allows commonality and differentiation to be identified easily. The commonalities and uniqueness can, in turn, be identified as modules. A row-wise grouping identifies the same function targets into multiple brands of possible modules shared across brands, i.e., a brand platform. A column-wise grouping that incorporates multiple functions in a product leads to the identification of possible product modules, which can be selected by applying modularity rules such as dominant flow, branching flow, and conversion-transmission, as discussed in Chapter 3. A column-wise grouping that incorporates brand differentiation attributes identifies functions important for establishing the dominant theme of a brand. The modularity

matrix in Table 5.3.1 provides an example of some of the functions shown in the family function structure of Black & Decker® and Firestorm® cordless drills/drivers. Row-wise observations in the modularity matrix show that the "Convert Electricity" functions (i.e., DC motor) are common between the two brands, while the "Transform Torque (τ) and Speed (ω)" (i.e., transmission) as well as "Transform Power" (e.g., clutch) functions are unique for each brand because these functions are brand-differentiation carrying functions. Column-wise observations, in conjunction with modularity rules, reveal possible modules as exemplified by "Transform $\tau\omega$" and "Switch Speed." The combination of "Transform $\tau\omega$," "Switch Speed," and "Transform Power" functions a create unique dominant theme for each brand and thus they are used to support brand differentiations. The case of the Black & Decker® brand family will be discussed further in the next section.

Table 5.3.1. Partial example of modularity matrix for Black & Decker® and Firestorm® cordless drills/drivers.

	Firestorm	B&D
		
	High Performance	Basic
Convert Elect	Basic 100	Basic 100
Transform $\tau\omega$	2 speed Box	1 speed Box
Switch Speed	Ring Gear	--
Transmit Power	Cut outs 24 Slip Clutch	Lines 6 Slip Clutch

5.4. Black & Decker® Cordless Drill/Driver Case

In this section, we analyze Black & Decker® cordless drills/drivers brands, which includes DeWalt®, Firestorm®, Quantum®, Basic Black & Decker®, and VersaPak®. Among the various size product variants[6], we selected 9.6 Volt versions except for VersaPak® which is available only at 7.2 Volts. Scalable platform of product variants with various sizes can be handled easily by having

[6] There are 9.6, 12, 14.4, and 18 Volt product variants employing "Scalable Platform" mentioned in Chapter 3.

different sized modules that swap (Conner, et al., 1999; Simpson, et al., 1999). The family function structure for all of these selected products is shown in Figure 5.4.1. The family function structure shows that all of the products share almost the same functions, except that DeWalt® and Firestorm® brands have two additional functions: "Input Speed/Torque Selection" and "Transmit Selection" as depicted by boxes with thick lines in the diagram.

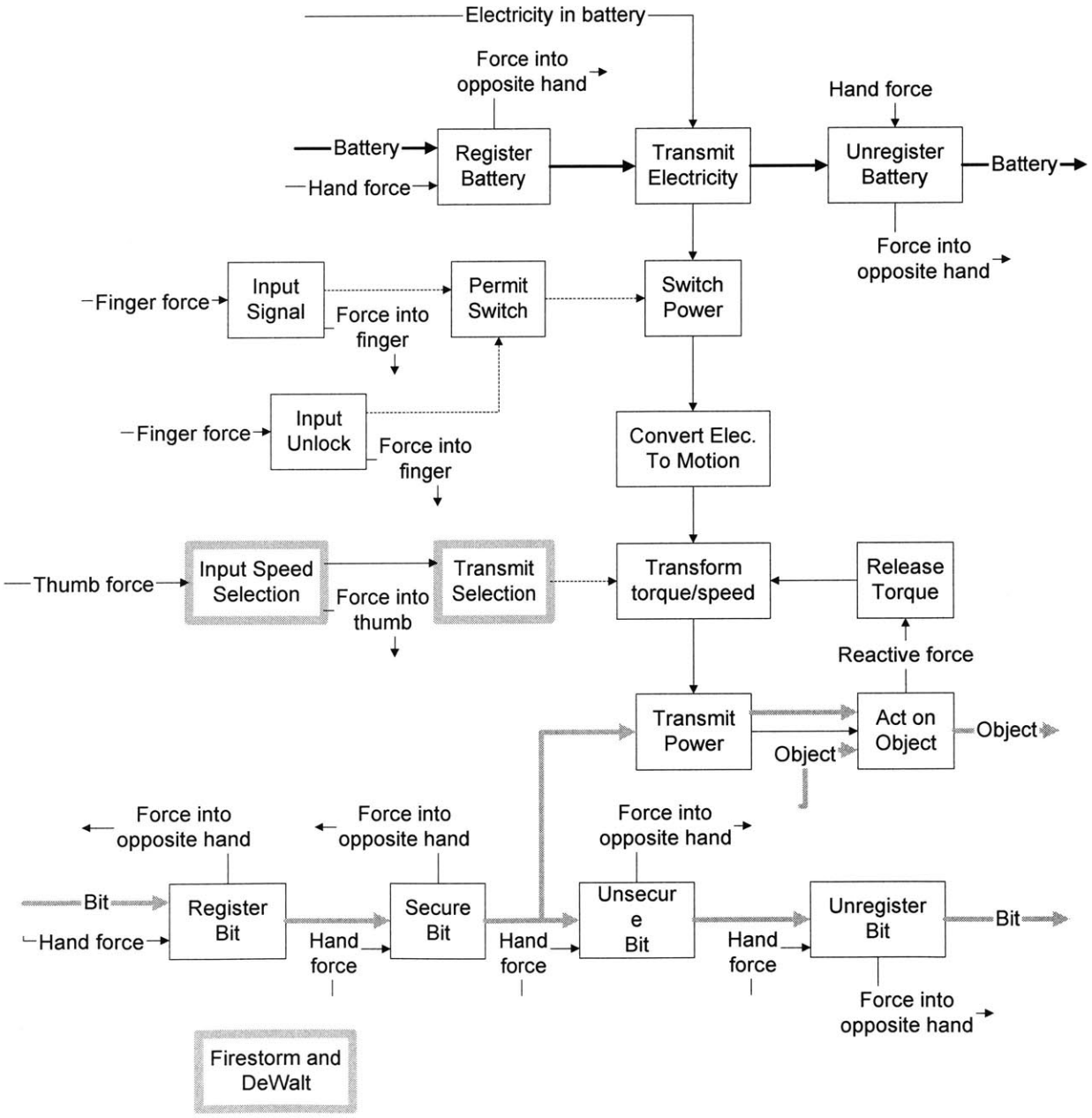


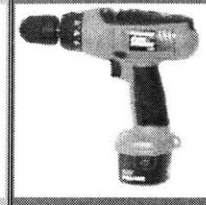
Figure 5.4.1. Black & Decker® brand function structure.

The modularity matrix in Table 5.4.1 presents concise descriptions of the functionality targets and brand differentiations among the products. The specification values and brand differentiation attributes entered in each matrix represent targets for functions and their associated brand identity for each product that was selected by the Black & Decker® design team.

The row-wise grouping identifies the same function targets into multiple brands reveals possible modules shared across products as a product platform. The exact shared modules are depicted by shaded boxes whereas shared modules with distinct brand appearances are depicted by diagonal lines. For example, the "Input Signal" function is shared across all products but is differentiated from each brand by its color. Note that DeWalt® and Firestorm® share exactly the same component, and similarly, Black & Decker® and VersaPak® to deliver "Input Signal" functionality. On the other hand, the module consists of "Transform τω," "Switch Speed," and "Transmit Power" is unique for each brand except for Quantum® and Black & Decker® brands. The column-wise grouping incorporates these multiple functions into a module and is identified by applying the conversion-transmission modularity rule. The utilization of unique module for each brand reflects the selection of the module as part of a dominant theme of a brand. Here, the Black & Decker® design team applied the dominant theme rule, "*A dominant theme must be created from the integration of distinct customer perceived functional characteristics (i.e., features or quality of functional performance) or product aesthetic forms,*" as discussed in Section 5.1.2. That is, the module for each brand is distinguished by distinct functionalities as well as aesthetic form presentations.

The modularity matrix shows that there are very little sharing of modules between DeWalt® and the rest of the Black & Decker® brands. In this case, the DeWalt® and Firestorm® brands have the same functionalities and features. The dominant theme differentiation of "heavy duty" in the DeWalt® brand is accomplished by a distinct quality level of achievement of the functionalities (e.g., more powerful motor, quieter gears) as well as a distinct product aesthetic form. On the other hand, there are many shared modules among the Black & Decker, Quantum, and Firestorm® brands. Other than distinct colors, these brands are differentiated solely by their incremental features from the basic to the high performance brands. The Black & Decker® and Quantum® brands are differentiated by dual, versus variable, speeds, while the Quantum® and Firestorms brands are differentiated by the number of slips in the clutch and the high speed/torque selection in the Firestorm® brand.

Table 5.4.1. Black & Decker® brand modularity matrix.

	DeWalt	Firestorm	Quantum	B&D	VersaPak
					
	Heavy Duty	High Performance	High Value	Basic	Multi-purpose
Input Signal	Black Trigger	Black Trigger	Yellow Trigger	Orange Trigger	Orange Trigger
Switch Power	Integrated Variable speed	Discrete Variable speed	Discrete Variable speed	2 speed	2 speed
Unlock Switch	Black oval Button	Black Button	Black Button	Black Button	Black Button
Convert Elect	Powerful 200	Basic 100	Basic 100	Basic 100	Light 75
Transform τω	Quiet 2 Sp Box	2 speed Box	1 speed Box	1 speed Box	1 speed Open
Switch Speed	Fine Ring Gear	Ring Gear	--	--	--
Transmit Power	Embosses 16 Slip Clutch	Cut outs 24 Slip Clutch	Lines 6 Slip Clutch	Lines 6 Slip Clutch	Solid Shaft
Input Speed	Thin Button	Wide Button	--	--	--
Act on Object	Bit	Bit	Bit	Bit	Bit
Register Bit	Wide Lines Chuck	Thin Lines Chuck	Thin Lines Chuck	Thin Lines Chuck	Thin Lines Chuck
Secure Bit					
Unsecure Bit					
Unregister bit					
Transmit Electricity	Square 2 point	Open 2 point	Open 2 point	Open 3 point	VersaPak Round
Register Battery	Bevel 9.6 V	Straight 9.6 V	Straight 9.6 V	Straight 9.6 V	VersaPak 7.2 V
Unregister battery					
Permit Positioning	Rough Palm	Padded Palm	Diamond Palm	Diamond Palm	Diamond Palm
Encase	Yellow 2 piece	Red 3 piece	Green 3 piece	Blue 3 piece	Blue 2 piece

It is interesting to note that the Black & Decker® design team relied heavily on product functionality and not so much on product aesthetic form as the dominant theme (e.g., strong elements of product aesthetics such as shape and size are not emphasized). While this approach may be justified as indicated by the gestalt study in Section 5.2, one may question the Black & Decker® design teams' approach as they did not adhere to the dominant theme rule that suggests using both functionality and aesthetic form to create differentiation. As a result, some of these brands may be perceived too much alike by their customers, especially the Quantum® brand. This example demonstrated the power of brand modularity matrix to highlight the strength and weakness of the product portfolio to support multiple brands. The lack of a distinct dominant theme as shown in the modularity matrix may raise questions of product distinction as well as brand. In this case, particularly the existence of the Quantum® brand, may be questionable as slight variations of features can be part of product variety within a brand instead of a separate brand.

The modularity matrix also depicts the complexity of a product platform in the Black & Decker® brand portfolio, as there is no single platform that is shared among all of the brands other than "Trigger," "Chuck," and "Bit." The use of these shared components suggest that these modules are not considered part of a brand dominant theme, and thus they are commonized for the entire portfolio—an example of platform rule application. There are three distinct "motors" in the portfolio to deliver the "Convert Electricity" function, as this component is crucial for making a differentiation for some brands, especially to the DeWalt® brand. As a result, this component cannot be commonized for the entire portfolio. A similar situation happens to the "gear box" module to deliver "Transform τω," "Switch Speed," and "Transmit Power" functions. Yet, the commonization of the drill platform is not as comprehensive as it might be, without loss of brand identity. An opportunity for platform commonization can be explored in the modularity matrix by following the "subtract and analyze" process, i.e., each function is analyzed, and possible commonization among brands is investigated, to merge the product platform while maintaining brand differentiation. The following questions need to be asked to further commonize an element. Is the element a part of a brand signature that must be maintained across products within a brand? Should the element be differentiated (i.e., in terms of either function achievement or product aesthetic forms) among brands to maintain the current dominant theme of each brand? Will giveaway/loss opportunity costs (see Section 5.1) due to commonization exceed the cost of variety? If the answer to any of these questions is a resounding "yes," then the element should not be

commonized. Table 5.4.2 illustrate possible platform merging for the Black & Decker® drills/drivers.

Table 5.4.2. Black & Decker® brand modularity matrix with merged modules to reduce the number of platforms.

	DeWalt	Firestorm	Quantum	B&D	VersaPak
					
	Heavy Duty	High Performance	High Value	Basic	Multi-purpose
Input Signal	Black Trigger	Black Trigger	Yellow Trigger	Orange Trigger	Orange Trigger
Switch Power	Integrated Variable speed	Integrated Variable speed	Integrated Variable speed	2 speed	2 speed
Unlock Switch	Black Button	Black Button	Black Button	Black Button	Black Button
Convert Elect	Powerful 200	Basic 100	Basic 100	Basic 100	Basic 100
Act on Object	Bit	Bit	Bit	Bit	Bit
Register Bit	Wide Lines Chuck	Thin Lines Chuck	Thin Lines Chuck	Thin Lines Chuck	Thin Lines Chuck
Secure Bit					
Unsecure Bit					
Unregister bit					
Remaining functions are kept the same					

5.5. Hamilton Beach® and Proctor-Silex® Case

As another example, the Hamilton Beach® and Proctor-Silex® (HB/PS) are two brands owned by NACCO Industries. HB/PS sells 32.5 million small appliances every year. One out of every four small electric appliances sold in the United States is either a Hamilton Beach® or Proctor-Silex® model. Hamilton Beach® is the brand for "better" and "best" segments while Proctor-Silex® is the brand for the "good" and "better" segments (NACCO, 1999). In this section, two of their products—electric mixer and can-opener—which are developed from a common platform and marketed under different brands, will be analyzed. This case provides somewhat of an

opposite perspective to the Black & Decker® approach in developing a platform to support multiple brands. As will be exhibited in the following discussions, HB/PS employed the maximum of product commonization between the two brands in terms of product features and functionalities. The distinction of a dominant theme between the two brands was achieved by their aesthetic form differentiations, in particular, for the mixer products. The can-opener products, while exhibiting the same characteristics, are less consistent in using product commonality. As a result, the element differentiations other than the aesthetic form are less effective in creating perceived distinction, as they do not strengthen the brand dominant theme differentiation.

5.5.1. Hamilton Beach® and Proctor-Silex® Mixers

The family function structure for the 5-speed HB/PS mixers is shown in Figure 5.5.1. Both brands have exactly the same functionalities and architecture as depicted by their family function structure. Considering this situation, both brands share commonality of most elements except the aesthetic form of the "encasing" function. Figure 5.5.2 shows the internal components used by the two brands.

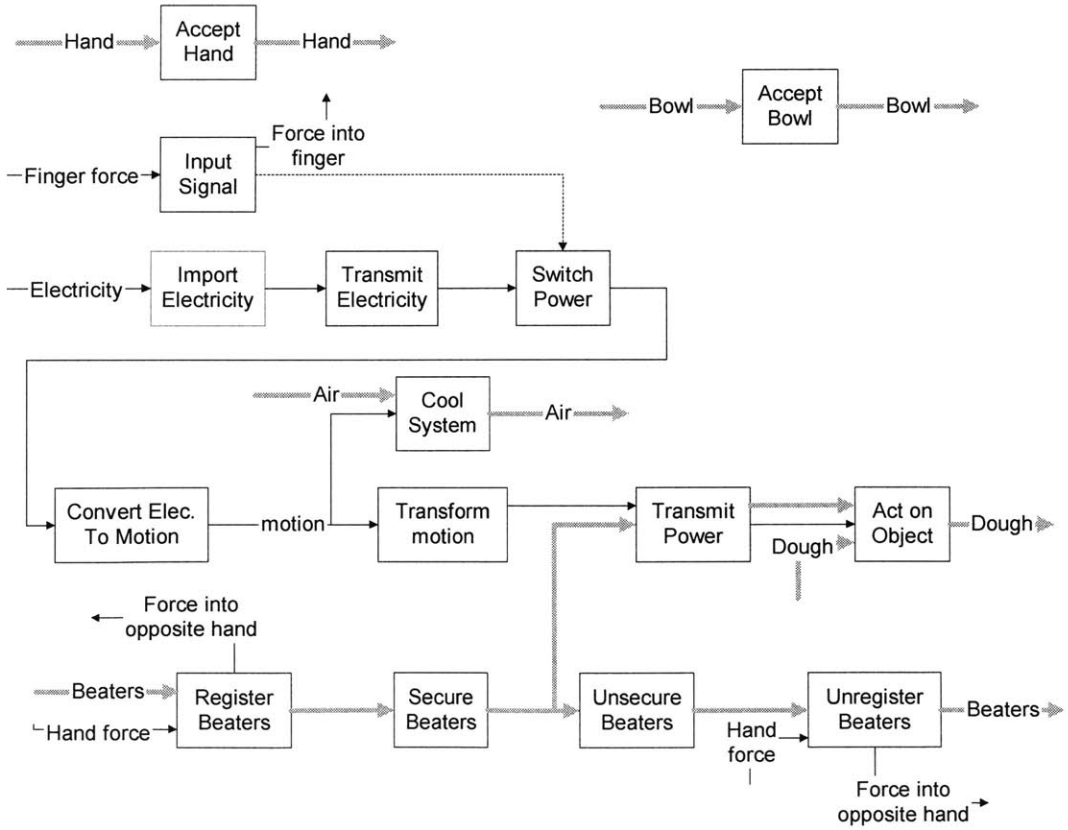


Figure 5.5.1. Hamilton Beach® and Proctor-Silex® mixer family function structure.

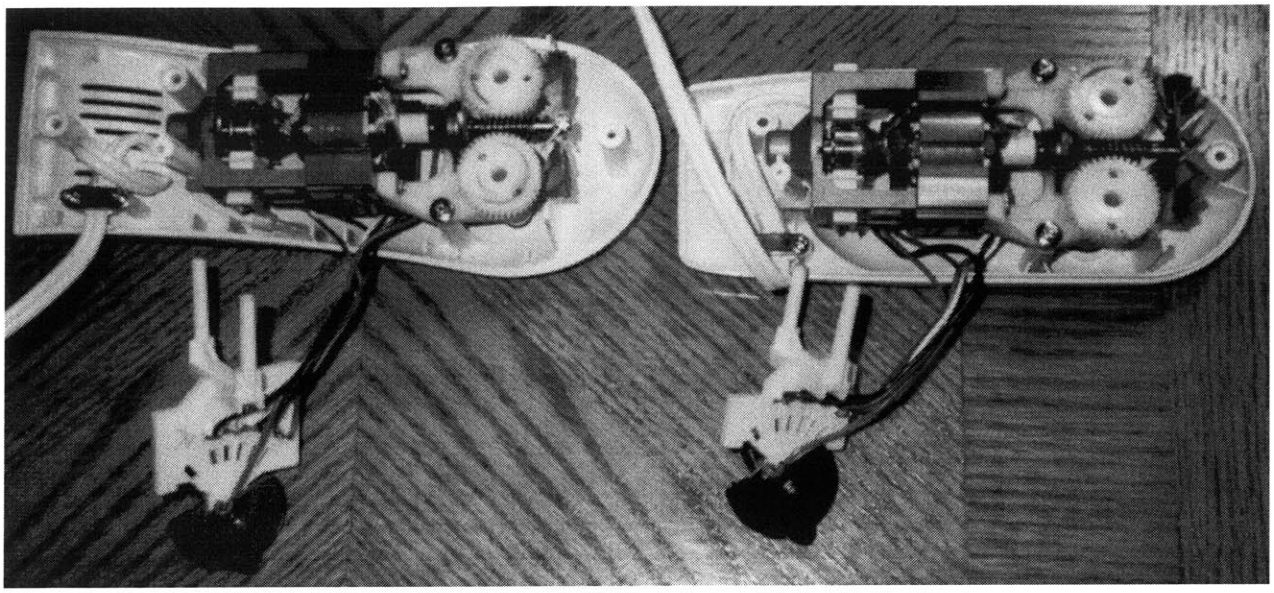


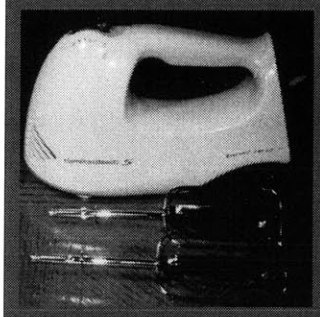
Figure 5.5.2. Hamilton Beach® and Proctor-Silex® mixer components

The modularity matrix in Table 5.5.1 provides a concise listing of commonization and differentiation between the two brands. The double-line boxes depict element groupings that form modules. The row-wise groupings show elements of the product platform that are shared across brands which, in this case, include most of the functions. The shaded boxes depict the exactly common elements. These functions such as "Input Electricity" and "Transmit Electricity," are not parts of the brand dominant theme. The diagonal line box consists of "Input Signal" and "Switch Power," is a module that is shared between the two brands with exception that part of this module (i.e., the thumb switch) has a distinct aesthetic form in terms of color (gray for the HB brand and black for the PS brand) as part of the brand dominant theme. The column-wise groupings show modules identified by single product modularity rules (dominant and branching flows).

In contrast to Black & Decker's strategy, which uses product functionalities as a brand dominant theme, HB and PS brands solely employ a product aesthetic form (Dominant theme rule 1.2) to create a distinct dominant theme: distinctive shape embodiment for "Encase," "Accept Hand," and "Accept Bowl" functionalities, as well as the switch colors. The "better" and "best" brand positioning of HB brand is delivered by a curved shape with white and gray colors as the dominant theme while the "good" and "better" brand positioning of the PS brand is implemented by an angular shape with white and black colors as the dominant theme. The question is whether the HB/PS selection of a dominant theme for each brand is sufficiently different to support distinct brand positioning. For example, applying the Dominant Theme rule 1.1 in conjunction with the

modularity matrix, one may choose to enhance the dominant theme differentiation by making the "Switch Power" different between the two brands (e.g., different speed levels). The HB/PS brands heavily employ the platform rule where the brand signature rule is absent. This point will be further elaborated in Section 5.6.

Table 5.5.1. Hamilton Beach® and Proctor-Silex® mixer modularity matrix (current design).

	Hamilton Beach	Proctor-Silex®
		
	Better-Best	Good-Better
Input Signal	Grey Thumb switch	Black Thumb switch
Switch Power	5 speed	5 speed
Import Electricity	2 prongs	2 prongs
Transmit Electricity	White Cable	White Cable
Convert Electricity to Motion	125 Watt AC motor	125 Watt AC motor
Cool System	Fan	Fan
Transform Motion	Worm gear	Worm gear
Transmit Power	2 slots	2 slots
Register Beaters		
Secure Beaters		
Unsecure Beaters		
Unregister Beaters		
Encase	Curved 3 piece	Basic angular 3 piece
Accept Hand	Deep finger pocket	Shallow finger pocket
Accept Bowl	Deeply curved	Shallow angular

5.5.2. Hamilton Beach® and Proctor-Silex® Can-Openers

The family function structure for the HB/PS can-opener is shown in Figure 5.5.3. Both brands have exactly the same functionalities and architecture as depicted by their family function structure. Considering this situation, both brands are expected to share many elements. Figure 5.5.4 shows the internal components of the two brands.

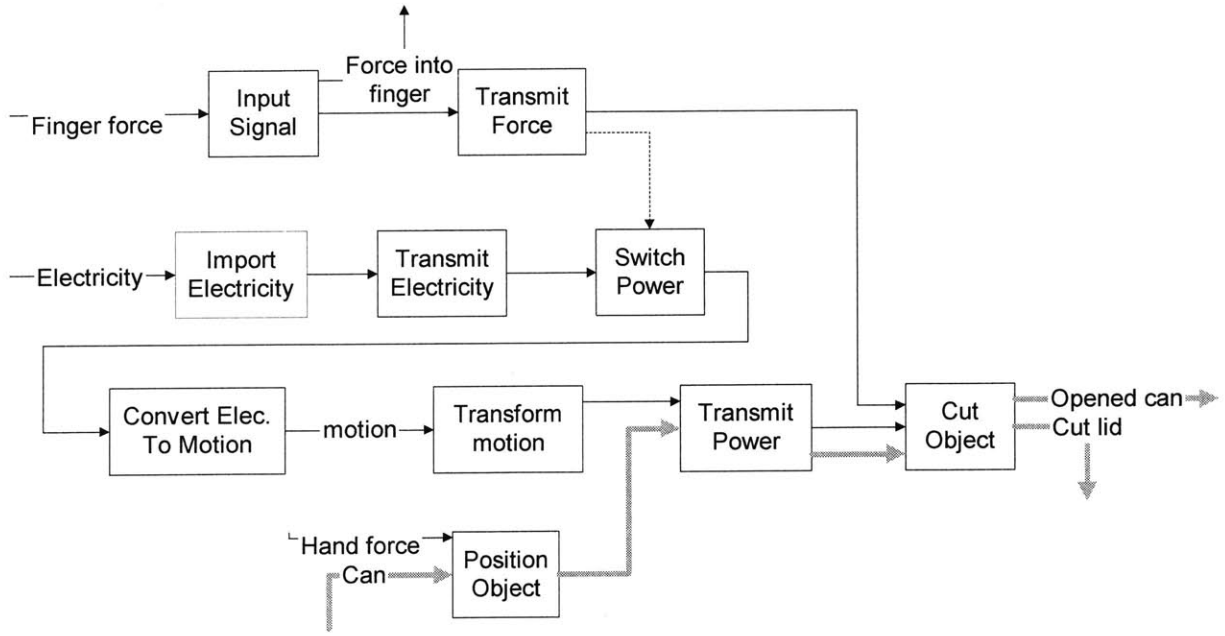


Figure 5.5.3. Hamilton Beach® and Proctor-Silex® can opener function structure.

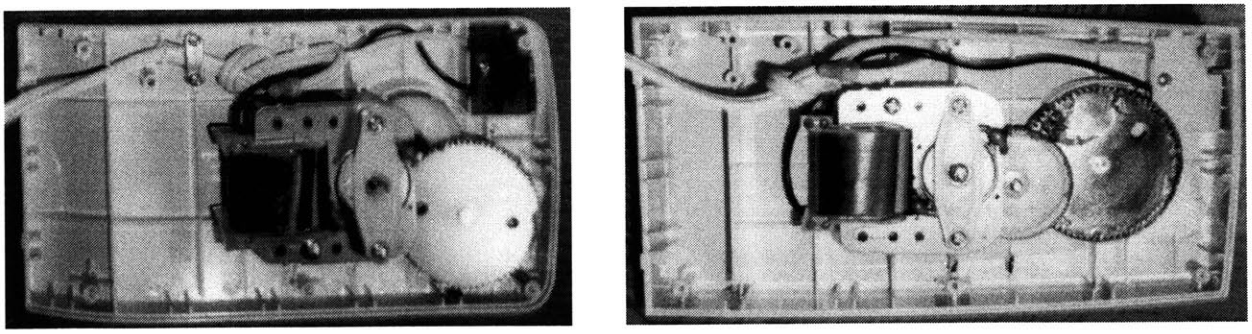
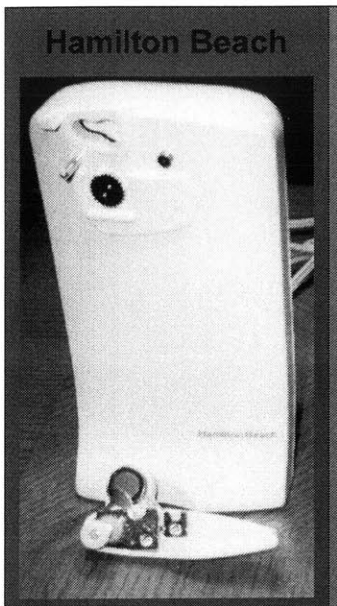
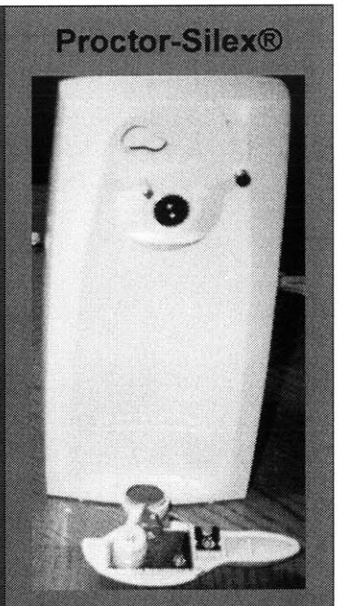


Figure 5.5.4. Hamilton Beach® and Proctor-Silex® can-opener components.

The modularity matrix in Table 5.5.2, surprisingly, shows little similarity between the two brands. That is, only two modules are shared between the two brands.

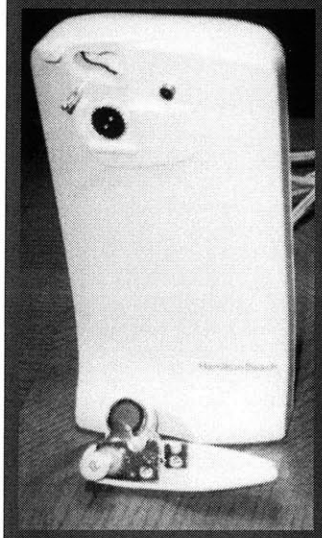
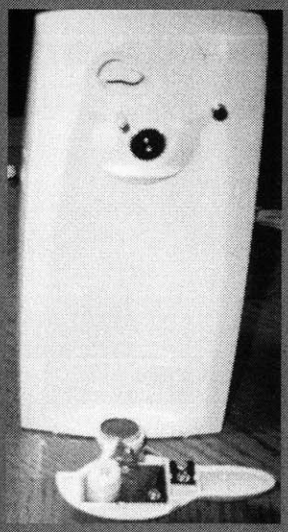
Table 5.5.2. Hamilton Beach® and Proctor Silex can-opener modularity matrix (current design).

		
Switch Power	On/off	On/off
Import Electricity	2 prongs	2 prongs
Transmit Electricity	Cable	Cable
Convert Electricity to Motion	AC motor	AC motor
Transform Motion	Stack gear A	Stack gear B
Transmit Power	Shaft	Shaft
Position Object	Pin/spline A	Pin/spline B
Cut Object	Blade A	Blade B
Input Signal	Flat Thumb	Thumb shape Thumb
Transmit Force	Flat Lever	Oval Lever
Encase	Flat 2 piece	Curved 2 piece

One may argue that HB/PS used unnecessary element differentiation, as most of these elements deliver the same functional performance level, and customers cannot perceive the differentiation such as the internal "gear stack." Merging the two brands while maintaining the same

level of product differentiation can be done easily as shown in Table 5.5.3. Here, the "Transform Power" and "Position Object" are commonized between the two brands as these functions do not influence brand differentiation in the dominant theme as stated by the Dominant theme rule 1.2.

Table 5.5.3. Suggested platform commonization for HB/PS can-opener.

	Hamilton Beach  Better-Best	Proctor-Silex®  Good-Better
Switch Power	On/off	On/off
Import Electricity	2 prongs	2 prongs
Transmit Electricity	Cable	Cable
Convert Electricity to Motion	AC motor	AC motor
Transform Motion	Stack gear A	Stack gear A
Transmit Power	Shaft	Shaft
Position Object	Pin/spline	Pin/spline
Cut Object	Blade	~~Blade~~
Input Signal	Flat Thumb	~~Thumb shape~~ Thumb
Transmit Force	Flat Lever	~~Oval~~ ~~Lever~~
Encase	Flat 2 piece	Curved 2 piece

Note that in the proposed architecture only two modules (i.e., module 1: "Cut Object, "Input Signal," "Transmit Force" and module 2: "Encase") are made different to establish distinct dominant themes. This new platform architecture has the same dominant theme differentiation as the existing products. In this case, the column-wise module constructions were done by applying the dominant flow and conversion-transmission modularity rules.

The HB/PS case uses a strategy distinct from that of Black & Decker® in establishing a dominant theme. While Black & Decker® uses heavily functionality differentiation to create distinct dominant themes, HB/PS uses only aesthetic forms (Dominant theme rule 1.2). Additionally, Black & Decker® effectively uses the "Brand signature rule," while HB/PS products lack brand signatures. Because they lack a dominant theme and brand signatures, HB/PS brands are perceived as being too much alike by customers.

5.6. Architecting Multi-Brands and Multi-Products

As a brand typically encompasses multiple products (e.g., Hamilton Beach® mixer and can-opener), there is a need for simultaneously architecting a platform to support multiple brands and multiple products. Therefore, developing a product platform in the context of multiple products and multiple brands requires the consideration of modules that will be used by multiple products and multiple brands. Modules in a platform design must be made compatible with all of the supported product variants as well as brand identity. The family function structure and brand modularity matrix can be easily expanded to guide the architecting process of a platform to support multi-products and multi-brands. In this case, two perpendicular dimensions of brands and products are simultaneously captured in a single diagram of a family function structure and modularity matrix by unionizing all products and all brands. While a multiple-brand modularity matrix provides a concise representation of dominant themes and elements of a product platform, the simultaneous representation of multiple products in a single matrix allows for explicit identification of brand signatures as well as elements of the product platform. In particular, the brand signatures that must be maintained across all products within a brand may be identified through row-wise grouping within a brand. This is complementary to the product platform design problem, which seeks to maintain the shared functions of a platform across brands within similar product categories. A row-wise grouping encompassing all products and brands indicates elements of a platform that can be shared across products and brands. In this section, the method will be demonstrated with both Hamilton Beach/Proctor Silex and Black & Decker® cases.

5.6.1. Hamilton Beach/Proctor-Silex® Mixers and Can-Openers

The family function structure of Hamilton Beach/Proctor Silex (HB/PS) mixers and can-openers is shown in Figure 5.6.1. The intersection between mixer and can-opener function structures are shown in unshaded boxes. The shaded boxes are the functions unique to a mixer where the diagonally shaded boxes are functions unique to a can-opener.

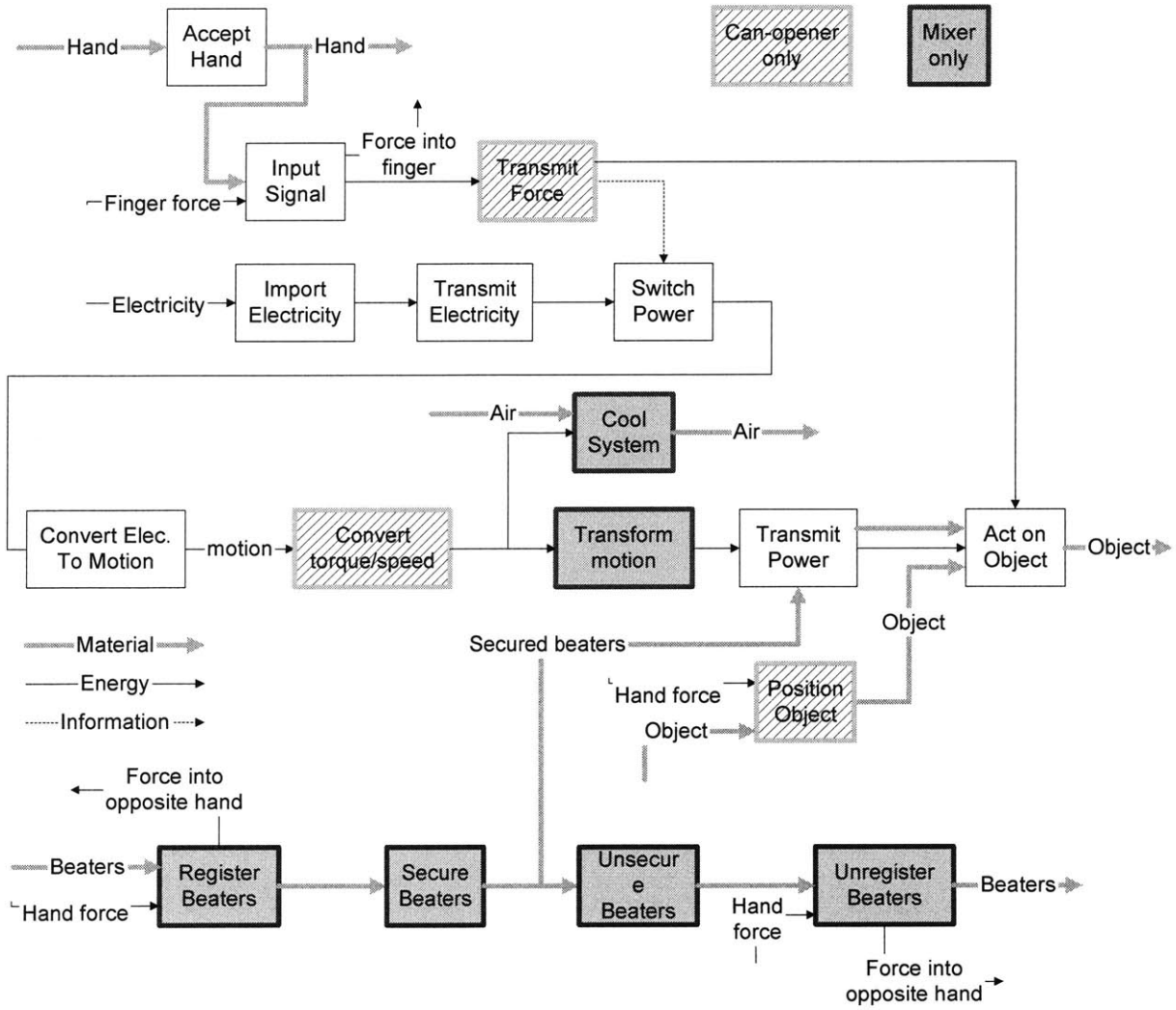


Figure 5.6.1. Family function structure of HB and PS mixers and can openers.

In the current design, only "Import Electricity" and "Transmit Electricity" functions are implemented using shared module and the rest of the functionalities are unique. Here, a possible modularity matrix as shown in Table 5.6.1 is constructed by merging the brand modularity matrices

for multiple products presented in Tables 5.5.1 and 5.5.3. To increase clarity, the functions are rearranged according to possible modules identified by column-wise grouping of modularity rules (i.e., dominant flow, branching flow, and conversion-transmission).

Table 5.6.1. HB and PS mixer and can-opener modularity matrix.

	Mixer		Can Opener	
	HB Better-Best	PS Good-Better	HB Better-Best	PS Good-Better
Input Signal	Pin Grey Thumb	Pin Black Thumb	Flat Thumb	Thumb Shape Thumb
Transmit Force	--	--	Flat Lever	Oval Lever
Act on Object	Beaters		Blade	
Import Electricity	2 prongs White Cable			
Transmit Electricity				
Switch Power	5 speed		On/Off	
Convert EE to Motion	AC motor			
Cool System	Fan		--	--
Convert torque/speed	Worm gear box		Spur gear box	
Transform Motion				
Transmit Power	2 slots		--	--
Register Beaters			--	--
Secure Beaters			--	--
Unsecure Beaters			--	--
Unregister Beaters			--	--
Encase	Curved 3 piece	Basic angular 3 piece	Flat 2 piece	Curved 2 piece
Accept Hand	Deep pocket	Shallow pocket		
Accept Bowl	Deeply curved	Shallow angular		

Note that for multiple products within a brand the dominant theme differentiation is not a concern because it is taken care by different functionalities/utilities provided by each product. When the columns of the table are sequenced such that different brands are placed next to each other for the same product category (e.g., mixer), elements of dominant theme among brands can be quickly compared. A product platform for multiple brands within each product category as well as elements of platform that are shared across products can also be quickly pinpointed. For example, all products share the same module to deliver "Import and Transmit Electricity" functionalities. Similarly, all mixers use a "worm gear" module to deliver "Convert speed/torque" and "Transform motion" functionalities.

The modularity matrix presentation, grouped by product category (i.e., by placing various brands for the same product category consecutive to each other), clearly exhibits shared elements across brands. The modularity matrix with a product category grouping, however, fails to highlight the elements of brand signatures (i.e., elements that are shared across products in the same brand but not other brands) because brands are scattered across the columns, and consecutive row-wise grouping across products within a brand is hindered. To alleviate this problem, a complementary view of a combined modularity matrix, where multiple products within a brand are placed to each other forming a brand grouping, may be chosen to signify the existence of brand signatures as exemplified by the Hamilton Beach®/Proctor-Silex® case in Table 5.6.2. This representation of brand grouping clarifies the presentation of brand signatures. The Hamilton Beach®/Proctor-Silex® case indicates that there is no module that is indicative of brand signature (a group that is shared among products in a brand but not with other brands), as there is no row-wise grouping of multiple products within a brand but not outside a brand. The modularity matrix in Table 5.6.2 indicates that there is a lack of a brand signature for both the Hamilton Beach® and the Proctor-Silex® brands, a weakness that the brands must address in the future. While a dominant theme provides a gestalt distinction for brands of the same product utility (the dominant theme may not be shared across products within a brand), a strong brand signature can substantiate the expression of a distinct dominant theme.

Table 5.6.2. HB and PS mixer and can-opener modularity matrix by brand grouping.

	Hamilton Beach		Proctor-Silex®	
	Mixer	Can-Opener	Mixer	Can-Opener
	Better-Best		Good-Better	
Input Signal	Pin Grey Thumb	Flat Thumb	Pin Black Thumb	Thumb Shape Thumb
Transmit Force	--	Flat Lever	--	Oval Lever
Act on Object	Beaters	Blade	Beater	Blade
Import Electricity	2 prongs White Cable			
Transmit Electricity				
Switch Power	5 speed	On/Off	5 speed	On/Off
Convert EE to Motion	AC motor			
Cool System	Fan	--	Fan	--
Convert torque/speed	Worm gear box	Spur gear box	Worm gear box	Spur gear box
Transform Motion				
Transmit Power	2 slots	--	2 slots	--
Register Beaters		--		--
Secure Beaters		--		--
Unsecure Beaters		--		--
Unregister Beaters		--		--
Encase	3 piece	Flat 2 piece	Basic angular 3 piece	Curved 2 piece
Accept Hand	Deep pocket		Shallow pocket	
Accept Bowl	Deeply curved		Shallow angular	

5.6.2. Black & Decker® Drills and Saws

Black & Decker® developed Firestorm® and DeWalt® brands utilizing strong brand signature elements to signify each brand identity. Figure 5.6.2 shows the family function structure of Firestorm® and DeWalt® drills, reciprocating saws, and circular saws. The modularity matrix associated with Figure 5.6.2 is shown in Table 5.6.3. The table groups products based on each brand to clearly exhibits the elements of brand signatures.

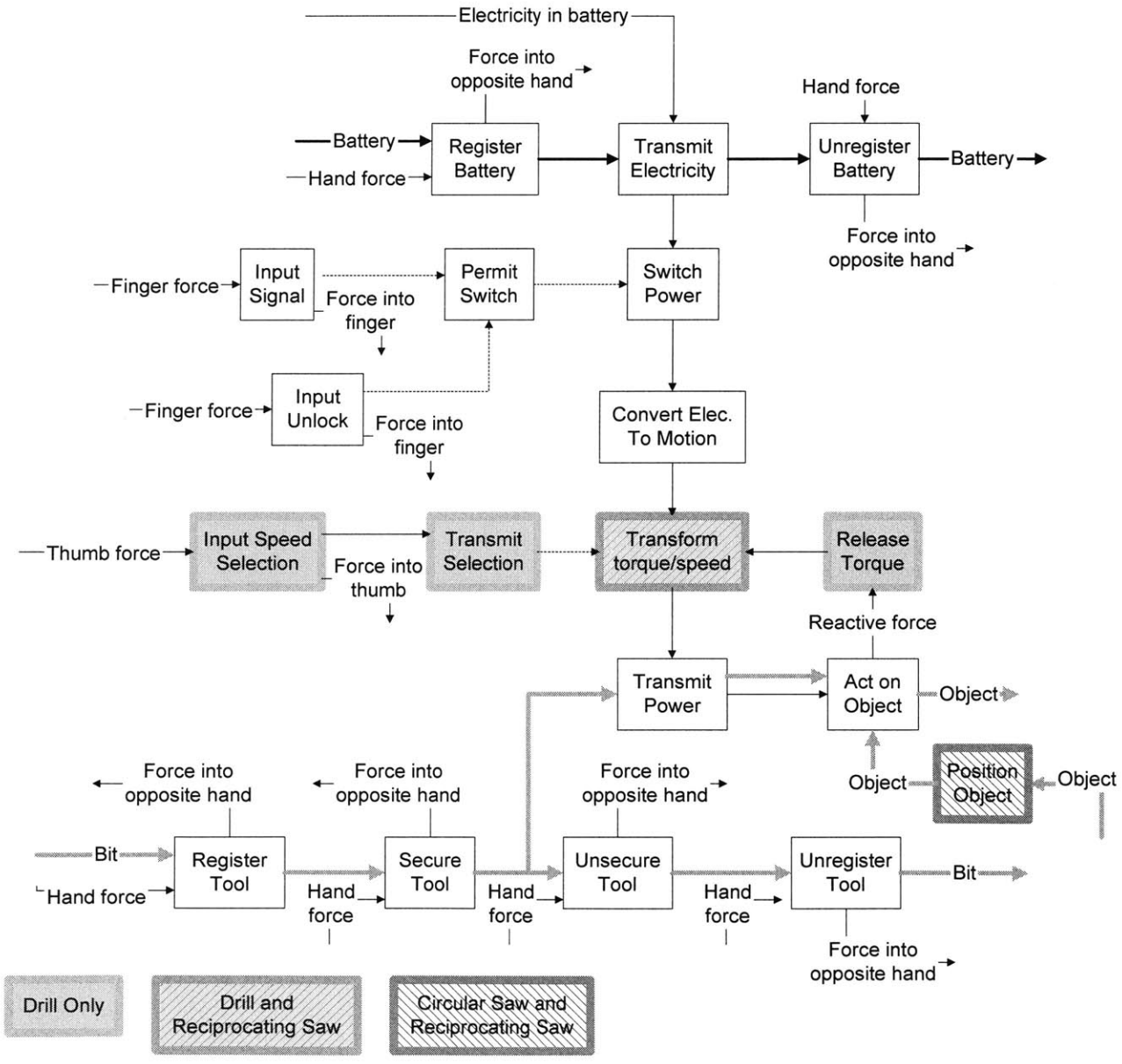


Figure 5.6.2. Family function structure of cordless drill, reciprocating saw, and circular saw.

Table 5.6.3. Modularity matrix of drill, recprocating saw, and circular saw.

	Firestorm			**DeWalt**		
	Drill	Reciprocating Saw	Circular Saw	Drill	Reciprocating Saw	Circular Saw
	High Performance			**Heavy Duty**		
Input Signal	Black Trigger					
Switch Power	Discrete Variable speed			Integrated Variable Speed		
Unlock Switch	Black 3 pos. Push Button	Thin Black Slide Button	Thin Black Vertical Hold Button	Black 3 pos. Push Button	Oval Black 2 pos. Push Button	Oval Black Horizontal Hold Button
Convert Elect	Basic 200			Powerful 300		
Transform τω	2 speed Planetary	Spur	--	Quiet 2 sp Planetary	Quiet Spur	--
Transmit Power	Rubber 24 Slip Clutch	Crank slider	Shaft	Steel 16 Slip Clutch	Crank slider	Shaft
Switch Speed	-- Ring Gear	--	--	-- Fine Ring Gear	--	--
Input Speed	Wide Button	--	--	Thin Button	--	--
Position Object	--	Wide Small Shoe	Black Large Shoe	--	Narrow Small Shoe	Silver Large Shoe
Act on Object	Bit	Saw blade	Circular	Bit	Saw blade	circular
Register Tool	Wide Lines Chuck	Lever clamp	Clamp	Thin Lines Chuck	Lever clamp	Clamp
Secure Tool						
Unsecure Tool						
Unregister Tool						
Transmit Electricity	Open 2 Point			Square 2 Point		
Register Battery	Straight 14.4 V			Bevel 18 V		
Unregister battery						
Accept Hand	Padded Palm			Rough Palm	Padded Palm	Rough Palm
Encase	Orange-Black			Yellow-Black		
	3 piece	2 piece	3 piece	2 piece	3 piece	4 piece

In contrast to the Hamilton Beach/Proctor-Silex® brands, the modularity matrix of Firestorm® and DeWalt® suggests that there is almost no commonality between the two brands (see also Table 5.4.1 for Black & Decker® drill portfolio). However, each brand exhibits strong brand signature elements. Firestorm, for example, uses strong brand signature elements to delivers "Transmit Electricity," "Register Battery," "Unregister battery,", "Accept Hand," "Encase," and "Switch Power" functionalities, in particular for the product aesthetic form of the orange-black colors and the padded-palm. Similarly, DeWalt® uses strong brand signature elements that are distinct from Firestorm. Clearly, the design team of Firestorm® and DeWalt® brands, at the expense of the platform strategy across brands, deliberately chose to excel in a dominant theme to provide a gestalt distinction (for brands of the same product utility) as well as strong brand signatures to reinforce the distinct expression of dominant themes.

Chapter 6. Conclusion

6.1. Conclusion

This thesis attempted to answer a major challenge in designing a product platform to support multiple brands by creating distinctive brands' dominant themes. That is, to simultaneously design necessary differentiation among brands in the portfolio and to utilize acceptable brand parity as a common product platform. A framework was developed based on applicable research on consumer responses to product characteristics, functional architecture methodology to define possible product platforms, and an empirical "listening to customers" study of an automotive case to understand necessary brand differentiation and acceptable brand parity. The proposed framework provides a systematic and practical approach to consistently develop successful platform commonization.

Several principles (e.g., distinct product-beliefs and categorization) and rules (i.e., dominant theme of product functions and aesthetic forms, brand signature, and platform rules) for product modularization were proposed to guide the development of a product platform to support multiple brands. One of the important principles in developing a platform to support a brand is the gestalt nature of products; that is, customers' perception of overall products is more than the sum of their individual elements, as demonstrated in this thesis using a designed experiment. As a result of this finding, "dominant theme" and "brand signature" rules have been proposed to ensure that brands developed from the same platform will have sufficient differentiation. The complementary result of these rules is the emergence of modules that can be commonized among brands that serve as the product platform. Functional architecture based on a function structure methodology and a brand modularity matrix were proposed to provide a concise representation of a product portfolio architecture and to facilitate the applications of modularity rules to investigate possible modules for a product family.

The proposed methodology in this thesis is useful to help in deciding necessary brand differentiation and acceptable brand parity to support brand portfolio positioning, i.e., to identify systems/components that can be commonized among multiple brands and systems/components that must be unique in every brand so that brands developed from a common platform are perceived differently by their customers. The applicability of the methodology was evaluated using several cases where multiple brands were developed from a common product platform.

6.2. Suggestion For Future Study

In addition to optimizing product commonization and differentiation to support multiple brands, the decision to modularize a product portfolio architecture is also affected by other considerations, such as the assembly process, the product development process, core competency and outsourcing strategy (including supplier capability), product serviceability (including repair and consumable elements), logistic and transportation for product assembly, product freshening or update, product options and variations to support mass customization, the rate of technological changes of its subsystems or components, and the variation or adjustment of customer usage during the life of the product. Any of these factors individually, or in combination, may conflict with each other and thus they may lead to different product partitioning strategies. The design of a modular product portfolio architecture is incomplete without simultaneously considering the above factors. A systematic and more comprehensive approach must be made available to address all of the aforementioned issues including extensions of the principles/rules, function structure and modularity matrix proposed in this thesis.

References

Aaker, D.A. (1996), *Building Strong Brands*, The Free Press, New York.

Aaker, D.A. and Joachimsthaler, E. (2000), *Brand Leadership*, The Free Press, New York.

Anderson, D.M (1997), *Agile Product Development for Mass Customization*, McGraw Hill, N.Y.

Agresti, A. (1990), *Categorical Data Analysis*, John Wiley & Sons, N.Y.

Baldwin, C.Y. and Clark, K.B. (2000), *Design Rules: The Power of Modularity*, MIT Press, Cambridge, MA.

Berkowitz, M. (1987), "Product Shape as a Design Innovation Strategy," *Journal of Product Innovation Management*, 4:274:283.

Bloch, P. (1995), "Seeking The Ideal Form: Product Design and Consumer Response," *Journal of Marketing*, 59:16-29.

Bremmer, R. (1999a), "Cutting-Edge Platforms," *Financial Times Automotive World*, June 1999:30-41.

Bremmer, R. (1999b), "Common Knowledge," *Financial Times Automotive World*, June 1999:42-46.

Bremmer, R. (2000), "Big, Bigger, Biggest," *Financial Times Automotive World*, June 2000.

Burchil, G., and Hepner Brodie, C. (1997), *Voices into Choices: Acting on the Voice of the Customer*, Joiner Associates Inc., Madison, WI.

Carpenter, G.S., Glazer, R., and Nakamoto, K. (1994), "Meaningful Brands From Meaningless Differentiation: The Dependence On Irrelevant Attributes," *Journal of Marketing Research*, 31: 339-350.

Conner, C., De Kroon, J. and Mistree, F. (1999). "A Product Variety Tradeoff Evaluation Method for a Family of Cordless Drill Transmissions." *ASME Design Engineering Technical Conferences*, Las Vegas, Nevada. DAC-8625.

Cusumano, M.A. and Nobeoka, K. (1999), *Thinking Beyond Lean: How Multi-Project Management is Transforming Product Development at Toyota and Other Companies*, Free Press, N.Y.

Cutherell, D. "Chapter 16: Product Architecture," *The PDMA Handbook of New Product Development*, Rosenau, M. et al., ed., John Wiley and Sons, N.Y.

Dahmus, J.B., Gonzalez-Zugasti, J.P., and Otto, K.N. (2000), "Modular Product Architecture," *Proceedings of DETC 00: ASME Design Engineering Technical Conferences and Computers and Information in Engineering Conferences*, Baltimore, Maryland, DETC2000/DTM-14565.

Durgee, J.F. (1988), "Product Drama," *Journal of Advertising*, 17:42-49.

Eppinger, S.D. (1991), "Model-Based Approaches to Managing Concurrent Engineering," *Journal of Engineering Design*, 2.

Eppinger, S.D., Whitney, D.E., Smith, R.P., and Gebala, D. (1994), "A Model-Based Method for Organizing Tasks in Product Development," *Research in Engineering Design*, 6:1-13.

Green, P.E. and Srinivasan, V. (1990), "Conjoint Analysis in Marketing: New Development with Impications for Research and Practice," *Journal of Marketing*, 5:3-19.

Griffin, A. and Hauser, J. (1993), "Voice of Customers," *Marketing Science*, 12:1-27.

Hamilton, J.O. (1999), " The Sweetest Apples in Ages," *Businessweek Online*, June 7.

Haubl, G. and Elrod, T. (1999), "The Impact of Congruity Between Brand Name and Country of Production on Consumers' Product Quality Judgments," *International Journal of Research in Marketing*," 16:199-215.

Henderson, R.M. and Clark, K.B. (1990), "Architectural Innovation: The Reconfiguration of Existing Product Technologies and the Failure of Established Firms," *Administrative Science Quarterly*, 35.

Hirschman, E. C. (1983), "Aesthetic, Ideologies and the Limits of Marketing Concept," *Journal of Marketing*, 47:45-55.

Holbrook, M.B. and Zirlin, R.B. (1985), "Artistic Creation, Artworks, and Aesthetic Appreciation," *Advances in Non-Profit Marketing*, 1:1-54.

Kardes, F.R. (1999), *Consumer Behavior and Managerial Decision Making*, Addison Wesley, Reading, MA.

Kaul, A. and Rao, V.R. (1995), "Research for Product Positioning and Design Decision: An Integrative Review," *International Journal of Research in Marketing*, 12:293-320.

Kohler, W. (1947), "Gestalt Psychology: The Definitive Statement of the Gestalt Theory," Liveright, N.Y.

Little, A., Wood, K., and McAdams, D. "Functional Analysis: A Fundamental Empirical Study for Reverse Engineering, Benchmarking, and Redesign," *Proceedings of the 1997 ASME Design Theory and Methodology Conference*, DETC97/DTM-3879.

Martin, M. and Ishii, K. (1997), "Design for Variety: Development of Complexity Indices and Design Charts," *ASME Design Engineering Technical Conferences*, Sacramento, CA, DFM-4359.

Meyer, M.H. and Lehnerd, A.P. (1997), *The Power of Product Platforms: Building Value and Cost Leadership*, Free Press, N.Y.

Meyer, M.H., Tertzakian, P., and Utterback, J.M. (1997), "Metrics for Managing Research and Development in the Context of Product Family," *Management Science*, 43:88-111.

Moore, W.L., Louviere, J.J., and Verma, R. (1999), "Using Conjoint Analysis to Help Design Product Platform," *Journal of Product Innovation Management*, 16:27-39.

NACCO (1999), *10-K NACCO Industries, Inc.*, Securities And Exchange Commission Filing, December 31, 1999.

Naughton, K. (1999), "This Jag Lives Up to Its Looks," *Businessweek Online*, June 28

Otto, K. and Wood, K. (2000), *Product Design*, Prentice Hall, Englewood Cliffs, N.J.

Pahl, , G. and Beitz, W. (1996), *Engineering Design: A Systematic Approach*, Springer Verlag, N.Y.

Pimmler, T. and Eppinger, S.D. (1994), "Integration Analysis of Product Decompositions," *Proceedings of the ASME Design Theory and Methodology Conference*, DE-Vol. 68.

Pine II, B.J. (1992), *Mass Customization: The New Frontier in Business Competition*, Harvard Business School Press, Boston, MA .

Sanchez, R. (1999), "Modular Architectures in the Marketing Process," *Journal of Marketing*, 63: 92-111.

Sanderson, S. and Uzumeri, M. (1995), "Managing Product Families: The Case of Sony Walkman," *Research Policy*, 24.

Saunders, J. and Fu, G. (1997), "Dual Branding: How Corporate Names Add Value," *Journal of Product and Brand Management*, Vol. 6, No. 1, pp. 40-48

Simpson, T., Maier, J. and Mistree, F. (1999). "A Product Platform Concept Exploration Method for Product Family Design." *ASME Design Engineering Technical Conferences*, Las Vegas, Nevada. DTM-8761.

Smith, R.P. and Eppinger, S.D. (1997), "Identifying Controling Features of Engineering Design Iteration," *Management Science*, 43:276-192.

Smith, P. and Reinertsen, D (1992), *Developing Products in Half the Time*, Von Nostrand, N.Y.

Steward, D.V. (1981), "The Design Structure System: A Method for Managing the Design of Complex Systems," *IEEE Transactions in Engineering Management*, 28:71-84.

Stone, R.B. (1997), *Toward a Theory of Modular Design*, Ph.D. Dissertation, Dept. of Mechanical Engineering, The University of Texas, Austin, TX 78712.

Ulrich, K.T. and Eppinger, S.D. (1999), *Product Design and Development*, McGraw-Hill, N.Y.

Ulrich, K.T. and Tung, K. (1991), "Fundamentals of Product Modularity," *Proceedings of the 1991 ASME Winter Annual Meeting Symposium*, Atlanta, GA.

Urban, G.L. and Hauser, J.R. (1993), *Design and Marketing of New Products*, Prentice Hall, Englewood Cliffs, N.J.

Venables, W.N. and Ripley, B.D. (1994), *Modern Applied Statistics with S-Plus*, Springer-Verlag, N.Y.

Veryzer, R.W. (1993), "Aesthetic Response and the Influence of Design Principles on Product Preferences," in *Advances in Consumer Research*, Vol. 20:224-231, Leigh McAllister and Michael Rotschild, eds., Asscociation for Consumer Research, Provo, UT.

Veryzer, R.W. and Hutchinson, J.W. (1998), "The Influence of Unity and Prototypicality on Aesthetic Responses to New Product Designs," *Journal of Consumer Research*, 24: 374-394.

Wheelright, S.C. and Clark, K.B. (1992), *Revolutionizing Product Development: Quantum® Leaps in Speed, Efficiency, and Quality*, Free Press, N.Y.

Zamirowski, E. and Otto, K. (1999), "Identifying Product Portfolio Architecture Modularity Using Function and Variety Heuristics, " *ASME Design Engineering Technical Conferences*, Las Vegas, Nevada, DTM-8760.

Zesiger, S. (1999), "Separated at Birth," *Fortune*, Vol. 139, 11:251