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MODELING & DEVELOPING A COMMONALITY STRATEGY IN THE AUTOMOTIVE INDUSTRY

by

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ABSTRACT

In an increasingly competitive environment that is global, intense, and dynamic, the development of new products and processes has become a focal point for automotive manufacturers. Shrinking product lifecycles, increasing international competition, rapidly changing technologies and customers demanding a high variety of options are some of the forces that drive new development processes in this industry. Many automotive original equipment manufacturers (OEM) have shown that time and costs must (and can) be streamlined out of the product development system to improve a corporation's total efficiency. The reduction in redundant vehicle model variations and functional uniqueness is being accomplished by sharing components across models, carrying over commodity-type parts that provide little to no differentiation to the consumer, and designing new products that reuse existing manufacturing equipment and processes. Commonality that is not well-managed can result in widespread usage of parts with mediocre quality and/or functionality. Commonizing products, engineering, and processes the "right" way, the way that fits a company's unique set of constraints, can be an effective way to improve product development cycle times, customer satisfaction, vehicle quality and engineering depth.

Several well-established automotive original equipment manufacturers (OEMs) have demonstrated how effective platform and component commonality can be. Why haven't all the auto manufacturers embraced a similar strategy? Are those strategies applicable for all companies that manufacture cars? Is maximum component/subsystem/system commonality always "right?" Through a series of models, we suggest commonality can offer many benefits to an automotive OEM, but the conclusion is not that commonality is right, or necessary, for all companies. These models were developed using data from industry-specific interviews and research that helped to identify elements considered critical for the successful implementation of a commonality strategy. For a company considering the implementation of a commonality strategy, the models can be used as a set of tools to determine what might be appropriate, based on the goals it has established. The industry interviews were also used to complete two case studies that demonstrate the power of the organizational structure and company dynamics and their (strong) link to difficulty of commonizing.

Commonality appears to yield benefits that outweigh the challenges if the strategy is implemented with a consistent process, the "proper" organization, understanding of the cost trade-offs, and with controls in place to remove (or minimize) the balance of power barriers. Companies must consider what organization is best for their total set of goals, but also understand where it may limit the possibility/benefits of commonality. Cost, often thought to be the force behind the implementation of a commonality strategy, can also be its biggest inhibitor. While a reduction in costs will always exist as an opportunity, a company pursuing a commonality strategy must understand the customer, administrative, and the political pressures to realize quick results that accompany commonality. Simply stated, companies have to make sure the commonality strategy is not executed by "doing the right thing wrong." Commonality is a long-term endeavor; it needs to be continually reevaluated to ensure maximum benefit is being captured and the strategy is being optimized.

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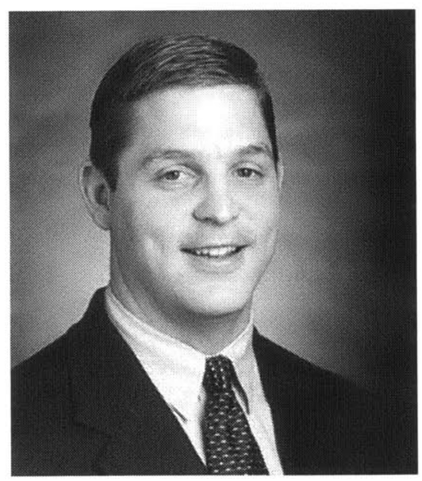
BIOGRAPHIES

Lisa Cratty is a design and release engineer at OEM A, a major automobile manufacturing company. She has held various positions within the company over the last seven years, including launch engineer, design and development engineer, buyer, and program planning analyst. These positions were related to multiple vehicle lines and vehicle systems within OEM A. Lisa is a graduate of Albion College (1992, Bachelor of Arts in Economic and Management) and Michigan State University (1995, Bachelor of Science in Mechanical Engineering).

Matthew Sahutske is a design and release engineer at OEM A, a major automobile manufacturing company. He came to OEM A as a project engineer three years ago, bringing extensive supply-base expertise for the subsystem on which he now works. Prior to employment at OEM A, Matt worked at Delphi and Lear Corporation for a cumulative seven years. Matt is a 1993 graduate of University of Michigan, with a Bachelor of Science in Mechanical Engineering.



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GLOSSARY

Badge Engineering	A lack of product distinctiveness created through a superficial attempt at customizing a brand.
Carry-Over Product	Product, component, assembly or feature from prior generation to new model. Can enable reuse of existing manufacturing equipment.
Commonality	The use, over time, of components, assemblies, features, facilities or tools in multiple vehicles lines and/or platforms.
Complexity	The number of orderable marketing combinations available to the customer that an OEM assembly plant is required to build.
Component (Part)	The lowest level unit of any system that is independently engineered.
Disruption	A change in product expectations by the end customer due to new technology.
Economies of Scale	Cost reductions or avoidances gained through the production of additional parts on a design that is in production.
Functional Engineering	Engineering group responsible for designing & developing core vehicle components. Functional engineering often reports to a program team.
Functional Team	Engineers grouped by the component/system/subsystem for which he/she is responsible.
OEM	Original equipment manufacturer
OEM A	Original equipment manufacturer "A" – a global automotive manufacturer, disguised to protect proprietary information.
Product Team	Team required to develop a vehicle (engineer, program management, finance, etc...) grouped by product (vehicle line or platform).
Reuse	A subset of commonality. The use of prior model facilities and tools (including components, systems, and basic architectures) to build additional new models.
Subsystem	A group of components/systems engineered and supplied as one part to the OEM assembly plant.
Supplier A & B	Widget suppliers who participated in the widget commonality study. Suppliers A & B are both global manufacturers of widgets and other vehicle components.
Technology Transfer	Passing of knowledge/information on the problems, benefits, and basic characteristics of any component or system from one program to another.
Vehicle X & Y	Vehicle programs (unique models) based on the same platform. Studied for commonality and disguised to protect proprietary information.
Widget	A subsystem studied for commonality opportunities, disguised to protect proprietary information.

1.0 INTRODUCTION

In an increasingly competitive environment that is global, intense, and dynamic, the development of new products and processes has become a focal point for automotive manufacturers. Shrinking product lifecycles, increasing international competition, rapidly changing technologies and customers demanding a high quality and a wide variety of options are some of the forces that are driving new development processes. In the quest to manage the complexity of expected greater product variety, firms in many industries are considering platform-based product development as a way to offer a high level of value with no trade-off in price, quality, and response time. One primary enabler for this is the sharing of components, modules, and other assets across a family of products. Companies that have been successful in this realm have shown how cost efficiencies, technological leverage, and market power can be gained when companies redirect their thinking and resources from single products to families of commodities or subsystems built upon robust product platforms.

In the world of product development, engineering changes are unavoidable, as projects are generally initiated using preliminary information that is incomplete or inaccurate. Additional engineering changes arise during the integration of components into subsystems and subsystems into systems and as designs are fine-tuned to improve market success. Evidence suggests that, long term, aiming simply for new designs, or hit products in isolated projects is not enough.[1] High-performing companies view projects as part of a product portfolio and make the most of their investments by introducing new technology in as many products as possible, as frequently as possible.[2] Accordingly, companies work continually to make their product development and manufacturing processes less laborious and variable than their competitors'. The approach being used with increasing frequency is the utilization of existing standardized and time-tested components to facilitate improved product performance & quality, and to drive rapid deployment of cutting-edge technologies and products.

Corporations in industries of all types are demonstrating that time and costs must be streamlined out of the product development system by reducing product-related investment. In the automotive world, this is being accomplished by reducing vehicle complexity and functional uniqueness by sharing components across models, carrying over commodity-type parts that provide little to no differentiation to the consumer, and designing new products that reuse existing manufacturing equipment and processes.

Should all the major manufacturers mimic this type of product and process commonality strategy? Is maximizing component, subsystem, or system commonality always the right answer? Is there only a single optimal commonality strategy that is universally applicable? The basic answer to these questions is "no." The more in depth answer is that companies dissimilar in size, market vision, customer base, and operating philosophy cannot (and likely should not) have the same strategy. Many global automotive OEMs have demonstrated through profit margins, product quality, and customer satisfaction how success can be driven by the prudent creation of a commonality strategy that suits its uniquely-identified goals.

Companies do not succeed on luck and short-term improvements. It takes good management practice and a well-planned long-term strategy. All corporate commonality strategies (in any industry) will possess unique characteristics that are used to "customize" a base strategy – one whose foundation is comprised of benefits and challenges that support a company's commonality credo or

[1] Cusumano & Nobeoka, pg. 63
[2] Ibid, pg. 7

philosophy. From a resource-based perspective, the differences in firms' performance are most likely to be determined by organizational capabilities and establishing a strategy for the whole, rather than the parts.[3] This is not to suggest there is a single, optimal organization, but rather that the implementation of the "right" strategy will be aided or inhibited by a company's structure.

Since many companies design new products one at a time, the focus on individual customers and products often results in a "failure to embrace commonality, compatibility, standardization, or modularization among different products or product lines."[4] The end result is a "mushrooming" or diversification of products and parts with proliferating variety and costs. At some point in the past or present, nearly every automotive OEM has been organized so that dedicated program teams work on individual vehicle lines. In most cases, the result of program teams has been a proliferation of almost identical components, often produced by the same suppliers for different, but similar vehicles. A considerable amount of research points to reduced commonality and increased complexity resulting from program teams working in isolation.[5] This condition of rampant complexity can often be attributed to designers and engineers working in a virtual vacuum and devising near-identical solutions for the same or similar engineering problems.

From a satisfaction perspective, customers are unlikely to care if the individual working parts they rarely (if ever) experience visually or tactically are identical across different models as long as these parts meet functional expectations. Knowing this, a company needs to develop a strategy that allows it to reduce the number of components (while ensuring that high quality standards are maintained) and realize product and process economies of scales benefits. Concurrently, a company must manage the increased cost of change associated with "hard" costs related to the physical part

[3] Schonberger, pg. 159-160
[4] Meyer & Lehnerd, pg. 1
[5] Cusumano & Nobeoka, pg. 53-54, 77-78 & 80

change (e.g. tooling) and the "soft" costs related to administration of the change (e.g. communication). Commonality that is not well-managed can result in widespread usage of parts with mediocre quality and/or functionality. When economies of scale benefits begin to diminish, the question becomes whether the cost of change of a part, across so many vehicle lines, is prohibitive. In addition, commonization of vehicle platforms at some vehicle manufacturers is causing the gap between brands to narrow. With common powertrains, chassis systems and electronic systems, differentiation between brands and models within an OEM is becoming harder and harder to achieve. When the fine line between a company's individual brands begins to erode, there is a risk that customers will realize this and migrate to the lower-priced (and generally, lower profit) products.

Developing a comprehensive product and process-related strategy is neither easy, nor quick. Albert Einstein once said, "without changing our patterns of thought, we will not be able to solve the problems we created with our current patterns of thought."[6] Intuitively, a corporate commonality mandate will disrupt the normal culture of a company by instilling a new set of values, and thus possibly require new incentives to get the desired behavior. While incentives may help, a corporate culture takes years to change. So, if the goal/strategy is pure part commonality, time to goal may be relatively short, but engineering and manufacturing process commonality could take as much as ten years. In the interim, costs will be incurred that may make implementation of the strategy seem counterproductive. Commonality will (should) have a short-term negative effect on cash flow. Regrettably, not all companies can endure the Wall Street pressure to cut expenses at all costs and, in those cases, successful strategy implementation is unlikely, or considerably more difficult. However, there are also cost penalties associated with choosing *not* to commonize with

[6] Ackoff, pg. 3

like-functioning commodities or subsystems. To maximize utility and engineering benefits of commonality, managers need to think of a "stream of new products" created over time and in multiple market segments. Commonality is not in the present; it's in the past, present, and most importantly, in the future.[7]

2.0 SCOPE & FOCUS OF PAPER

Developing a commonality strategy is an extensive endeavor that impacts all levels of a company's value chain; therefore, within the bounds of this paper, it would be nearly impossible to fully address all the affected areas. Based on our research of and collective experience in the automotive industry, we have chosen to identify the benefits and challenges, and evaluate the implementation of a commonality strategy as it applies to the automotive product development process. While focused on manufacturing, the lean principle of "do it right the first time" fits with the implementation of any corporate strategy. In the example of commonality, speed of implementation may not be beneficial if you later discover a "better answer on another branch of design solutions is available."[8] Our objective is to use a series of models (validated through previously published works and unique, OEM-specific research) to explore the cost implication of choosing to adopt or eschew a commonality strategy. We will also describe the barriers and enablers to implementation of that strategy, and suggest that commonality is not a necessity, but a tool or strategy that, if adopted, should be an integral part of a corporate vision that is tailored to help a company meet its long-term strategic goals.

Every automotive manufacturer is forced to balance the need to customize products for target markets while pursuing global economies of scale. A proliferation of options and model derivatives

[7] Cusumano & Nobeoka, pg. 2
[8] Schonberger, pg. 172

leads to increased tooling costs and unmanageable production line complexity. Prudent commonization of products, engineering, and processes can be used to improve product development cycle times, customer satisfaction, vehicle quality and engineering efficiency. Our research and benchmarking of corporate/industry practices indicates that the philosophies expressed in this paper (relative to the aforementioned universal concerns) may be applicable to any company whose scope and complexity is similar to that of a global automotive OEM. Any long-term corporate strategy needs to be implemented with care to preserve core competencies, and with a structured/rigorous process, to ensure it fits with the corporate goals. If common products are first developed and optimized prior to standardization, one can be sure the common solution is the best option, not just the available one.[9]

To gather data and understand the power the organizational structure and company dynamics have on the implementation of a commonality strategy, we used previously published research and conducted two case studies at a global automotive manufacturer, OEM A (used for anonymity). The studies, based on the design and development of a specific subsystem and vehicle platform, were undertaken to identify barriers and enablers related to commonality strategy implementation and to corroborate our theories and hypotheses. The outcome of this research is a series of models that illustrate the relationship between costs (cost of change, cost to commonize, cost to not commonize, etc…), organizational structure, balance of power (between functional engineering, product platform engineering, and design and/or marketing) and decision-making, using a flow chart that links the three concepts together.

The layout of this paper is designed to suggest a style of execution made possible by following the elements as they are sequenced here. To explain the importance of commonality as well as a

[9] Ibid, pg. 148-149

method for corporate implementation, we start by establishing the general benefits and challenges of commonality, using industry benchmark data to show varying strategies so that the reader can understand why implementation of a commonality strategy would be compelling or even necessary. We then introduce our organization and cost models that are intended to aid in understanding a company's unique strategic barriers and the factors that will need to be controlled for successful implementation of a commonality strategy. Following this, two case studies will be reviewed (vehicle platform and subsystem case studies) to validate the assumptions of the models presented, and to demonstrate the need for consistent and integrated usage of the models day-to-day. We conclude by presenting a balance of power model and decision making flow chart that allow individual teams to understand and follow the steps necessary to sustain robust implementation of a commonality strategy. This paper is not intended to prescribe the "right" commonality strategy for OEM A or other OEMs, nor is it intended to state there should always be one or that just one type exists. The intent is to offer insight on why a company might want or need a commonality strategy, how that strategy might best be implemented, and – should the attempt at implementation fall short of the goal – suggest why the failure occurred.

3.0 DEFINITIONS

OEM A defines commonality as "the product, process, technology and knowledge that can be reused in the development, manufacturing and service of vehicles and is aimed at improving quality, reducing lead times, lowering cost for the same part, and realizing more features for the same cost." It is our belief that this definition is so complex in itself that individual and specific sub-definitions are required to fully explain the contents within. It will become apparent as the paper develops that each commonality "subset" has a unique set of benefits and challenges associated with it and it is up to the individual companies to structure its strategy so that the desired end goals can be reached.

The case studies in this paper illustrate more than one type of commonality strategy. A company's structure and vision will determine what, or how many types of commonality can, or should be leveraged (there may be additional benefit in addressing single types of commonality or in other forms of part control). Commonality should be viewed as an enabler for achieving existing business plan targets and more efficient product delivery through customer satisfaction improvements, engineering and investment efficiencies, material cost reductions, manufacturing efficiencies, improved quality/reduced warranty costs and reduced aftermarket inventory/material handling costs.

The benefits of commonality are often measured using metrics related to usage or dollar value of parts. Commonality extends beyond the part level and should be gauged by consistency of process, reduction of engineering resources, quality of system-to-system interfaces and capital investment rather than pure part number count. This is not to say the end goal of a commonality strategy cannot be an attempt to simply make as many parts common as possible; or, for that matter, to encourage a corporation to commonize the product development and manufacturing-related process and to create a product development culture of consistent and common engineering practices. The multiple metrics and the potential variations of commonality implementation often create confusion about what is and is not commonality. Despite very different definitions and intents, commonality, re-use, and complexity are frequently used interchangeably. For the purposes of this paper, and within the automotive industry, however, the distinction of each is necessary. For this reason, this section will define each of these terms individually and establish the context in which they will be used. As a baseline, we will simplify the definition of commonality to be, "the use, over time, of components, assemblies, features, facilities or tools in multiple vehicle lines and/or platforms." This is done to allow commonality to be distinguished from complexity and establishes re-use as a subset of commonality.

A company may find more benefit in addressing commonality as it relates to engineering, process, and system interfaces rather than by part or part number. Each of these alternatives is an enabler of part commonality, and, in some cases each could be a more comprehensive method of executing commonality. In each instance it is "time to implement" that causes companies to focus on part commonality first and then, secondarily, attempt to continuously improve their internal operations by moving closer to commonality of engineering, process, and system interfaces.

Pursuing a strategy of common engineering practices is the best approach if a company has adequate time to do so. Common engineering processes will drive product development and manufacturing process commonality and reduction of unique parts, but extensive training and organizational changes would be required to capture the maximum amount of engineering commonality. When the same component or system is developed by following documented best engineering practices every time, the end result will be high quality parts with manufacturing repeatability. Issues can arise due to the difficulty of measuring both the progress and results of engineering commonality, since the degree of commonality cannot be measured simply by counting part numbers. Consider, for example, fasteners (screws, bolts, pushpins, etc...) in a vehicle. Hypothetically, if every fastener was common (and this commonality was measured by part number), a quantity of 400 parts would effectively be reduced to one. Given that the average vehicle typically has about 2,000 parts, this translates to a commonality *by part number* of approximately 20% - a number that correlates to a commonality *by value* percentage of 0.5%.[10] Calculating the reduction of engineering and investment costs long term is so extremely cumbersome and ambiguous it is not typically done. Common engineering processes will ultimately shorten cycle times and improve

[10] Fastener cost estimated at ~$0.07/fastener and vehicle material cost estimated at ~$11,000.

quality, provided "doing the right thing wrong" can be avoided, but it generally requires resources (time/money) that companies looking for immediate operational improvements are often without.

Commonality goes well beyond part, engineering, and system interface commonality; it can also extend to processes within an enterprise. This pushes commonality down to the lowest working level of the corporation in which there is a standardized process interface (engineering, marketing and sales, purchasing, etc...). This type of commonality is designed to ensure optimal efficiency of operational procedures developed to improve the corporation's bottom line. It will also promote part commonality through repeated usage of consistent processes at all levels and in all areas of the organization. On the other hand, political and cultural issues can make commonizing even the most basic operating procedures extremely difficult by changing "the way things have always been done." In addition, it will be nearly impossible to identify a single best process and prepare for the new problems that may result from process commonization. Time and cultural pressures make widespread deployment and usage of these corporate processes extremely difficult for the automotive OEMs.

System interface commonality should be viewed as a hybrid of part and engineering commonality; it is an output and a catalyst for both. Whenever common parts are being integrated, it is critical to have two-way transfer (back & forth) of the technological interdependencies between components. This leads to the need for "systems" engineers and the commonizing of component interfaces.[11] Similarly, the adoption of engineering commonality increases the need to impose standard, flexible architectures – a critical component of common system interfaces. The issues related to system interface commonality are similar to those of engineering commonality, since the implementation of each is dependent on the other. However, it should be noted that overcoming the system interface issues will expedite commonality in the long run by decreasing architectural barriers.

We will be concentrating primarily on the part domain of commonality and the strategies of implementation as they apply to it. For the entirety of this paper, commonality referred to as "part commonality" will be defined as the sharing of components, assemblies and features between similar or dissimilar vehicles. This definition concentrates on the physical and visceral elements of commonality; those that can be readily seen, touched and measured. The case studies presented later will be analyzed against this definition to determine the ability of our models to predict the outcome. In addition to discussing commonality misnomers (other terms that are often substituted for "commonality"), this section will also introduce the benefits and challenges that accompany commonization.

Re-use is the term most often used synonymously with commonality. In this paper, it is simply a subset of what we refer to as commonality. Reuse is the use of prior model facilities and tools (including components, systems, and basic architectures) to build additional new models. In other words, reuse can be described as any part-sharing across various model types, brands, or vehicle lines with a shared platform. Commonality, on the other hand, would encompass this, as well as cross-platform part sharing. Identifying parts for reuse is considered "picking" the low-hanging fruit because it is the easiest portion of a commonality strategy to execute. In this way, tools (as defined above) that are reused are the cornerstone for the development of a more exhaustive commonality strategy. Without these key components in place it is difficult to determine the level of cross-platform sharing that will be possible for the end product. These baseline architectural components

[11] Cusumano & Nobeoka, pg. 165

are critical to expanding any commonality strategy based on the creation of flexible platforms that allow a vehicle to accommodate common components yet retain "personality."

Reuse is critical to any platform commonality strategy since the key architectural components will perpetuate manufacturing processes, engineering, and part commonality. Similarly, component commonality across an entire corporation will perpetuate re-use; as more common parts are introduced, the number of possible basic architectures (platforms) will become limited to those that are flexible enough to accept the common parts. Just as the concepts are similar, so are the challenges of commonality and reuse; the platform case study presented in this paper focuses on the reuse element of commonality and the accompanying issues.

Complexity of product offering as it is used in the automotive industry (as opposed to the complicated nature of a system) is defined as the number of orderable marketing combinations available to the customer that an OEM assembly plant is required to build. The definitions of complexity and commonality are not generally a source of confusion; it is the impact each has on the other that is often over-emphasized. This is not to say these two different concepts have an effect on each other, just that a change in the level of one does not imply that a change in the other is inevitable. There are generally no situations where a change in complexity will cause a change in the amount of corporate commonality. Commonality will always be a strategy in and of itself that can affect other areas such as complexity, quality, and cost. On the other hand, complexity reduction can aid a commonality strategy; limiting orderable build combinations allows a company to engineer, design, and supply fewer unique parts to the final assembly plant. This, in itself, does not create commonality – this can only occur if the corporation uses the reduction in complexity to gain knowledge of its customer base to determine what options, or packages of options are necessary to sell the vehicles. Similarly, increased commonality can aid corporate-wide reduction in complexity by making fewer component options available to create fewer vehicle variations. In both cases, the benefits will be realized only as marketing establishes what the customer needs and reduces the variants of similar components and therefore reduces complexity. Increasing commonality alone does not reduce a company's complexity.

> *"The reason you get such a lack of commonality and high level of complexity in the product is that the different teams are working in isolation."*[12]

As this quote states, organizational structure and a general lack of communication can have a profound effect on the difficulty of reducing complexity and increasing commonality. This point is critical to a company's day-to-day operations, as complexity reductions support commonality improvement and reduce costs. Unnecessary complexity increases the cost of material handling at the suppliers' facility or at the vehicle assembly plant. These shipping and handling costs are often the result of the OEM's attempt to reduce the end-item complexity at the assembly plant by having the supplier "sequence" parts and ship them to the plant in the vehicle build order. Paradoxically, the perceived reduction in complexity at the vehicle assembly plant almost always leads to unwieldy complexity at the supplier facilities as suppliers are given the responsibility for storing the excess inventory generated by unique color and design requirements. The complexity costs incurred by the supplier are ultimately passed back to the OEM, usually in piece price (variable part cost). Complexity, while not a key element of our commonality investigation, still must be managed so that commonality cost reductions are not offset by supply chain costs.

Subsequent sections of this paper will provide a more practical (vs. theoretical) perspective for each of these concepts and the role they play in developing a commonality strategy. These definitions are intended to help the reader understand the context of the nomenclature used in the case study discussion.

4.0 GENERAL BENEFITS & CHALLENGES OF COMMONALITY

Most corporate strategies are deployed with the expectation that the benefits will outweigh the consequences of not implementing the strategy. It is intuitive, therefore, that any commonality strategy will have many inherent benefits and challenges that are irrespective of its depth. The magnitude and impact of the challenges and benefits will be tempered or exacerbated by strategic intent and organization size; most assuredly, there will not be an equal effect on all the activities in an organization. Our frame of reference for prioritization and noteworthiness of the benefits and challenges is a complex global product development and/or manufacturing organization – in particular, an automotive OEM. While not an exhaustive list, we believe strongly that our paper has captured those most influential when considering whether a commonality strategy is appropriate.

The benefits we will identify – economies of scale, quality associated with a robust design, increase of core competencies and improved knowledge of the customer – need to be measurable and quantifiable. While the challenges – quality issues associated with the proliferation of sub-standard parts, cost of change, and differentiation – need to be manageable and controllable. A commonality strategy should be designed with "quantifiables" in mind, and must incorporate metrics and controls as part of the framework. In this general "identification" portion of the paper, the benefits and challenges will simply be revealed for the reader, but not resolved. In succeeding sections, these issues will be addressed and accompanied by suggestions for identifying and removing potential obstacles to strategic success.

[12] Steve Young, AT Kearney

Competition in the automotive industry is driving every company to pursue advantages in any area they believe necessary (and possible) to produce the highest quality vehicles at the lowest feasible cost. For this reason, economies of scale are often the first and highest priority of an OEM considering implementation of a commonality strategy. In the most basic form, economies of scale can be described as the point at which increasing volume of a product results in a lower variable cost. The reduction in cost per unit is a result of the increased production and thus, operational efficiencies. One of the premier examples of a commonality strategy with cost as an impetus is the Volkswagen group. Its production strategy, per former president Ferdinand Piech, is based on the premise that "savings will include lower overall capital investment, a reduction in parts diversity, lower development costs, and scale effects on material prices as a result of higher purchase volumes."[13]

Although variable cost reduction is the most frequent justification for commonality, there are other critical elements that perpetuate economies of scale. As commonality increases, the volume of a current production component (or system) increases and the efficiency of the tools to make those parts increases until another tool is required to meet demand. Each additional part produced in excess of the expected (and priced) volumes increases the efficiency of the tool. In the automotive industry, where tooling is often amortized over time in the piece price, the additional volume should directly reduce the cost. The other option – paying completely for the tool prior to the inception of production – means that incremental volume just short of the tool's maximum capacity is a measurable cost avoidance. In either instance, the improved efficiency allows short or long-term costs to be reduced significantly as the level of commonality increases.

[13] Jensen, pg. 1

However, another significant area of cost reduction from commonality comes from a reduction in the cost for engineering, design, and testing of new components or systems, or those being used in a different application. Many of the redundant costs in these areas can be reduced, or eliminated, by using the original information as a surrogate or minimizing engineering review of possible new failure modes, based on differing vehicle requirements or new system interfaces. Real world examples of this type of economies of scale cost reduction are seen every day; for example, former Mazda president Mark Fields estimated that joint product development with parent company Ford cut engineering expense per unit by 10-50%, varying by vehicle line.[14]

Cost reduction related to economies of scale has other fringe benefits companies can choose to exploit, depending on their strategies and goals. The money saved from commonizing parts and/or processes can be used to strictly improve the "bottom line" or, if a company has other priorities, the resources can be focused on meeting those. For example, a company might choose to introduce more functionality into its mainstay vehicle(s) or into the priority systems that are the trademark of their company. Another option is using the incremental cash flow to further refine part quality through the use of more costly materials that possess improved performance characteristics, or by making a change to a manufacturing process that reduces variability through tighter tolerance controls. Ultimately, the corporate strategy and philosophies will dictate how the additional resources will be used.

Differentiation of components, systems, and vehicle appearance is the most significant challenge of gaining acceptance for a commonality strategy. This is inherent in the fact that a customer can easily identify a lack of visible uniqueness and, in many cases can ascertain the strategic intent behind the commonality. Accumulated experience has sensitized customers to differences in product

[14] Treece & Rechtin, pg. 2

dimensions that go beyond technical performance and superficial design features; meaning the customer is becoming more sophisticated in evaluating a vehicle, especially when comparing it with other brands. On the other hand, components and systems that are not visible and with which the customer has no direct interaction are prime candidates for commonization. In virtually every instance, customers care very little about individual working parts being shared across vehicle lines if the integration of these parts is invisible.[15] So, the challenge is to prevent a commonality strategy from compromising the brand or company image through a lack of noticeable product differentiation (regardless of execution, e.g. functional, appearance...).

Third-party customer satisfaction surveys have shown customer satisfaction decreasing due to observable sharing of parts – particularly between low- and high-priced models within a company, or when the end product is not distinguished significantly from another vehicle in the same platform family. The second issue (platform differentiation) is more problematic since consumers struggle to decide whether one or both the vehicles are more (or less) attractive due to the overt similarities to each other. Brand differentiation has a critical impact on specific platforms where cannibalization of brand identities is a significant risk to planners looking to reduce complexities (but maintain a brand's character) while holding or increasing market share. If customers do not see value in each of the different brands a company produces, it will be difficult for some or (maybe) all of those brands to survive. Brands impacted recently by this phenomenon are General Motors' Oldsmobile division, and DaimlerChrysler's Plymouth division. Conversely, Ford has recognized the potential obsolescence of its Mercury brand and is working to enhance the independence of the nameplate and prevent the disappearance of it altogether.

[15] Waller, pg. 2

The differentiation challenge does not seriously inhibit commonality, but it must be controlled through rigorous decision-making; significant levels of commonality can be reached without encountering brand homogeneity. In the case of combined commonality and re-use, 60% common by value is often used as a target where no adverse effects are expected. The key to controlling this sensitive issue is in keeping the commonality invisible to the customer. Decisions on what parts to commonize and what measures should be taken to protect the brand identity must be made in a consistent and rigorous manner to ensure avoidance of the negative customer satisfaction issues related to a lack of product differentiation.

Like other dichotomies within product development, commonality has the ability to effect quality both positively and negatively. The tools used to commonize and the effectiveness of the commonality initiative are critical to ensuring that results are beneficial to a company and not counter-productive. To seamlessly increase the use of common parts, a significant amount of knowledge of the performance characteristics of these parts must exist; minimally, it needs to be greater than just being able to read and interpret the specifications on a black-box drawing. A company has to offer educational and training opportunities that allow the engineers to gain the expertise required to identify or design parts with high levels of quality, robustness, and flexibility. Ideally these core competencies would already exist, but in the event that they do not, they must be acquired so that commonization becomes integral to the product development process. As much as 80% of a product's costs are determined during the product engineering stage of development and it is believed that a similar relationship also exists for quality and reliability.[16]

With commonality, good quality perpetuates good quality. This makes the choice of commonizing to an existing high quality component or system or creating a new part designed to be used in a variety of applications critical. In either case, engineers need to be sure the end result is the incorporation of the highest quality part that will benefit subsequent teams using that part. Additional benefits can be realized when an existing part is used in a "new" application if the lessons learned on the original part are available for the new team. The margin of error and need for full engineering validation of the "new" component or system and in development is greatly reduced by leveraging re-use of products and processes.

The key quality risk with commonality is "doing the right thing wrong." A commonality strategy will not survive if it results in the widespread propagation of low-quality parts and systems. Accordingly, the focus for successful commonization falls on the process of decision-making and effective implementation. Most commonality strategies are implemented with cost savings as the major driving force. These forces usually have a critical time element where projections need to be identified and turned into reality in a very short time. Such product timing constraints can force teams to make decisions based on incomplete or inaccurate information relating to part availability, part quality, supplier capacity, or part performance. If the decisions are not made with all the risks and benefits being considered it is likely that a significant drop in total quality will be experienced.

Another risk with commonality that can affect quality is the unknown, and possibly unresolved, system interface and appearance at the vehicle level. With the incorporation of any new part, rigorous engineering needs to be completed to ensure that the system level interface failure modes are considered. This process should result in quality designs, but because the responsible engineer may not be familiar with the new vehicle, "...it may also result in sub-optimal parts design from a total vehicle perspective and thereby jeopardize design quality..."[17] A part placed into a new

[16] Meyer & Lehnerd, pg. 3
[17] Ibid, pg. 115

environment can behave in ways not anticipated by the engineer who designed that component or system. In addition, not all parts are initially designed as optimal "plug-in" type components. Both these issues need to be seriously considered by the component and system engineer as well as the vehicle integration engineer (even if they are the same person) on a program committed to using common parts.

Increasing commonality has the long-term effect of strengthening a company's technical expertise and, if properly focused, will lead to the development of one or more core competencies within the company. This increase in technological expertise is both beneficial and challenging for seamless commonization of parts or processes. The basic benefits are obvious: greater technical expertise, fewer engineering hours required (giving production benefits of cost and time), and quality improvements related to greater engineering knowledge of components and/or systems. The increase in technical expertise is a result of engineers working to overcome the challenge of integrating the same parts into different applications. This continual process improves an engineer's understanding of the function of a component or subsystem in any environment. One benefit that may be less obvious is improved technology transfer from one program to the next. The proper execution of technology transfer is also a significant challenge due to the time sensitivity of implementation. Avoiding issues associated with loss of knowledge or improper use of a common component/system is critical to successful commonization. Weighed together, the benefits of increased expertise are more substantial than the challenges, but each needs to be considered and accounted for to optimize the benefits of commonality.

As the automotive industry becomes more global and competitive, every company is attempting to find advantages wherever possible. An increase in core competencies is one of those areas of particular importance. Companies are fighting to establish an identity and drive it into both the marketplace and throughout the corporation. It is imperative that employees understand a company's strengths and objectives, for "...increasingly, it is through their capabilities and competencies that they (companies) compete."[18] Stated more simply, every company needs to concentrate on doing what they do best to continuously improve their products and attempt to outpace the competition in doing so. Although a company may be satisfied simply maintaining the status quo, its competitors likely will not. In the most simplistic terms, in a highly competitive marketplace, if the company is not getting better, it is getting worse.

One area that benefits from developing core competencies is time to market. Throughout the 1990's, automakers were trying to improve vehicle cycle times to get the cost benefits associated with shorter development time and to be first to market with cutting-edge technologies and designs. A large-scale commonality strategy could significantly decrease the new model time to market as it precludes continuous re-engineering of components and manufacturing processes. As platform architectures are reused more often and many of the "major" systems are made common within and across platforms, product development times should diminish significantly.

Two other important benefits attributable to an increase in engineering expertise are improved quality and an increased ability for technical innovation. Quality improvements happen over time as incremental changes are made that are commensurate with the engineer's increasing knowledge of the design and development of his or her parts. The added benefit of product knowledge is that the improved awareness affords the engineers the time and skills necessary for keeping up with, or surpassing, the competition in innovation clockspeed. The "extra" time and skills are increasingly essential in the auto industry because, "...occasional significant innovations...'rapid incremental

[18] Martin, pg. 28

innovation' in both products and processes is constantly shifting the standard of product excellence upward, making new product development a critical capability for competition."[19]

> *Technology Transfer: the sharing of knowledge from one product to another about the performance, requirements, interfaces, and history of a component, system, or platform.*

While not as obvious as other potential roadblocks or enablers to the implementation of a commonality strategy, technology transfer has the potential to be both. The ability to have complete design and engineering knowledge of a part prior to the attempt to introduce it to a new vehicle is affected by both cost and timing. While any benefit can quickly become a challenge if there are not controls in place to prevent "doing the right thing wrong," technology transfer is a special case due to the widespread use and time-specific constraints imposed upon it. If done properly a company will most likely see only the benefits expected from a commonality strategy. If done improperly the result could be worse than the lowest levels of expected function.

The key to controlling technology transfer is time management. When considering product cycles for component sharing, parallel project development is almost mandatory to allow appropriate time for quality, technology and/or information transfer. If too large a time lag occurs, lost knowledge could lead to improper, or even destructive, use of the shared component.[20] One reason for this is that when companies are basing new designs off old platforms or designs, design requirements often change between the intended initial and new usages.[21] Time can also be a catalyst for problems if the proper amount needed for assessing the scope of implementation of a new technology is not allocated. An off-the-shelf type commonality strategy can be a challenge if

[19] Clark & Fujimoto, pg. 3
[20] Cusumano & Nobeoka, pg. 116-117
[21] Ibid, pg. 133

the technology is not a good fit for many, or all applications. From the corporate strategy to the component strategy, each part has to be rigorously reviewed to determine the appropriate areas of use and reuse. Even when a design has been thoroughly analyzed, reusing it may not be beneficial and may even have a profoundly negative impact if, for example, the technology/component/ system is outdated or insufficiently meets customer needs or the "expected level of competitor's products."[22]

Ironically, it is the necessity of proper technology transfer to maximize the benefits of commonality that creates the aforementioned challenges, and according to Cusumano & Nobeoka, "...projects using concurrent technology transfer strategy are, by far, more efficient...only through concurrent technology transfer can a company reuse technology from a base project in another project and effectively share tasks among products as well as make mutual adjustments and conduct joint design work."[23] In an industry as complex and competitive as the automotive industry, continuous incremental improvement is critical to any company's long-term success; the concepts mentioned here are those that can be the "difference-makers" in the future.

After an operating philosophy is significantly modified, it takes years for the corresponding cultural change to infiltrate the entire company. Furthermore, in an industry that changes as rapidly as the automotive industry, day-to-day pressures to keep up with the competition can leave employees feeling as though their jobs are already a continuous series of incremental changes. Commonality poses a challenge to a company's culture because often employees have the desire to do things their own way or invent something unique; both are philosophies contrary to the basic principles of commonality. This desire to innovate and be creative is deeply-rooted in the culture

[22] Ibid, pg. 116-117
[23] Ibid, pg. 115

and the mindset of much of the working population and is especially strong within the engineering community. A counter-argument does exist that says that you cannot only control this issue, but, if done properly, it can become a benefit. By creating an organization that fosters expertise through functional learning and organization for the purpose of commonality, a company can actually boost creativity.[24]

Engineers will always argue that having to use common parts and engineering practices or standards will inhibit creativity and innovation in any environment – a rapidly changing, high-tech industry notwithstanding. This may sound logical, but in reality, there are many areas in which innovative force can be exerted. The adaptation of legacy systems to new technologies and the practice of replacing a widely-used common part with a new and better one are both difficult tasks with many problems and many more solutions. Additionally, working on the refinement of a common design is a critical responsibility. In a situation where new or different design solutions to a common engineering problem have multiplied over time, it is likely that no one design has proven to be the best solution for the company; meaning there are often two or more available, yet substandard designs. An analogy often used amongst football aficionados is that "if you have two starting quarterbacks, you don't have one." The same holds true with system or component design.

Creativity and innovation can (must, really) be a reaction to commonality simply because the goal of commonality is to reduce the number of unique parts performing the same function – something that may seem easy in theory, but is actually very difficult in reality. With fewer components and systems to monitor, problems and improvement opportunities are confined to a lesser number of variables. True creativity is making fewer parts work in many applications and this

[24] Amabile, pg. 78

"standardization does not inhibit innovation; it allows it to be successful."[25] Therein lies the concept of improved core competence through the execution of a commonality strategy, as "...the notion of core competence can refer not only to developing highly innovative technologies, but also to utilizing these core technologies later on multiple products."[26] The points above illustrate that the trifecta of creativity, innovation and increased core competency are interrelated. All benefit commonality, and over time, the converse becomes true – commonality benefits creativity, innovation, and core competency. In contrast to what is generally believed, the criticality of the ability to successfully integrate a carry-over component in a new environment without compromising expected function, quality, or customer perception increases with a decreasing number of available design solutions.

Just as often as the cost benefits of commonality are mentioned as the primary reason for implementing a commonality strategy, the cost and management of engineering changes are ignored. The reason for this is that in many instances, the cost of change is not a strict dollar amount that can be easily measured and tracked. Most often, change costs are related to communication and organization issues, intra-company politics, and current standard operating procedures. As different as the theoretical and actual costs are, they almost always impact a company in tandem and are rarely, if ever, zero. The cost magnification associated with modifications to a tool or a common component with wide-spread usage are measurable, and a significant challenge to commonality. The most obvious examples of this are when a regulatory or technological modification becomes mandated or when a part has a design deficiency that needs to be eliminated (as in the case of a

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25 Schonberger, pg. 129

26 Cusumano & Nobeoka, pg. 105

recall or systemic quality problem). The key elements of these costs will be discussed here, with their additive behavior introduced as the foundation for the cost models in Section 7.3.

Communication and organization are so tightly linked that even the challenges associated with each are tied closely together. With respect to organization, a company is not always aligned in a manner that best supports a commonality initiative. It can be unwieldy and expensive to set-up and maintain a dedicated subsystem organization that handles only the common parts or the "parts bin." The creation of such an organization and its integration into the original corporate structure is not a trivial exercise and poor facilitation of the change can result in a communication breakdown. Increasing commonality across many product lines complicates the coordination and cooperation requirements and can beg the question, "who owns/manages this?" Having the answer to that question does not solve the key difficulty: the coordination of change and communication between a product's product and functional engineering teams or across platforms that share components company-wide. In either instance, the politics of control and responsibility will likely create a major barrier to communicating effectively enough to achieve a significant level of commonality.

Corporate accounting practices, specifically those used in the United States, make commonality more difficult to justify – at least on paper. While many Japanese firms allocate commonality-related funds to an engineering process group, US companies tend to allocate funding to specific projects; this makes the business justification of commonality difficult since one program tends to shoulder the burden for all the upfront costs.[27] In this situation, a staggered cycle plan appears to "punish" the lead-user of a common component, system or platform because of the initial capital expenditure. Budgeting annually discourages investment with promises of future payoffs and often leaves little money to change architecture on legacy platforms. Without precedents in place, it is difficult to quantify cycle-plan benefits that justify up-front investment. This challenge must be overcome, or at a minimum, understood or any commonality strategy will be doomed to failure before it can get started.

The execution of a commonality strategy is different for different companies. Unless the companies are the same size, with the same goals and strategies and indistinguishable product portfolios, there will always be subtle nuances in operating practices used to incorporate commonality. In this way, the execution of a commonality strategy essentially mandates improved knowledge of the customer so that human and monetary resources are utilized most efficiently. For some companies this means a minimal implementation, for example "BMW, Mercedes, and Volvo have strong functional departments and operate in matrix systems...they try to optimize product performance or appearance, rather than 'cost performance'...for high-end customers, producing a highly innovative product may be more important."[28] The self-awareness of these companies demonstrates the importance for the rest of the market to understand where, why, and how commonality and knowledge of the customer should be used.

Once a company has decided to pursue large-scale commonality it will need to determine where to focus its efforts; the preferred components are those whose feel and function is invisible to the customer. However, the more critical goal should be to avoid commonality that alters the customer's perception of value. Customer opinion is not based on the seemingly intangible components (those they cannot see or feel), it is formed based on receiving value in two places: where they can see it and where they expect to see it (e.g. engine power – it is not visible, but can be perceived). According to Richard Schonberger, the "...primary drivers of genuine success are...a

[27] Ibid, pg. 180
[28] Ibid, pg. 57-58

product line that has high value in the eyes of the customer..."[29] This is not an easy position to find and maintain; the line between optimal value and customer dissatisfaction is fine and easily crossed without warning. Martin Leach, Chief Engineer of Product Development – Ford of Europe, once reflected, "There is evidence of people going too far in sharing, and vehicles becoming too similar in character." Although he did not identify Volkswagen by name, many executives and analysts saw VW has made its Volkswagen, Seat, Skoda, and low-end Audi models too much alike. Once viewed as a brilliant use of cost-saving common architectures, critics say VW's shared platforms now overlap too much.[30]

As more and more new components and systems are commonized, the customer's choices will become limited and a company will have to dig deeper into the customers' minds to determine the lowest limit of content and function they will accept. This will require thoughtful and critical analysis of customer wants versus customer needs, as companies deal with the concept that "customers don't know what they want, they want what they know."[31] And, the concern remains still that the company will go too far and lose brand identity. This philosophy is best captured in AT Kearney consultant, Steve Young's thought: "It is essential to ensure that quality is not compromised and the core values of the brand are maintained. If the customer ever thought that in buying a Volvo or a Jaguar, they were buying a souped-up Ford, you would be dead."[32] These challenges are not insurmountable; in fact, they need to be viewed, as we have here, as a benefit to drive the entire organization to determine how to meet the needs of the customer's expected level of value while meeting the corporate goals of commonality.

[29] Schonberger, pg. 63
[30] Treece & Rechtin, pg. 2
[31] Lisa Cratty, Massachusetts Institute of Technology, ESD.33J, December 2001
[32] Steve Young, AT Kearney

Even a cursory investigation of the automotive industry will reveal that many of today's successful automotive manufacturers are leveraging "product families" (or some other form of commonality) to improve investment and knowledge efficiencies, shorten technology deployment cycle times, gain greater customer understanding, and improve quality. Automakers' continual pursuit of cost-saving economies of scale has always been constrained by the need to offer a large variety of brands and products to maintain the consumers' interest and the OEM's market share. Much to the dismay of the OEMs, the ability to balance these objectives is becoming increasingly elusive. Increasing consumer savvy, shorter vehicle ownership periods, and widespread whole platform (versus component) commonality is creating an intangible commonality boundary – one that defines the point at which a company begins to jeopardize its market or competitive position. Widespread and ill-planned commonality makes it far too difficult year-over-year for the customer to discern what, other than purchase price, is unique about their vehicle.

Customers have little interest in components that cannot be seen or touched – provided the functional characteristics are delivered. In all markets, a design with visual and tactile appeal has an advantage; Lee Iacocca may have said it best in the 1960's as he was evaluating the relative importance of a new piece of technology and he stated, "Give 'em leather, they can smell it."[33] It has long been an axiom in marketing that "customers don't buy products; they buy benefits," so adding value through differentiation is a powerful means of achieving a defensible advantage in the market.[34] Likewise, not offering value (or the perception of it) is assurance of swift migration to alternate brands believed to have it. For this reason, not all commonality strategies are created

[33] Clark & Fujimoto, pg. 56
[34] Christopher, pg. 7

equal, nor is a single strategy equally applicable to all OEMs or even brands within an OEM. Brand and market consideration factor heavily into creating the appropriate strategy as what is acceptable to the mass market may be the farthest thing from being so in the executive and luxury categories.

In addition to differing market and brand strategy philosophies that distinguish commonality strategies, internal implementation difficulties prevent OEMs from adopting the Intel philosophy of "copy exactly" with respect to these strategies. Some have tried – for example, Ford's attempt to mimic Toyota's organizational structure – but substantial political and cultural differences at the companies make pure imitation nearly impossible. Just as most successful strategies are founded on a core set of principles, so are those that have failed. They are simply the wrong principles. Strategies that create cannibalization among the company's own markets, whose roots are in "badge" engineering, or (on a more macro level) base too many vehicles off a mediocre product platform are all ways of "doing the right thing wrong." The anecdotes that follow are industry examples that illustrate how a commonality strategy, if not executed properly on the first attempt, requires modifications to ensure success.

5.1 VOLKSWAGEN (VW)

Any paper discussing the pros and cons of adopting a commonality strategy would be remiss in not mentioning Europe's largest automotive OEM, Volkswagen, as "commonality personified." Ironically, the corporate commonality mandate that saved the one-brand company from extinction a half-century ago wreaked commercial and financial havoc on the highly profitable multi-brand corporation that exists today in as recent a time period as the past decade. By the early 1990s, Volkswagen (under the leadership of Ferdinand Piech, the oft-referenced corporate "dictator") had managed to diversify its "every man's transportation" historical motif of gasoline/diesel options and functional interiors into "luxury" (Audi) and "affordable" (Skoda and Seat). In 1995, Volkswagen developed the industry's best known common platform strategy, cutting its sixteen platforms to four.

Audi had a lineage as the VW flagship product, upper class and full of safety & luxury accoutrements. Skoda & Seat, with their spartan interiors, simple and utilitarian engines, and quirky maintenance reputations were purchase-price-friendly – all clearly differentiated products. With an approach to drastically reduce costs, commonize part/systems, and eliminate brand redundancies, VW was able to transform Skoda and Seat into competitors in the highly-competitive European market for the first time. This was made possible by borrowing design cues from the other two brands, utilizing common suppliers and eliminating unique sub-structures. Skoda and Seat captured market share via splashy interiors, a full array of safety systems and reliable powertrains shared with VW. In a remarkably short time period, the negative differentiators of the Skoda and Seat brands began to disappear; unfortunately, some of Volkswagen's positive ones did as well.

Piech's vision was to implement common modules and systems, rather than common platforms. His proclamation (illustrated in Figure 1) was that VW's module strategy "will extend the use of common parts for eleven selected modules to three or four vehicle classes. The modules involved

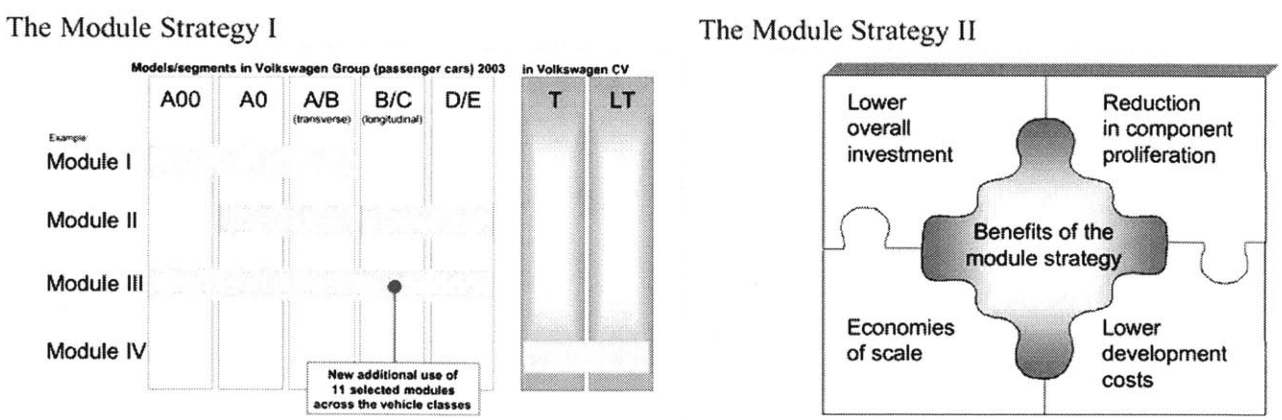

Figure 1: VW Group's Module Strategy (Source: VW 2001 Annual Global Press Conference)

include axle suspensions, brake systems, locking systems, or engine/transmission units. In other words, components that are not dependent on the size of the vehicle."[35] These modules and systems provided different ways of looking at the components that make up a car, with the module being a manufacturing idea and the system an engineering idea. Stated another way, the use of the module simplifies the manufacturing process to a "plug and play" approach. At the engineering level, the interfaces between the systems (that make up the modules) are designed and reconciled so that "part" and engineering and manufacturing process commonality is possible. The commonality benefit derived from this approach did not simply relate to a high-volume material cost save, but rather to the engineering and development. Using the module approach, design redundancies could be eliminated and work could be done just once for many products, thus trimming the investment required significantly.

VW's fourth generation "A" platform, introduced in the form of an Audi A3, is arguably the world's most successful example of one platform producing the largest number of significantly different vehicles. This particular vehicle platform provides the mechanical foundation for the Golf, Jetta/Bora, Audi A3, Seat Toledo and Audi TT (with more planned). In 2000, VW had a volume of 1.9M units on its "A" (Golf) platform (26.6% of total production), and another 1.5M units on its "A0/A00" (Polo/Lupo) and 0.8M on its "B" (Passat) platform – common parts across these platforms can (and are) produced in volumes of 4.2M/year. With fifty models based on just four platforms, time-to-market and development costs have been slashed. According to Mark Phelan of *Automotive Industries*, VW's "...platform sharing strategy has produced 60% parts commonality for

[35] Kiley, pg. 2

the VW Beetle, Golf, and Skoda Octiva..." and "...will raise VW's profit margin to 6.5% in 2000. In contrast GM and Ford are struggling to hit 5%."[36]

This, according to Garel Rhys of *Automotive Business Industries,* is the pinnacle of success. He states that, "The optimum position is to obtain maximum product commonality and the minimum degree of product differentiation..." and that "...a commonality of at least 60% by parts – even better, by value – allows substantial cost savings and the product differentiation required by the market."[37] Platform engineering, he claims, was the "...huge advantage GM had from 1930-1980. Then it all went wrong as commonality went too far..." Rhys contends the criticism of VW's platform strategy misses the point; "There is a world of difference between...60% commonality of common platforms (and architectures) and badge engineering," and VW's mistake was to attempt to obtain even more commonality by making even the upper portion of the vehicles too similar."[38]

Volkswagen believes that model diversity and superior quality are the core components of its car brand and that its aspirations to design and produce high value cars have set standards for volume manufacturers in the automotive industry.[39] The challenge the VW Group faces, however, is taking what is often referred to as the "Golf platform" and producing a vehicle that is not merely a variation, but so radically different that it has the potential to be an Audi. Historically, European firms that have chosen to focus on high-priced, high performance luxury products have confronted quite a different set of customers and a markedly different market environment than the "economy" counterparts. Because this is well-known and widely accepted among European automakers, critics (and consumers) contend that VW, by borrowing so heavily from its high-end products, may be diluting the cache of Audi and VW. Once viewed as a brilliant user of cost-saving common

[36] Phelan, pg. TBD
[37] Rhys, pg. 38
[38] ABI, Issue 1, pg. 38

architectures, dealers and customers now suggest that VW's shared platforms overlap too much.[40] In essence, frugal European automotive consumers quickly realized that a Seat or Skoda was almost identical to its VW sister at several thousand dollars less.

The April 2002 changing of the CEO guard at the Volkswagen Group is expected to stop this. Replacing Piech, Dr. Bernd Pischetsrieder, is expected to continue developing VW's position as a premium mass manufacturer and to tackle the growing encroachment of the luxury brands into the traditional smaller and mass-market segments with advances upstream. His first order of business was to split the VW Group brands into two distinct categories that will create a complementary product offering with few, if any, overlaps. Seat will stop where Audi starts, for example, and no Seat model with the dimensions of an Audi will ever reach the market. Under the new strategy, the brands will also cover more market niches. The key task, as Pischetsrieder sees it, is "almost undoubtedly to sort out the model portfolio and sharpen up the brand profiles to achieve better customer orientation and avoid the cannibalization phenomenon of the past....successful implementation of a more modular strategy will allow greater flexibility in the number of body styles and variants that can be offered from a common set of modular building blocks from the group."[41] "In the next two years, the company must live with the consequences of its model strategy..." said Greg Melich, an analyst at Morgan Stanley in London. "The challenge for Pischetsrieder is to implement his own strategy, with a product portfolio that is different and correct. But he must also show how to turn market share into cash flow."[42]

39 DRI-WEFA Study, pg. 492
40 Clark & Fujimoto, pg. 51-52

41 DRI-WEFA Study, pg. 493
42 Weernink & Auer, pg. 6

5.2 TOYOTA

Another automaker whose name alone imparts a sense of maximum commonality is Toyota. Despite the company's size, Toyota has proven itself adept at both identifying significant cost-saving trends in the global auto industry and reacting to or influencing them. This skill has led many to argue that Toyota, not Volkswagen, should be the benchmark for automotive commonality. In the early 1990s, with cost pressures mounting and economic conditions worsening, Toyota executives acknowledged that the little-by-little cost reduction approach of *kaizen* was going to be insufficient to resolve competitive deficiencies, and that a more dramatic attack on costs would be required. The approach that allowed the company to make significant gains in cost and cycle time reduction while still introducing new models in both the luxury and economy brands was increased standardization of parts and processes.

Highly revered for process excellence, Toyota applied the corporate philosophy of "continuous improvement" at an accelerated pace until the company had the structure believed necessary to alleviate issues related to poor internal communication and to gain additional advantage on the competition that had suddenly begun to incorporate the lean product development tools. Interestingly, the end result of a functional organization, in many ways, does not resemble what is often considered the model of Japanese product development – a heavyweight program management organization (see Section 6.1). Using a semi-centered structure, it maintains a functionally-based organization while achieving its impressive degree of product development and manufacturing-process integration.

As shown in Table 1, Toyota produces a relatively large number of models and achieves a relatively high "models to platform" ratio. Over the 2000 to 2007 period, Toyota Group manages a

15.1% increase to average production per model, and a 30.3% increase to average production per platform. Within these models, part uniqueness is capped at 30%.[43]

Table 1: Toyota Group Production by Platform (MY 2000 & 2007)

	2000 MY	2007 MY	% CHANGE
Total Production	5,886,166	6,449,188	9.6
Number of Models	104	99	(4.8)
Production by Model	56,598	65,143	15.1
Number of Platforms	44	37	(15.9)
Production by Platform	133,777	174,302	30.3
Model to Platform Ratio	2.4	2.7	13.2

This has not always been the case. Toyota's philosophy of continuous improvement permeates the entire corporation and assists the company in reacting fairly swiftly once a problem is identified. In the early 1990s, Toyota's structure was such that chief engineers had autonomous teams and were part of a big, flat functional organization. A single chief engineer had to coordinate 48 departments in 12 divisions to launch a project. Continuous benchmarking against global peers was used to highlight product development weaknesses, and it ultimately led Toyota to make a radical organizational shift – one believed critical to the long-term success of the company. Grouping the company into three platform centers (with a structured functional and program team hierarchy within each vehicle center) was expected to increase vehicle center focus. In addition, the simplified integration for each chief engineer and greater cross-platform coordination (with increased standardization of parts) was designed to make the company more proactive and simply, better.

Toyota's success in commonizing parts and platforms can be largely attributed to the company's organizational composition (including an entire development center for engineering common parts)

43 DRI-WEFA Study, pg. 446

and adherence to a strict set of rules regarding the types of parts on which they concentrate. They are:

- Components that need extensive tailoring for each product
- Components that need careful coordination with other parts
- Components that require a lot of new technology knowledge[44]

When Toyota decides to change a part, a process is followed that allows the company to seamlessly incorporate that design across its model lineup. Rather than boast about starting "from a clean sheet of paper," engineers use a process checklist to guide their designs through the stages of development. These checklists include detailed design information from styling to manufacturing guidelines, and if a design conforms to the checklist, the part is highly likely to meet the intended levels of functionality, manufacturability, quality, and reliability. Once in place, these design standards add predictability across vehicle subsystems as well as between product design and manufacturing engineers. Such rigor allows the engineer responsible for seats, for example, to take advantage of existing specifications for floor pan attachment locations and seat components and begin designing seats without coordinating directly with the other engineers working on seating systems.

With respect to product commonality, each center has a list of variations of "common" components. To use a new component, engineers must prove it has an improved cost-value ratio. They use a "one in/one out" inventory management system to keep the total number of variations from increasing. From the time of the reorganization in 1993 to present day, Toyota has been able to reduce the number of "key" parts by 40%, model variations have been reduced by 30%, and the corporate edict for all-new products is to target 70% in carryover parts. This strategy has allowed Toyota to adapt, as needed, to changes in customer preferences. Its compact sport utility vehicle,

[44] Cusumano & Nobeoka, pg. 33

the RAV4, was introduced in a ground-breaking 24 months in reaction to the SUV craze through 40% component re-use and by drawing on existing design standards for 80% of its development. In addition, Toyota has been able to globally leverage commonality – similar models being sold in different markets (the Corona and Carina, for example) share 40% of their parts.[45] Toyota's mix of social and standardization practices that affords the company such significant commonality benefits may not be right for all industries or even other companies in the auto industry. Different environments, different corporate cultures, and different circumstances mean that a company's approach to commonality must be uniquely designed to suit its distinct needs. Indeed, like Volkswagen, Toyota's system is not necessarily ideal even for Toyota. Although the company has succeeded mightily with its new products in mass-market sedans and luxury cars – two well-defined segments of the marketplace – it reacted late to the major shifts in consumer demand: first to minivans, then to sport-utility vehicles and pick-up trucks. So rigid product and process standardization, for example, may make for nimble and inexpensive product development, but perhaps at the cost of discouraging some big leaps in thinking, design- and technologically-wise. What a study of Toyota does reveal that is critical to a company's success in implementing a commonality strategy is that any well-designed strategy should balance the demands of functional expertise and cross-functional coordination.

5.3 THE "BIG THREE"

Going global is hardly a new idea for American automakers. They've been "global" in many respects throughout this century: exporting and/or assembling and engineering cars and trucks in foreign territories. That is different than developing basically the same vehicles that can be built and sold across international borders. As Ford Motor Company's experience with the Focus and

[45] DRI-WEFA Study, pg. 254

Contour/Mondeo/Mystique suggests, attempts at such "global cars" have resulted in mixed success.[46] General Motors (GM) engineered a common model, the J-car, in the early '80s - built in six countries but never tried again after receiving widespread scorn for its re-badging strategy. Today, GM relies on selective domestic and international partnerships with its European and Japanese affiliates: Opel, Isuzu Motor Corporation, Suzuki Motor Company Ltd, and SAAB.

Chrysler Corporation mounted a global common platform strategy in the '60s and '70s (primarily via acquisitions), but retreated and sold off most of its overseas operations during its escape from bankruptcy in the '80s. Theirs was the perfect example of "doing the right thing wrong" – choosing to make the K-Car, a platform considered mediocre at best, the foundation off which so many vehicles would be based. In the 1990s, the possibilities for greater sharing of parts expanded with the merger of Daimler-Benz and Chrysler. However, as DaimlerChrysler, domestic and foreign brand images and corporate strategies are making the forward progress slower than at least one of the companies would like. It should not be interpreted that struggles over the correct way to commonize are reserved solely for the North American-based OEMs – sky-rocketing costs related to parts proliferation have at some point in time plagued even those companies known for their legendary lean production systems. However, until recently, the domestic (North American) automotive market has been able to work around the fierce competition, frequency and severity of economic downturns and/or OEM consolidation with which the rest of its global cohorts have had to contend for decades.

The world continues to change and it now is a world where, under relentless competitive pressures, wasted time and cash simply can no longer be tolerated; where buyer preferences are coalescing, where computers and communications like the internet are breaking down barriers to

[46] Mol, pg. 2

international product development programs, and where commonality in processes and products is vital to leveraging resources - and ultimately to the bottom line.

5.3.1 General Motors (GM)

GM's most prominent philosophical invention since hitting its market share peak in the 1950s, often referred to as "platform sharing," but widely believed to be simply "badge engineering," is viewed as the reason for its decline in the late '80s and early '90s. A single platform with a limited choice of engine and equipment options was developed for five division brands (Chevrolet, Buick, Pontiac, Oldsmobile, and GMC) with the critical dimensions (floor pan dimensions, suspension design – less tuning, frame size, etc…) fixed for all. As a result, many vehicles in the company's expansive portfolio were found to feel and perform too similarly to one another. Perception of brand and acquisition cost are two strong purchase motivators, and, as with VW, the dilution of these contributed to the (often irreversible) migration of GM's customers to other brands or cheaper models in the corporate line-up. Moreover, like Chrysler, GM was not able to utilize savings realized from platform sharing to truly optimize a single platform or create the requisite "high value" differentiation among its vehicles.

In response to customer and industry backlash, GM formed global car and truck alliances in the mid-1990s that were aimed at developing and producing vehicles worldwide by linking together its three huge product development centers in Warren and Pontiac, MI, and Russelsheim, Germany. What the three big engineering campuses were charged with was "strategically running the engineering of the corporation." The intent of this setup was to have each vehicle center get together six times a year to resolve issues and optimize the design and development of the company's products worldwide. This tactic was intended to eliminate redundancies in engineering, design, and testing. According to a former truck vehicle center director, this "has saved us countless engineering hours by avoiding duplication and pushing common processes, components and module designs."[47] A nagging historical problem at GM has been a legacy of missed opportunities with its various global partnerships. Yet GM, pressed by ever-increasing competition and tighter margins, is now counting on partnerships with Fiat Auto, Suzuki, Subaru and Isuzu to give it a global competitive edge. Industry analysts acknowledge that GM's web of partner companies and subsidiaries gives it unprecedented scope. Moreover, the company has a fresh resolve to make its partnerships work for the purposes of saving money by sharing components and for developing vehicles that can capture significant chunks of global market share.

In 2001, GM (Opel) implemented a sweeping turnaround strategy named "Project Olympia" that calls for, among many other things, sharing components with alliance partner Fiat SpA – between 30-50% in some vehicles. Quick savings on these common parts and processes is a key element of this global strategy. GM and Fiat estimate they will save $1.7B in purchasing and powertrain development costs between 2001 and 2007, and 83% improvement over original projections – early savings are coming primarily from economies of scales related to purchasing power and sharing parts to lower unit costs.[48] Examples of success realized under the Olympia initiative are reducing the total number of:

- car platforms from twelve to five
- engine families from nine to five
- air conditioning types from ten to six
- steering columns from six to one
- seat types from 32 to four
- starters from 24 to ten
- batteries from twelve to five
- electrical connectors from 2,700 to 750
- unique body panels per by 33%[49]

[47] DRI-WEFA Study, pg. 258
[48] Ibid, pg. 265
[49] Reed & Leader, pg 2-3

Although GM has centralized many of its operations in the past few years, it is still struggling with its decentralized past. Historically, GM's partner companies (including Toyota at NUMMI) contributed only re-badged cars to meet fuel economy goals, quick fixes for one-time product needs, and subcompacts for developing markets. That strategy was unsophisticated, but today, GM's array of global partner companies and their new focus is unmatched by any other automotive OEM; the company is now betting on its alliance strategy to carry them well into the 21^{st} century world market.

5.3.2 Ford Motor Company (Ford)

Seeking 'economies of scale' and 'avoiding duplication of effort' are hardly new concepts for today's automakers. In the 1970s, Ford Motor Company had a revolutionary idea: engineer the 1981 Escort as a "global car" for Europe and the United States; the company could develop a single model which would be sold in most of Ford's markets and whose common components would be sourced in vast numbers from common suppliers, with significant economies of scale. But engineers on both sides of the Atlantic had their own priorities, and their own way of doing things. With the benefit of hindsight, it was perhaps inevitable that, as the program progressed, the two teams would find more and more reasons to differentiate what ultimately became two different Escort products for their respective home, regional markets. By the time the cars hit the market(s), there was almost nothing in common except some basic styling cues. According to Richard Parry-Jones, a Ford vice-president, "it was suggested that, in the end, the only common component was the Ford badge, which may be an exaggeration, but the outcome was one which hardly delivered a world car."[50] From the perspective of the automotive industry, it was a costly blunder.

At that time, the needs of the North American and European markets were perceived to be quite different, and in consequence, the Escort versions developed by those independent teams diverged to the point where one could barely discern an underlying visual similarity and where there was no pretense of component commonality. The world car was an idea whose time had not yet come, but it was sufficiently close for it to remain on the table in future product planning discussions. While the strategy itself was a bit ahead of its time, the execution of it was not appropriately supported by the company's organizational structure or product development and marketing philosophies. Encouraged by the Escort endeavor and intrigued by the possibilities, the company began planning its next world car – the Mondeo/Contour/Mystique. This project resulted in an overhaul of the entire organization; the "Ford 2000" globalization strategy. Ford 2000 was deployed in 1995, and the new strategy established specific vehicle development centers in Europe and the U.S. and was intended to facilitate sharp reduction in costly platforms, including powertrains. The primary expectation of Ford 2000: expedite platform standardization (with a goal to go from 24 to 16 platforms while increasing models by 50%) by organizing like Toyota.[51]

While Ford may in the end have succeeded in building an almost global car, it did not necessarily build a car that was competitive in various markets and the expected production scale magnitudes were never realized. Six billion dollars later, 90% of the elements in the vehicle were identical, although – smartly – that was not readily apparent from a visual comparison. However, certain differences remained. Seat belts and airbags had to be adapted to the local markets. U.S. drivers do not always wear seat belts, so the cars were equipped with larger airbags. Ford admitted that it had to cope with different supplier processes, which made it tough to achieve the desired component commonality. Furthermore, local conditions and mandates forced a number of changes; problems

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[50] Parry-Jones, pg. 51
[51] Cusumano & Nobeoka, pg. 110-111

arose when Ford had to re-engineer the Mondeo for the North American market and found the vehicle was not prepared to face the different U.S. federal standards and market conditions.[52]

Less than five years into the Ford 2000 initiative, the organization had migrated to program teams with selective core support. This was necessary, according to a senior executive who stated, "We have a clutch of companies, each with their own product-cycle plans and cadence and synchronicity. We have an end-game and migration plan, but it could take anywhere from 3-10 years." He also indicated that Ford 2000 had shown the top executives that the next logical response was to put together teams, vertically integrated under a single executive, to carry through unique vehicle programs - each based on a particular platform. Program team designers and engineers were joined by representatives from manufacturing, sales and marketing, purchasing and other functional groups to work side-by-side, dedicated to the task of producing a vehicle that met customer needs. The aim of the single project leadership was to define which parts of the vehicle could be developed on a common basis and which ones needed adaptation by engineers with experience of each market and customer base. Once that was done, the engineering would proceed accordingly. The high level of common parts was expected to bring a benefit for the manufacturer, but also, more importantly, for the consumer.[53]

After several years of operating nearly as pure program teams, all the brands in Ford's portfolio (Jaguar, Mazda, Volvo, Land Rover, Aston Martin, Ford, Mercury, and Lincoln) were facing intense pressure to cut burgeoning product development costs and cycle times. During an investigation in which the company was attempting to identify how, where and why the company's monetary reserves were hemorrhaging, it was revealed that there were 100 different caps on the fuel tanks, in Ford of Europe alone. Years of operating as stand-alone product teams had put in motion an

[52] Mol, pg. 2

endless cycle of "wheel reinvention." In addition, even when an opportunity for re-use may have existed, team members rarely knew which engineers to contact for information on the existing parts, so it was often easier to start from scratch. Not surprisingly, the culture had bred the "clean sheet" approach to component design; engineers taught to re-design a part, rather than adapt an existing one. Starting in Europe, Ford introduced a program of commonality across the group, while ensuring that the intrinsic differences between its various models were maintained. Initial costing studies suggested that the rationalization exercise could eventually save $1B over a six-year lifespan of an average model and allow a substantial increase in the number of new models brought to market.

Ford's fourth-quarter (2002) product development restructuring is expected to leverage lessons learned from previous commonality successes in the company: the first-generation Expedition sharing over 50% of its parts with the F-Series, the reduction of air extractors (14 to five), batteries (36 to eight), power distribution boxes (twelve to one), and cigarette lighters (21 to one). Near- and mid-term plans call for new products to have at least 25% "off-the-shelf" parts from existing production vehicles and to reduce the number of parts in the corporate "parts bin" by 30%.[54] Ford's global vice-president of purchasing, David Thursfield, was quoted in November as saying he would be "disappointed...if the company did not get savings through several new cost-cutting techniques...including...intensified parts sharing..." Among the changes already booked in the corporate cycle plan: 25 different brake calipers and rotors in 2002 will be cut to 11 by 2007; 26 front seat architectures this year will shrink to four in 2010; 31 radio variations will come down to 14 by 2007. Executives are also stating that the company is striving for 64% component commonality

[53] Parry-Jones, pg. 54
[54] Waller, pg. 1

among its vehicles, and 56% carryover content from one generation to the next.[55] Now, if a product team plans to change any of the commodities listed above, it must select one of the corporate designs in the "parts bin" for that commodity. In theory, this was done to eliminate the tendency for each product team to design its own unique part for that commodity. In actuality, it is working – the year 2002 marks the first year that there are just two fuel tank caps in production in Europe, a locking and a non-locking version.[56]

This time around, there is a holistic approach and each brand has an integral role in Ford's pursuit of commonality - but only up to a point. For example, Jaguar is using Ford components, but none that will appear to "cheapen" the brand in the eyes of the luxury car customers. Among multiple brands, powertrain sharing has been successful. Six engine families have been replaced with one for Ford, Mazda, and Volvo because "people don't buy the Volvo for its engine, so there's no problem sharing that."[57] Although a long time in arriving, commonization is now being recognized as being critical to Ford's goal of bringing better products into the marketplace with shorter lead times and less cost.

5.3.3 DaimlerChrysler (DCX)

DaimlerChrysler is another prime example of a company that (as Chrysler) used commonality to save them from extinction, over-corrected to the point of "doing the right thing wrong," and is now (as DaimlerChrysler) working through the company's dichotomous brands to globally leverage the benefits of commonality. Once widely panned for introducing the K-Car as the platform off which many look-alike vehicles would be developed, DCX is now regarded as one of the few automakers that have not fallen victim to the practice of badge engineering. With its high-end Mercedes-Benz

[55] www.thecarconnection.com, 11/2002
[56] Treece & Rechtin, pg. 2

nameplate on one end of the spectrum and middle-class Chrysler Corporation on the other, DCX planners have resisted the temptation to cross-pollinate between the two. No widespread platform sharing, no powertrain link ups, nor burled walnut Dodge Durango interiors…yet.[58] DCX Chairman Juergen Schrempp believes that "30% of all components can be shared without negatively infringing brand identity."[59]

Midway through its current cost and quality recovery plan, the Chrysler division of DaimlerChrysler announced it had created a process to better develop, build and market new products by modifying its platform teams to increase commonality and improve time to market. The major modification was to implement "component focus groups" whose jobs were to supplement the program teams and commonize as many parts as possible across the Chrysler Group.[60] The original product team organization was designed to quickly release new products off of new platforms – down to 31 months for the Neon, and technology/component sharing was attacked by informal "tech clubs" within the functional areas.[61] Under the new organization, fifty separate product innovation teams would work closely with the Chrysler Development System (CDS) that the company says is a "process for vehicle creation from the vision all the way through production." Chrysler Group president and chief executive Dieter Zetsche said the new process will result in greater, "…'commonality' within the company…" that will "…result in sharing vehicle platforms and components with the automaker's Mitsubishi unit, as well as the possibility of sharing components with Chrysler's corporate cousin, Mercedes Benz. We have 25 kinds of batteries. We

57 Tierney, pg. 1
58 Weernink, Wim Oude and Auer, Georg (11/2002)
59 Automotive News, 2/25/2002 (volume 77 no. 8)
60 Automotive News, 7/16/2001 (vol. 8)
61 Cusumano & Nobeoka, pg. 76-77

need only five."[62] As of 2002, the company says many elements of the new system are already in place, but that customers will not see the full effect until at least the 2004 model year vehicles arrive.

Every automotive OEM has a product development strategy that is tailored to support its corporate goals. In today's highly competitive global automotive market, many companies are using commonality as a means to a successful end. A thorough industry analysis would reveal that few companies have strategies and goals that are identical to others' around them; however, such inspection would also uncover core premises on which all commonality strategies are based. The similarities are so basic, in fact, that OEMs use them to join together to gain benefit where one company alone cannot. Balancing the need to customize products for target markets while enabling economies of scale in a "world car" is a challenge every automotive manufacturer faces. The Japanese mini-vehicle, necessary for the market, but unprofitable for single companies to produce on their own, has been made far more affordable for the manufacturers (and thus the consumers) now that Daihatsu, Suzuki, Mitsubishi, Fuji, Honda, and Mazda have discussed standardizing components across company lines.[63]

6.0 ORGANIZATIONAL STRUCTURE

Organizational form must be examined when implementing any new corporate strategy; a commonality strategy is not unique in this respect. The composition and effectiveness of an organizational structure has a profound impact on how difficult a commonality strategy is to execute. Consequently, reorganization is often viewed as a way to alter the structure of product development and its support organizations to achieve improved corporate results by focusing on a new or differing set of goals. There are myriad organizational structures, each associated with a

[62] Priddle, pg. 2
[63] Motor Business Japan, Q2, 1996, pg. 104

unique set of benefits and challenges that aid or inhibit a corporation's success. Within the automotive OEMs benchmarked for this paper, we found organizational extremes: pure product teams (operating as stand-alone, cross-functional organizations) with personnel focused on a single vehicle line and pure functional teams (located and collaborating by function - body, chassis, powertrain, marketing, etc...) where the personnel may work on several vehicle programs at one time.

Using the organizational model we've developed, we will demonstrate that a commonality strategy can be implemented (and more importantly, successfully so) with more than one organizational structure. It is not necessary, and, in fact, may not be possible, for a company to reorganize as a way to limit the challenges associated with strategy execution. On the other hand, every company should constantly reevaluate its core competencies and market position to determine whether an organizational change is necessary for achieving its corporate goals and whether this change is feasible. In the following sections we will review the benefits and challenges of different types of organizations, evaluate the difficulty of each in implementing a commonality strategy, and then demonstrate how our organizational model corroborates these findings.

6.1 TYPES AND DEFINITIONS

A company's organization is designed to distribute work to the parties able to complete it in a timely and efficient manner that supports the corporate goals. At the product development level, automotive OEMs have two basic ways of dividing labor: by function or by product. Most automotive organizations contain elements of both, using reorganizations to adjust the relative importance of each area, as needed. Generally, few if any companies would operate there, but the extreme ends of the organizational spectrum are pure functional divisions and pure program teams. It is in the area between these "bookends" that most companies will choose to operate and the line that connects these "points" will be used to introduce the framework for the Organization Model in this section.

6.1.1 Program/Product/Project Team Organization

The first organization type is the one we consider the far "left" of the organizational scale, the product team. Illustrated in Figure 2, product team organizations (program teams, in automotive jargon) "...generally create independent projects that focus on building one product at a time, though they may build multiple variations of the product (such as different body styles) in the same project."[64]

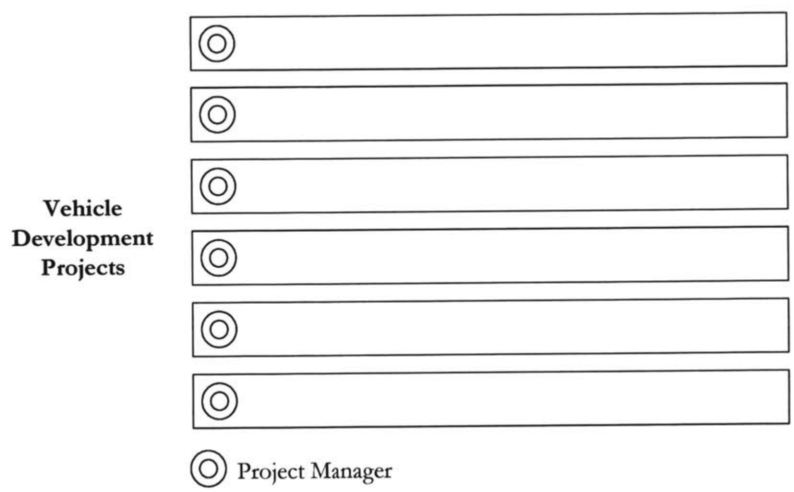

Figure 2: Product Team Organization

In this type of organization there is a project manager who is responsible for all aspects of product development. The team members from every functional group on the project are dedicated to only that project and report directly to the program manager. This organizational structure is intended to remove barriers between functional departments by having an "all-inclusive" team that includes all the personnel needed to complete the project; the expectation is that the team can concentrate on the product concept and system interfaces rather than component engineering.[65] This focus allows

[64] Cusumano & Nobeoka, pg 53-54
[65] Ibid, pg 159

the team to concentrate on meeting the customer's needs and attribute performance wants through holistic system integration and trade-off analysis during the whole product development process. The geographic proximity and team synergies also allow for decisions to be made in a timely manner because all responsible groups are together and they all report to one project manager.

Project teams are not optimal for all situations; more often than not, they are used for special projects within a company instead of as a complete organizational structure. According to Forsberg, Mooz and Cotterman, "pure project (organization) is a good choice for projects for which schedule and/or product performance is paramount and development cost is relatively unimportant"[66] The cost of development issue arises when every product team duplicates the tasks of the others, creating a significant amount of redundant expenditures, company-wide. Even with the stated benefits, it should not be construed that all product teams will automatically operate at a high level. In reality, if most or all of the engineering is done at the component level and the systems engineers are simply acting as integrators, there could be poor team function.[67] Furthermore, the replacement of functional experts with system integrating engineers can lead to a serious reduction in functional expertise over time. Program teams require a tremendous amount of cross-functional intra-team coordination and in a complicated system (such as a car), the task of managing all the components and system interfaces becomes uncontrollable. The same can be said for company-wide inter-team communication. Communication between teams is critical for the swift and flawless execution of a commonality strategy, and a predominantly program team-based organization does not have anything in place to coordinate these efforts.

Often, product teams and their products take on the personality of the leader. Since all responsibility falls on one person in the end, it is inevitable that his or her pattern of decision-making will reflect personal philosophies over time. Ownership of this magnitude can eventually lead to the presence of the "not invented here" syndrome. No leader relishes being told how to run their business, and commonality (especially if mandated at the corporate level) can be seen as being contrary to the decisions a program manager might naturally choose to make (with respect to performance and appearance items). With this organizational structure no real mechanism exists to evaluate/monitor how the many individual program decisions affect commonality, and any functional group suggesting it (commonality) can be vetoed by the program manager without any system in place to challenge that decision. We will elaborate on this phenomenon in the balance of power and decision-making sections of the paper.

6.1.2 Functional Organization

The second organizational type that merits discussion is the one at the other end of the spectrum, the purely functional organization (shown below in Figure 3). Under this regime, all the

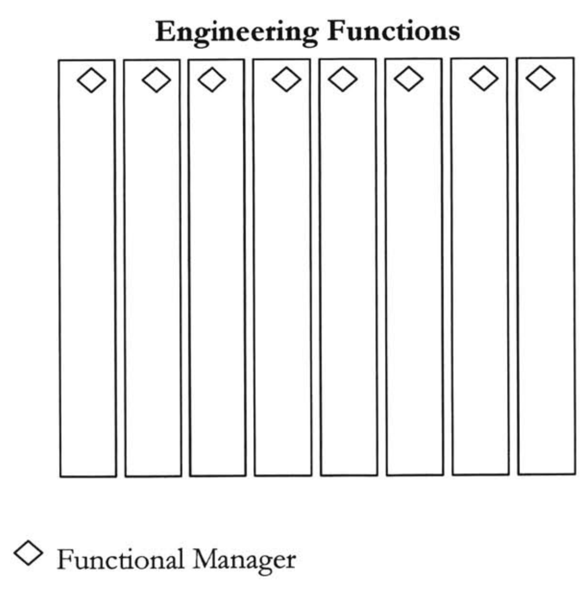

Figure 3: Functional Organizational Structure

[66] Forsberg, Mooz & Cotterman, pg. 143
[67] Clark & Fujimoto, pg. 105

functional groups are centralized, providing every program with the components, systems, or services they need to develop a product or complete a project. When functional personnel are assigned to a project, it is not uncommon for them to also be involved in other projects or have additional responsibilities above and beyond the new project. In this structure, functional engineers do not report to the program team(s) to which they are assigned (per se), but to the functional group in which they work. This alignment in skill-sets (by functional expertise) and closeness in proximity of like-minded engineers enables a dramatic improvement in intra-functional communication, a key element to achieving maximum part, and perhaps process, commonality.

An organization in which engineers work closely in functional groups is more likely to be aware of the latest research and development and technologies, tends to achieve higher levels of technical expertise (since it is what their performance is rated on), and generally has a higher propensity for radical innovation.[68] Communication is again the catalyst for these behaviors. The ability to discuss technological advances and potential customer applications leads to more innovative component use and system development. In fact, the general learning or experience curve illustrates how "cost of knowledge" (real costs per unit) decreases as the cumulative volume increases (as shown in Figure 4).[69] The improved communication within a functional group also enables more efficient and higher quality technology transfer. When a program adopts a part already being used by a different program, information on the performance characteristics of that part is more readily accessible to the engineer (via lessons learned documentation and the engineers themselves) supporting the new application. Technology transfer is critical to ensure components or systems are being re-used correctly and that problems from previous programs are not repeated or carried-over into the new application. This is a key argument for creating functional groups instead of autonomous program

68 Cusumano & Nobeoka, pg 159 – 160

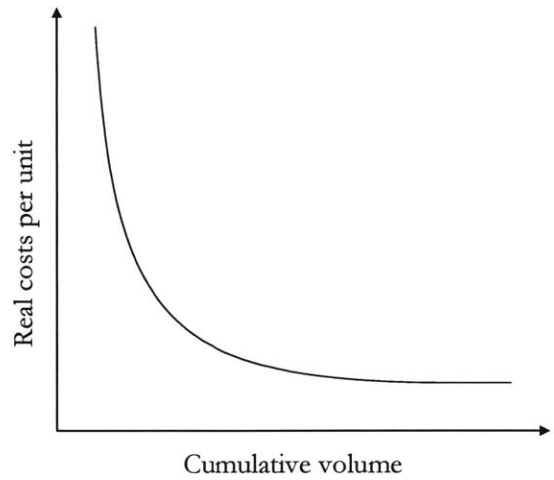

Figure 4: The Experience Curve

teams. The expedited communication coupled with the component or system ownership (versus dedication to a program) will make technology transfer easier to execute. Some of the key benefits of improved technology transfer are related primarily to quality; either avoidance of previously identified performance issues or minimizing (or eliminating) system interface incompatibilities associated with the improper use of a part in a new application.

The advantages that functional organizations offer are not always the highest priority for companies in the automotive industry. Even those that seek to reduce costs by commonizing parts or processes recognize that it is easy to go too far, or become too functional. Product differentiation is the argument against a predominantly functional organization, because uniqueness of appearance and function is mandatory in a market that demands quality, cost, style, and innovation of technology.[70] The ultimate goal of commonizing parts is having the ability to share components without losing product distinctiveness – something that can be hard to accomplish with a functional organizations due to the concentrated focus on component engineering specialization.

[69] Martin, pg. 6

From a systems standpoint, the integration of components is better accomplished through product teams, which tend to focus more on meeting vehicle level requirements.[71] If a company's highest priority is product distinctiveness, as it might be for many luxury car manufacturers, the risk of losing uniqueness as a brand image may supercede the operating cost benefits of a commonality strategy.

While functional organizations allow for improved communication within that function, there is a corresponding loss of communication with the programs the functions are intended to support. This is especially true in the engineering community where there is a tendency to concentrate solely on component and subsystem work with less regard for integration into the vehicle system. This introspective focus leads to too narrow of a specialization of engineers, thus creating poor quality linked to incomplete or inadequate integration.[72] Engineers must have a holistic perspective to avoid designing and/or perpetuating existing system interface weaknesses. The ability to have and maintain such a viewpoint is directly related to organizational structure and incentives (e.g. engineers are generally paid to "engineer" parts). A purely functional organization, while generally successful in optimizing component performance at a subsystem level, is subject to communication breakdowns at the system integration level. These coordination issues are related, in part, to the multitude of different functional areas and the quantity of engineers coming from these independent "organizations" that are needed to launch an entire vehicle. There are simply too many people for any vehicle manager to track.[73] The pros and cons of program and functional teams outlined here are the basis for the Organizational Model introduced in a subsequent section.

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[70] Cusumano & Nobeoka, pg 162
[71] Ibid, pg 163
[72] Clark & Fujimoto, pg. 333
[73] Ibid, pg. 272

All other commonly implemented product development organizational schemes fall somewhere between the product team and functional organizations; this happens as companies adjust and reorganize to meet internal goals. In theory, the optimal operating point should be the organization that allows the company to maximize the benefits and minimize the challenges of that scheme. The "combination" organizations can be classified into two types: the well-known *matrix* organization and the *centered* organization as described in Cusumano and Nobeoka's *Thinking Beyond Lean*. For both, there are additional variations that are designed to more strongly favor a product team or functional organization, should a company choose to do so.

6.1.3 Matrix Organization

Employees have two bosses in a matrix organization – one from the input unit of which they are a part (functional) the other from the output unit of which they are also a part (program team).[74] The generic form of this organization is shown below in Figure 5. In a matrix structure where

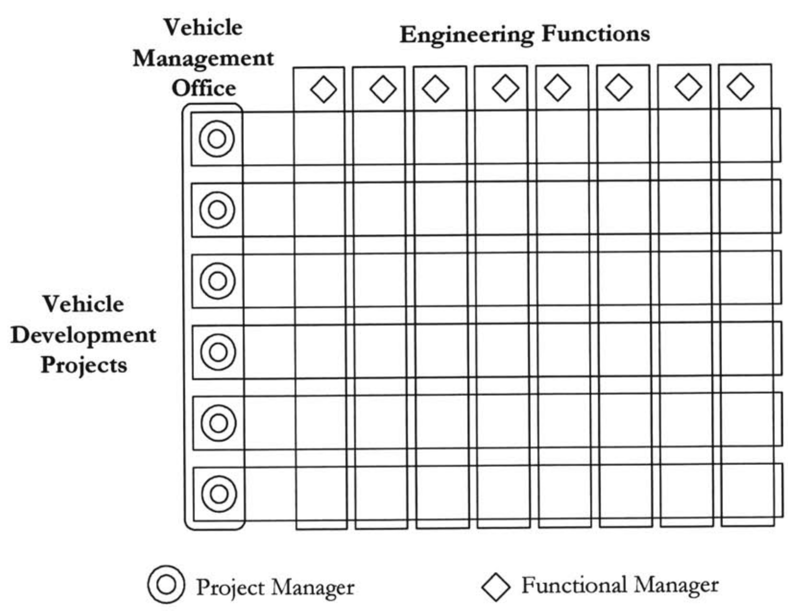

Figure 5: Traditional Matrix Organization

[74] Ackoff, pg 239

"engineering departments staff the platform teams with dedicated engineers...the goal is to do as much work in parallel to reduce calendar time and speed up problem-solving."[75] The group perceived as the most powerful – the program manager or the functional manager – determines the various forms of matrix organizations. In the traditional matrix this power is intended to be balanced between the managers.

6.1.4 Heavyweight Program Manager Organization

An organizational structure that was used, fairly successfully, by Toyota prior to its 1993 reorganization, is the heavyweight program manager matrix organization. Here the decision-making rests primarily on the (as the name suggests) program manager. The intent of this organization is to keep as much "power" as possible with the program manager without sacrificing functional expertise, and is probably as close as any company can get to operating at the program team extreme. Companies having strategies of "differentiation" and "product uniqueness" may want to adopt this organizational style, because while "...they do not normally have formal authority over detailed designs of specific parts, product managers can influence the important details of product design through cross-functional coordination and conflict resolution."[76]

Heavyweight program managers act as the much-needed liaison and moderator between program and functional teams – a skill whose importance will become more apparent when the Balance of Power Model is introduced. However, the lack of control of the detailed designs limits a company's ability to maximize the benefits of commonality (particularly process-based commonality). As suggested, this idea is not a new one. During the 1990s, U.S. corporations implemented heavyweight project manager organizations in an attempt to shorten lead times; while

[75] Cusumano & Nobeoka, pg 72

the goal was generally achieved, one outcome of this practice was the formation of distinct product teams (thus moving the companies to the outer extreme on the organizational scale). In the U.S. 66% of engineers are dedicated to one project versus 41% in Japan.[77] While advantageous on many fronts, as mentioned, this singular dedication can lead to a lack of communication within engineering functions and a loss of functional expertise. This organization is illustrated, generically in Figure 6.

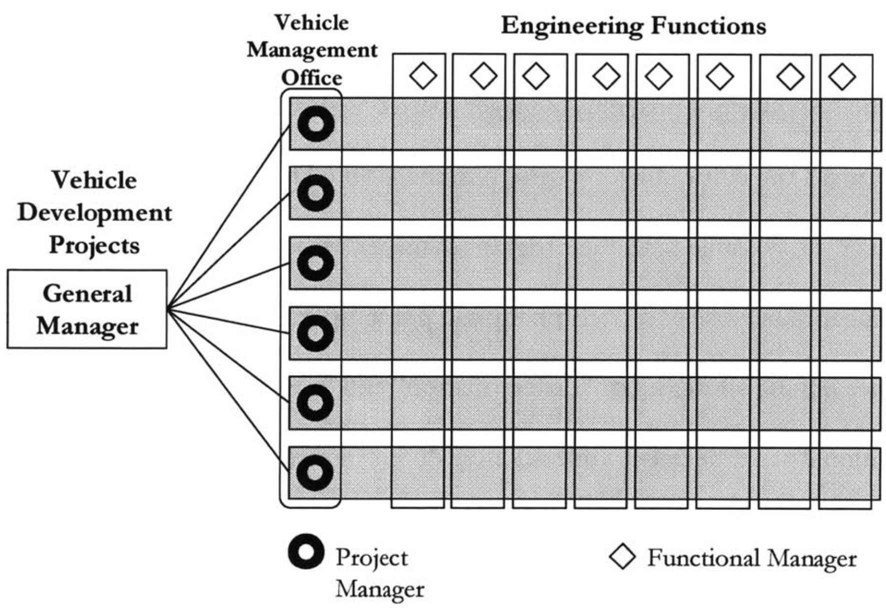

Figure 6: Traditional Heavyweight Program Management Organization

6.1.5 Differentiated Matrix Organization

The differentiated matrix organization (Figure 7) is very similar to the pure matrix organization with the exception of functional areas that "cluster" around different programs based on a philosophy of knowledge reciprocity (program-to-program, function-to-function, and function-to-program). Organizational studies have shown that "to make a differentiated matrix structure work…a company needs to have a strategy for creating sub-systems or common components and

[76] Clark & Fujimoto, pg. 260

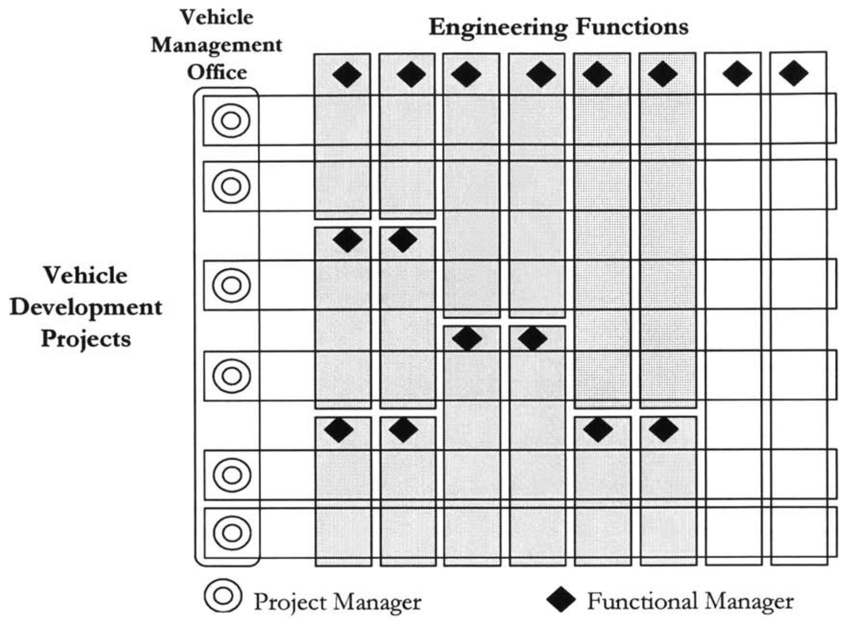

Figure 7: Differentiated Matrix Organization

then for sharing these across products. It also needs to organize and coordinate these groups."[78] The Organizational Model will show how, depending on the corporate strategies and goals, this statement holds true for nearly any type of organization. This is particularly relevant for a differentiated matrix organization as it is the only one that separates functional groups and program teams with the expectation of meeting a common set of goals.

6.1.6 Lightweight Program Management Organization

In a lightweight program management matrix the authority of the program manager is not much more than that of an "issues coordinator." This organization (Figure 8) is very close to the pure functional organization in that much of the power resides with the functional manager rather than the program manager. The design and assembly complexity of an automobile makes the likelihood of any manufacturer to use this type of organization extremely low. In effect, the lightweight program manager organization would have functional groups delivering parts directly to an assembly

[77] Cusumano & Nobeoka, pg. 127

plant without regard for mating or integrating components. Because the benefits and challenges would be the same as (or very similar to) those of the purely functional organization, they will not be discussed any further here.

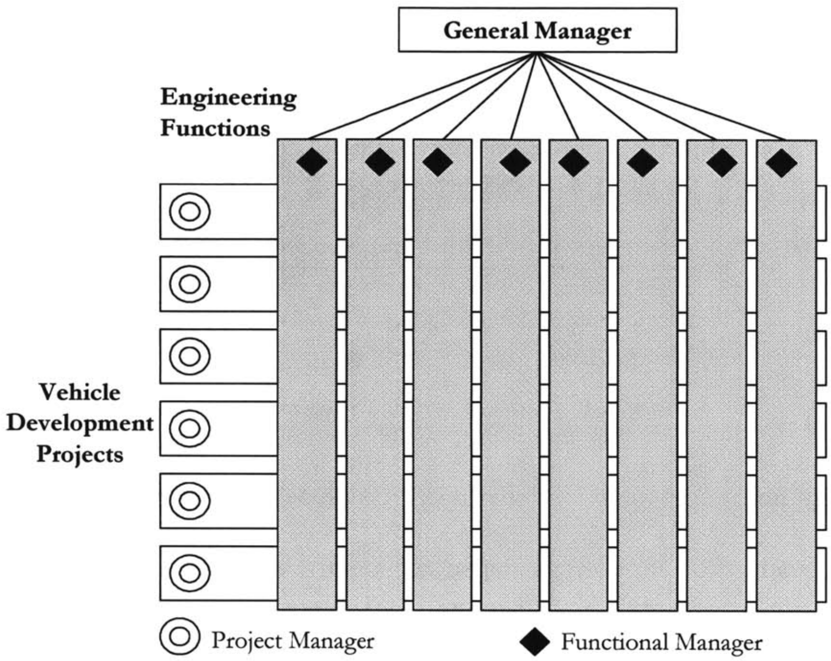

Figure 8: Lightweight Program Management Organization

6.1.7 Centered & Semi-Centered Organizations

Centered and semi-centered organizations are examples of functional team variants, using "clusters" of platforms or similar programs to loosely group the functional areas. The difference between centered and semi-centered is whether there is inclusion of all functional groups in the product or platform clusters. In the centered organization all functions are included, whereas in the semi-centered organization they are not. The most widely-recognized example of a centered organization is Toyota (since 1993), who uses a multi-project management organization containing three vehicle development centers that group projects together (based on common platforms) and a

[78] Ibid, pg. 169

fourth development center that develops common parts for the different centers. At Toyota, two different organizational layers are used to promote commonality: 1.) putting like platforms together within their functional groups and, 2.) creating a separate center for "corporate" commonality.[79]

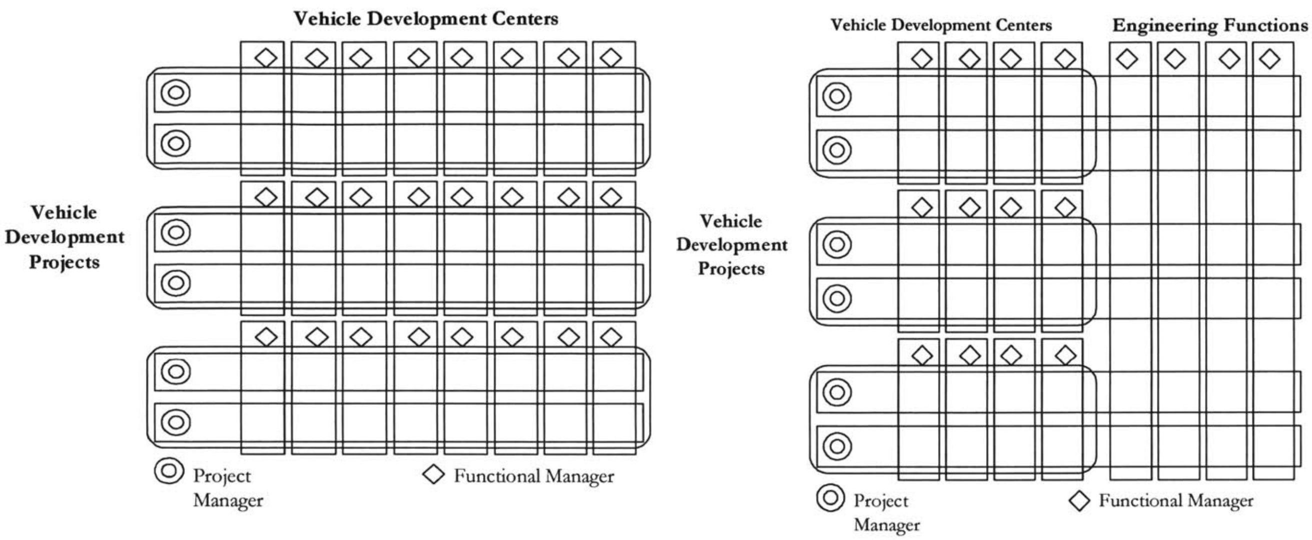

Figure 9: Centered & Semi-Centered Organizations

This structure is designed to promote communication by clustering like programs together and allowing the functional groups on those programs to work together day-to-day. The limited number of clusters also aids technology sharing across the corporation because each group only needs to understand what the other clusters are doing, rather than every other vehicle program. Seemingly, this would create problems similar to those of functional teams, where it is extremely difficult for program managers to coordinate all the input of the many functional areas. However, this can be handled much the way Toyota does it – by combining the functional groups in broader segments (e.g. body exterior, structures, and body interior into body engineering) to reduce the number to a manageable size.[80]

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79 Ibid, pg. 20
80 Ibid, pg. 31 – 33

The centered organization also seeks to eliminate some other challenges associated with pure functional teams. For example, the Toyota Core Business Groups (clusters) attempt to combine good cross-project and cross-functional integration. The structure is created to allow for efficient component sharing while balancing the "normal" low priority of a functional organization for product differentiation.[81] Toyota engineers are located by function, but assigned to specific projects to ensure development of engineering expertise in a particular function.[82] Being grouped with functional colleagues closes the functional communication gap; however, it is really the combining of similar projects that fosters information-sharing amongst like programs. Knowledge of the cluster's appearance goals and performance expectations allows functional employees to design and deliver the product-specific components each program requires.

Centered organizations appear to have adequate controls in place for many of the key challenges associated with program teams or functional organizations. The challenge is, however, the cost to implement and maintain a centered or semi-centered organization. As with program teams, many functions still become redundant since similar, but incremental, functional expertise is required to support each cluster. In 1993, Mazda attempted to implement a product center organization similar to Toyota's, but limited resources and a product portfolio that was difficult to divide into three groups caused the experiment to fail after just three years.[83] The implementation costs associated with this organization make it better suited to a company that has the size and complexity of a large(r) automobile manufacturer, therefore smaller companies with similar corporate goals may be better off pursuing a matrix organization.

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[81] Ibid, pg. 185
[82] Harvard Business Review, July-Aug 1998, pg. 4
[83] Cusumano & Nobeoka, pg. 84-86

6.2 EASE OF EXECUTING A COMMONALITY STRATEGY

Because corporate reorganization is so costly and time-consuming, it should be viewed as one way – but not the only way – for a company to realize its goals. This is not to say that resource re-allocation might not be necessary (or beneficial) for meeting the corporate objectives, but simply that the goals and strategies of a corporation need to be determined prior to establishing how the organization will meet them.[84] So, every company needs to establish its priorities and tailor its day-to-day operations (and organization) to optimally deliver the end result. A major barrier to an "idealized organizational design" is that the resource structure must be realistic in the operating environment, given the culture, financial stability, and the competitive nature of the industry.[85] Rearranging an organization so that it compliments a corporate strategy may be desired (and even necessary) for optimization, but should be prudently structured so that the "costs" to reorganize do not outweigh the potential benefits.

Consistency of process and policy are the keys to implementing any corporate strategy and maintaining the organization that results from the change. The success of the strategy is likely to depend more on the quality of implementation than its appropriateness as a solution to a company's troubles. Companies most successful in reorganizing realize that "...consistency in performance results from consistency in total organization and management."[86] This does not imply that doing the wrong thing right is better than doing the right thing wrong. It simply says that if the initial strategy is properly focused, consistency in execution will get one farther than the perfect strategy with erratic and inconsistent implementation. It is clear organizational change is not required to

[84] Ackoff, pg. 86
[85] Ibid, pg. 89
[86] Clark & Fujimoto, pg. 7

implement a new strategy. Any organization can work; it is a matter of having consistent and well-articulated corporate goals as well as a strategy to meet those goals.

There is a broad spectrum of corporate strategies in the automotive industry, each supporting the common goal of profitability. They range from OEMs whose competency is producing low-volume, one-of-a-kind luxury vehicles (e.g. Ferrari, Aston-Martin and Rolls Royce) to those who intend only to produce high volume, low-cost products, such as Hyundai or Kia. The strategies that support these brands are as wide-ranging as the products themselves. However different the intent to meet the goals, similarities in execution still exist. While high-end manufacturers use established engineering tradition and volume producers use organization and process structure, both use consistency to effectively carryout product development.[87] This is why BMW, Mercedes, or other "exclusive" automakers may choose not to adopt a purely part-based commonality strategy. If it does not explicitly support the total corporate vision they would better serve their customer base without one. Conversely, in the extreme example of Communist auto manufacturing, the goal to produce vehicles for the lowest cost possible drove so little product variation and such high levels of commonality that there was essentially only one vehicle model in production. Smaller OEMs that are less diversified by brand (Renault in the 1980s, for example) will very often use a matrix organization to maximize/optimize their size and strategy – attempting to create "hits" or distinctly innovative designs. This leads to relatively low amounts of component or platform sharing.[88] These examples are just three of many that demonstrate how the definition of the "right" organization is created with the corporate goals and resources in mind.

How does a company decide what organization is right? According to Cusumano and Nobeoka, "whether or not a company should be more functional or project-oriented in product development depends on management's long term strategic goals, short-term competitive objectives, the technology, and the competitive environment."[89] Each of these factors needs to be considered to ensure the new organization will be operationally viable and have the controls needed to balance potentially conflicting strategic goals. For long range strategic planning, Robertson & Ulrich focus on three information management tools: the product plan, the differentiation plan, and the commonality plan. The commonality plan describes the extent to which the products share physical elements. Since platform planning determines the products that a company introduces into the market during a 5-10+ year period, the types and levels of capital investment, and the R & D agenda for both the company and its suppliers, top management should play a strong role in this process.

A company needs first to evaluate all of its basic planning tools to determine what its long-term goals are and to put the enduring, time-critical strategies in place. Moreover, management needs to focus on these goals as they evaluate the daily short-term competitive objectives; it is critical that they do not undermine the long-term goals. The common corporate focus on near-term results makes it easy for a company to "...organize for rapid response to change and therefore decentralize, putting decision making responsibility where internal or external changes requiring organizational changes can first be detected and reacted to quickly."[90] A company's bias toward a functional or program team organization simply alters the difficulty of implementing a commonality strategy. Meeting high-level corporate goals (e.g. "to make money" or "to gain market share") should be the impetus for reorganizing or implementing a new strategy, rather than the converse – something that is often thought to be true.

[87] Ibid, pg. 304-306
[88] Cusumano & Nobeoka, pg. 62 – 63
[89] Ibid, pg. 161
[90] Ackoff, pg. 53

Where a company's primary goal can be met through the implementation of a large scale commonality strategy, and the risks of implementation are known, our Organizational Model can be used to demonstrate how a bias toward a functional organization will lessen the difficulty of execution. The key differentiator here is the communication within the functional areas, an organizational attribute that is critical to flawless execution of a commonality strategy. Functional communication is the major weakness of a program team organization, simply due to geographical disbursement of the functional teams and the remoteness from their colleagues. This same remoteness can also be beneficial, however. The co-location of like-minded functional teams expedites gain of functional expertise and knowledge-sharing as "...face to face technology transfer can be much more efficient than transfer through specifications and drawings."[91]

Many of the benefits of program teams directly conflict with the ability to execute a commonality strategy. For example, program teams are required to respond rapidly to on-going and near-term quality and design issues, but the benefits of commonality are generally realized some time in the future thus minimizing its perceived importance. In addition, to maintain vehicle uniqueness, program teams are more likely to support decisions that move the organization away from the corporate commonality objectives. As we are about to show, the tendency to "reinvent the wheel" or lack of systems integration focus may be dampened by a specific organizational structure, but no particular one is required for a commonality strategy to be implemented.

6.3 ORGANIZATIONAL MODEL

The Organizational Model is intended to illustrate the potential organizational difficulties associated with the implementation of a commonalty strategy – not whether the possibility of

[91] Cusumano & Nobeoka, pg. 133

implementation exists, given a particular organizational structure. We are not attempting to state that a particular organizational scheme would make it impossible to have a commonality strategy, but rather that the level of difficulty in defining and executing that strategy will vary based on the company goals and structure at that point in time. The model is intended to demonstrate the high-level effects on an organization, but can also be used to identify possible operating inefficiencies for segments of the company that may be considering operating outside its core competencies or primary corporate initiatives.

We refer to the model shown in Figure 10 as the *Base Organizational Model*. This model illustrates the difficulty of commonizing under the specific organizational regime in place at the point in time in which the commonality strategy is being deployed. As drawn in Figure 10, the model is generically applicable for a company attempting to operate in as many market segments as possible and in no one market segment completely. The symmetric U shape of the curve represents the changing difficulty levels encountered by the baseline organization as it attempts to introduce product or process commonality as an "extreme" product development organization (pure program team or pure functional team, shown at opposite sides of the U), or at a point in between. At almost any point on this curve, companies have to reconcile the benefits and challenges of its organizational composition (e.g. X% program teams and Y% functional teams), and as the curve shows, each extreme organizational scheme makes implementation of a strategy (perhaps) equally difficult; just for different reasons. Organizations will experience varying degrees of success between the two extremes (and in moving from one point on the curve to another); at each end of the organizational spectrum the marginal benefits decrease while the marginal challenges are increasing as the extremes are approached. This creates additional difficulty for commonization as organizations approach pure program or functional Teams. In general, the factors that situate or move a company along the curve to the point of greatest "ease" are shown in Figure 10:

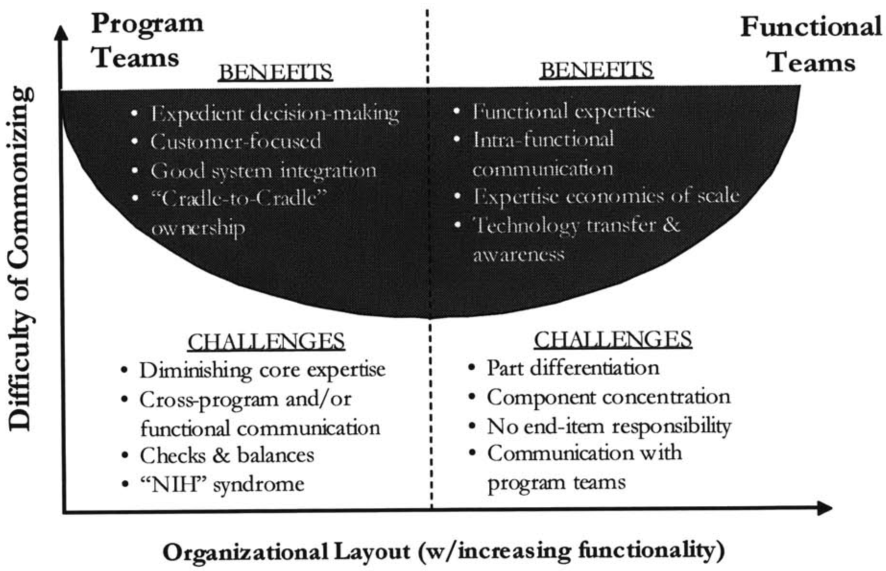

Figure 10: Base Organization Model for the Generic "Balanced" Company

Clearly, any organization deploying a new strategy hopes to completely circumvent (or at least minimize) the challenges and reap only the benefits. Being at either point at the top of the U makes this harder to accomplish. Ideally, a company-specific curve would be based on its corporate goals and the organization would be designed such that it would ultimately be positioned in a location that allows it to capitalize on the advantages of the program and functional teams while avoiding the inherent challenges of each. It is generally accepted that a move along the curve toward the midpoint will require a corporate reorganization. Examples given throughout this section will detail how the shape of this curve is derived, and later describe how it is tied to the total cost impact of implementing a commonality strategy.

The perfect **U** shape is not a forgone conclusion for any specific industry, nor is it likely to exist within the automotive industry exactly in this form. The shape of the curve is dependent on a company's goals and its operating structure. If challenged, most companies would contend that they are biased toward either program or functional teams. The trend is established by corporate goals that tend to favor a customer/differentiation focus or economies of scale/reduction of hard (fixed) costs focus. For example, a luxury automaker that is concerned with keeping consumers excited about its innovative and prestigious products would derive more benefit on the product team side of the model where component uniqueness (in design or performance) is valued. In this case, the base model curve would be modified to Figure 11 below, where it is shown that the difficulty of commonizing is lowest near the program team side. In this instance, the "difficulty of commonizing" can be interpreted to mean "corporate expectation to commonize." This is (in part) because the program team focus and mode of operation (performance/differentiation focus) more closely supports the development of a product expected to compete in the luxury (or other niche) vehicle segment. It should be noted, however, that the difficulty of commonizing is still higher than that of the base organization. The upward slope of the curve illustrates (directionally) the increasing difficulty of or resistance to commonizing parts based on the potential incompatibilities between "common parts" and "luxury brand differentiation."

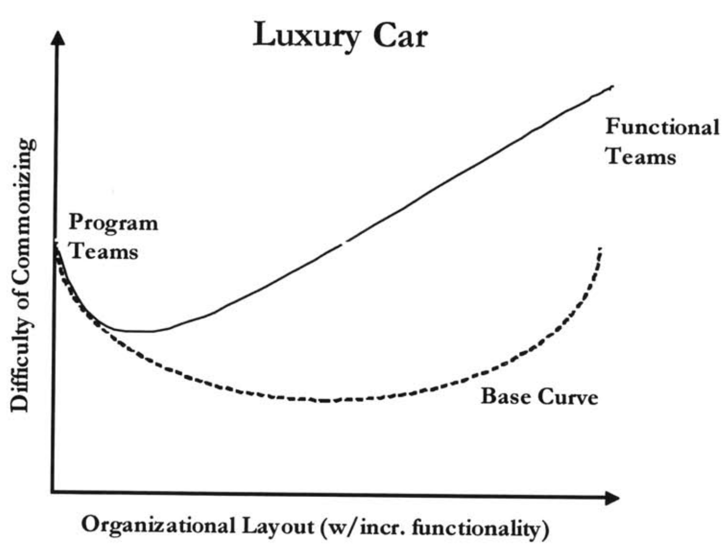

Figure 11: Luxury Automaker Organizational Layout

Conversely, there are companies at the other end of the spectrum, whose sole intent is to operate in the world of low-cost production. In this market segment, the goal is to optimize at the system level and retain acceptable variable cost margins while still providing the highest-quality, most affordable vehicles. For this manufacturer, the base organizational model might be modified to show an attempt at leveraging economies of scale, as shown in Figure 12. Again, the curve has been skewed from the base model, but with a slope opposite that of the luxury automaker because the difficulty of commonizing decreases with a move to a functional organization; also because the need and want of the low-cost producer to reduce costs (through commonality and other avenues) far outweighs the benefits of differentiation and performance offered by the program team organization. The curve moves to a lower position because the benefits and operating process of a functional organization are more closely aligned with a wide-spread commonality strategy.

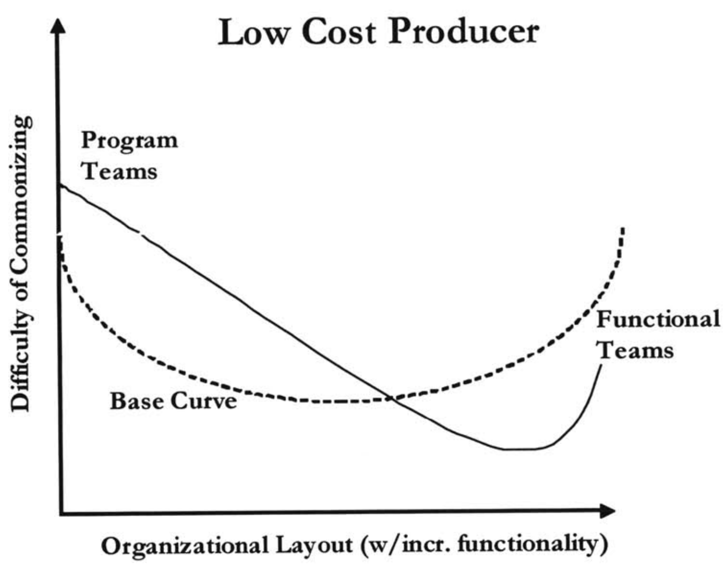

Figure 12: Low-Cost Producer Organizational Model

Although the organizational benefits and challenges are essentially the same (in varying magnitudes) for all automotive manufacturers, the organizational curves will still be significantly different among companies with dissimilar visions. This is due to the weight or priority a market assigns to a specific benefit or challenge. In <u>Section 7.3</u> a "Cost Model" will be used to describe and graphically demonstrate how the slope of the "difficulty" curve is based on the "soft" costs incurred by implementing (or rejecting) a commonality strategy.

In the base organizational model the critical area of operation is above the curve, for any type of organization (the gray zone in Figure 13). This curve demonstrates the lower boundary of the "difficulty range" associated with commonization. It is possible to reside on this curve, but since this represents optimal operating efficiency it is more likely that a company will be somewhere on a vertical line in space above the curve (on the blue line in Figure 13). Regardless of the corporate goals, the model has an optimal point – the lowest point on the organizational curve. This does not imply that all companies know where this point is or how to be efficient enough to arrive at and/or operate there.

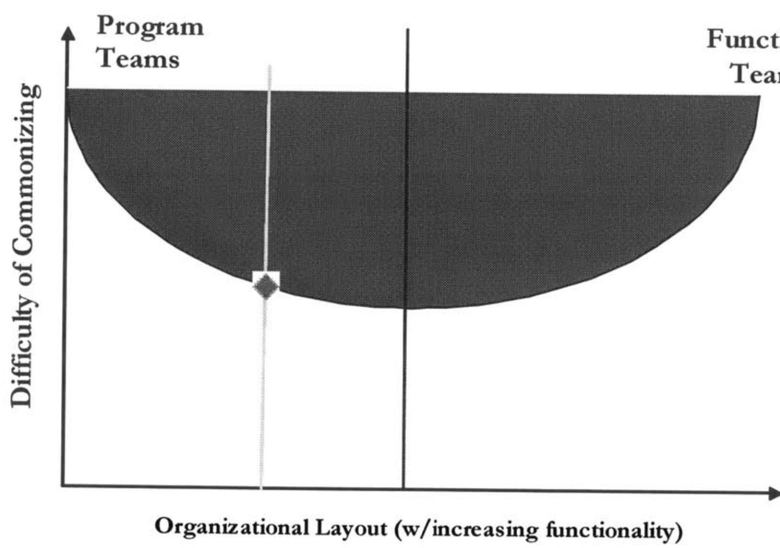

Figure 13: "Difficulty" Range Associated With Commonality

Operating inefficiencies or competing corporate strategies may not allow a company to be at the optimal point, or even on the lower boundary. Whether by design or happenstance, operating off the optimal point can create additional problems, particularly related to cost, and a new point of operation that is beyond the best possible will be created. The same holds true for the situation in which an area or division of a company chooses to operate outside the organizational structure, corporate strategies or core competencies. Consider, for example, a case where the low-cost producer decides to develop a single luxury (vehicle) model. This can be accomplished in one of two ways: by developing the new product within the existing organizational structure, or by creating a distinct, stand-alone product development group. In the first instance, the vehicle program team would be subjected to all the challenges of a luxury carmaker while gaining limited benefit from the company's baseline low-cost production strategy. This creates the situation depicted in Figure 14 where the difficulty for the luxury vehicle program team to commonize significantly increases (with the operational inefficiency illustrated by a large upward shift off the optimal curve). The overall effect to the organization is an incremental move off the same optimal point as the benefits and challenges reach equilibrium.

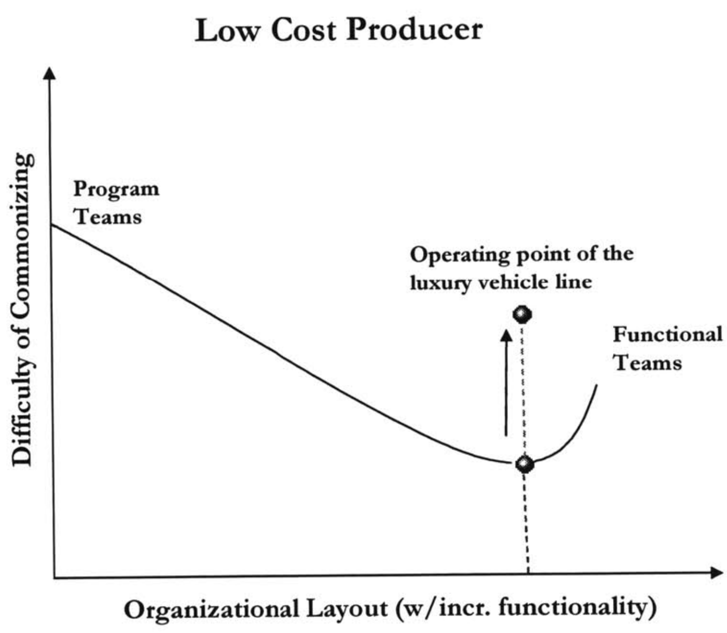

Figure 14: Low Cost Producer Operating Outside Core Competency

In the second case, a stand-alone group is established that either chooses to ignore the benefits of part and information-sharing or is unable to realize them because of the group's relative isolation.

The autonomous organization may be created so that customer expectations and functional requirements can be met without operating within the "constraints" of the standard organization. In this situation, the new luxury division will have its own organizational curve that will be similar to that of the luxury carmaker shown in Figure 11. The significant difference is that the baseline level of difficulty at which the new curve starts is higher than a company choosing to operate only as a luxury automaker (Figure 15). This is a result of the low cost producer's new luxury division having no comparable vehicles within its current portfolio from which it can select components or subsystems for commonization. In either case the *initial* result is an expected (and perhaps necessary) low level of commonality due to the difficulty encountered by operating outside of the company's core competencies.

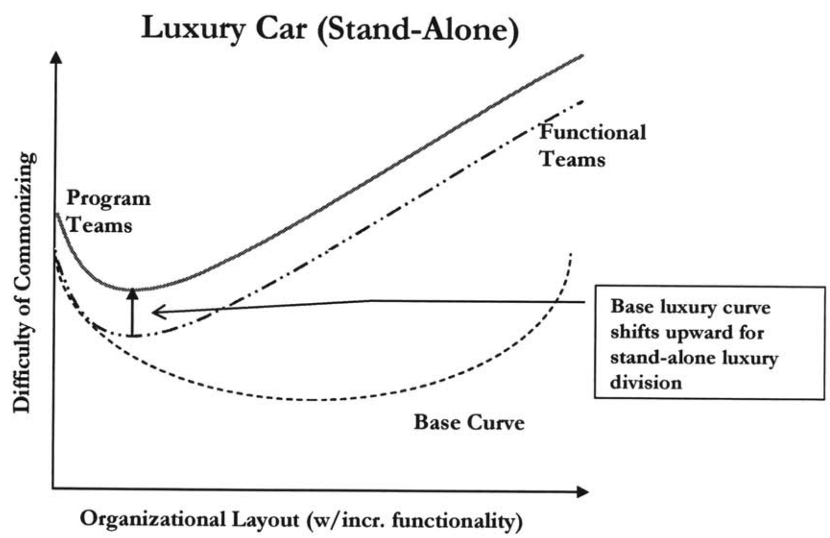

Figure 15: Low Cost Producer Operating Outside Core Competency with Stand-Alone Luxury Group

An example of this situation is Toyota's creation of its Lexus division. Utilizing the Toyota philosophies outside of the traditional product development regime, the Lexus group was able to operate more like a true luxury automaker than a low-cost producer. This separation (and continued Toyota affiliation) improved operational efficiencies related to commonization and allowed Lexus' difficulty-to-commonize curve to move down to that of the baseline luxury automaker.

One can see from this example how operating outside the corporate strategy can result in difficulty to commonize that is actually greater (proportionally) than those companies that plan to operate in that market as a normal course of business. The point to take from these examples is that every company needs to determine what goals it plans to meet and construct a model accordingly. The models should be used to assess the implications of operating outside the established strategies or to make adjustments to the corporate strategy so that it is aligned with and supports the company's goals.

Every company needs to continually re-evaluate whether organizational changes are necessary to finesse its high-level corporate strategy. As the want and need for commonality changes, the organizational model should be revisited to determine a (potentially new) course of action and the associated impact of that change. This does not mean reorganization is required with every fluctuation in corporate goals, but that the possibility should be evaluated and the new issues understood. Controls can be put in place to dampen or minimize the negative effects of a strategy change, so an idealized organizational design is not as weak as its seemingly weakest link. Benefits gained by the system and its interactions outweigh "soft" spots, and "...the plan can be implemented for the whole without inclusion of some of the parts."[92] This also allows companies to create a customized corporate strategy that uniquely affects the components, systems, divisions, or organizations.

With commonality, the goal is to maximize the total output, even if it means zero implementation for some parts. The development, assessment, and refinement of a strategy needs to be dynamic and ongoing. In Section 9.3 a Decision Making Flow Chart will be introduced that illustrates why the choice to exclude certain segments (ranging from a component to an entire division) from the strategy needs to be done early on in the strategy phase of implementation. This allows a company to put a "checks and balance" system in place so that any negative effects resulting from organizational change, including those related to increased operational costs, can be mitigated.

7.0 COST

Within the automotive industry and throughout our research, cost – as it relates to variable piece price reduction achieved through (a somewhat ambiguously identified) "economies of scale" – was often cited as the driver for developing and implementing a commonality strategy. Companies that have been able to successfully leverage economies of scale are realizing that this terminology can, and should be, applied to the multiple beneficial aspects of commonality. Economies of scale cost savings are also realized through fewer capital expenditures for redundant tooling, reduced warranty through improved quality, reduction in costs associated with fewer tool changes required on higher quality parts, and lower engineering, design, and testing (ED&T) costs because common parts may not require unique design validation in a common application. The first part of this section will discuss cost benefits associated with commonality.

Ironically, doing "the right thing wrong" (through company-wide propagation of poor quality common parts) is a serious economies of scale inhibitor. Cost inhibitors, such as costs related to the change process, reorganization, and tool utilization are introduced (after the benefits are discussed) and are the basis for the adjustments in the cost model unveiled in this section. As in Section 6.2, we will use generic examples to demonstrate the varying effects a company's goals and strategies (and the accompanying benefits and challenges) have on the company-specific cost model. In addition to the presentation and interpretation of the model, we expand on some of the benefits and

[92] Ackoff, pg. 98-99

challenges related to cost and commonality and discuss how a company's operational conditions can be used to generate more favorable cost effects (or avoid those that are less favorable).

7.1 COST ADVANTAGES OF COMMONALITY

Economies of scale are the primary force behind the implementation of a commonality strategy. A majority of these cost reductions come from variable cost decreases related to better tool utilization. As usage of a particular part increases, the tool approaches its production capacity. The cost reductions are a result of fewer tool changeovers, larger batch purchases of raw materials and/or simply amortizing the cost of the tool(s) across a greater quantity of parts. Bruce Henderson, consultant for the Boston Consulting Group, extended the concept of economies of scale by stating, "...that all costs, not just production costs, would decline at a given rate as volume increased." A more in-depth look at the production development process for economies of scale-type savings reveals a cost reduction through more expansive amortization of engineering, design, and testing costs. When a program decides to reuse or commonize a part, much of the engineering work has been completed. So while this is really cost avoidance rather than a savings, per se, it still reduces the corporate engineering, design, and testing expenditures over time. The most common driver of a commonality strategy is the potential gain in incremental operating efficiencies; additional benefits exist, but are often more difficult to identify or quantify.

While not often mentioned as a major cost benefit of commonality, improvements in quality have the potential to create the largest cost impact, long-term. As mentioned previously, with commonality, good quality perpetuates good quality. Rigorously evaluating components or systems before they are a candidate for commonality gives engineers high quality parts as a baseline to which they will commonize. This will improve quality, company-wide, by bringing component quality up to, or near, the highest levels in the company, and potentially the whole industry. The benefits here are two-fold. First, the improved quality will lower warranty and thus lead to a reduction in total operating costs. Secondly, this quality improvement and the reduction in "things gone wrong" complaints (that accompany poor quality) will directly and indirectly impact customer satisfaction. Independent companies, such as JD Power, that solicit consumer feedback have shown that fewer trips to a dealership for repairs greatly enhance a customer's satisfaction. This heightened reliability bolsters the company's overall reputation, particularly with respect to quality and reliability. These factors are likely to translate to additional sales by "word of mouth" and recommendations of automotive experts. All these benefits can, if correctly executed, significantly improve bottom line costs, corporate reputation, and ultimately, market share.

With respect to a commonality strategy, the points just discussed are those mentioned most frequently as having the ability to positively affect program costs and as being the items that provide the greatest returns on cost reductions gained through its implementation. Some additional factors with a lesser, but still significant, ability to make an impact are: (1.) fewer capital expenditures – where the tooling costs must be allocated up front, commonizing will result in fewer tools being required and therefore lower yearly capital investment, and (2.) reduced costs associated with service parts – with fewer unique parts being released for service an OEM can stock fewer parts resulting in higher-quality workmanship at the dealership, reduced inventory holding costs, and fewer obsolescence expenses.

7.2 COST DISADVANTAGES OF COMMONALITY

Every operational strategy, including commonality, comes with challenges. Cost is a serious barrier to the long-term stability of commonality; not just ensuring that the cost benefits meet the corporate expectations, but avoiding additional costs needed to overcome the challenges. One of the most significant challenges is the potential need for reorganization (related to meeting a set of corporate goals) using the Organizational Model proposed earlier. Reorganization is an extremely costly process, in that there are significant deployment and execution costs and the inevitable lost time during the transition. A company should carefully evaluate the cost (penalties) of organizational change against the cost (saves) of commonality to determine if a change is absolutely necessary or whether it would be more prudent to simply find a way to minimize the risks associated with operating away from the optimal position.

The cliché, "time is money," is highly representative of the lost time associated with the engineering and administrative process of implementing engineering changes. Commonizing means there will be fewer unique parts that require changes, but when changes are required, more vehicle programs will need to spend time assessing and processing each change; this will cause the actual cost of making engineering changes to increase. The theory is that it will take more time and money for six programs to jointly coordinate a single change to a common part than it would for six single programs to make the same change, independently of each other. This is an important point because, "...in the United States, engineering changes account for 30-50% of the cost of a die; ...attributable to a number of changes and the cost of those changes."[93] In essence, the increase in tooling costs should correlate strongly to the additional administrative time and cost of the engineering change.

To validate this assumption we analyzed 27,092 engineering changes implemented at OEM A between 6/20/1997 and 10/17/2002, with one to six individual vehicle teams affected on each change (where a team is represented by a unique "code" that is added to the engineering change to identify the team as a part of that change). The results and statistical analysis of that study are shown below in Figure 16.

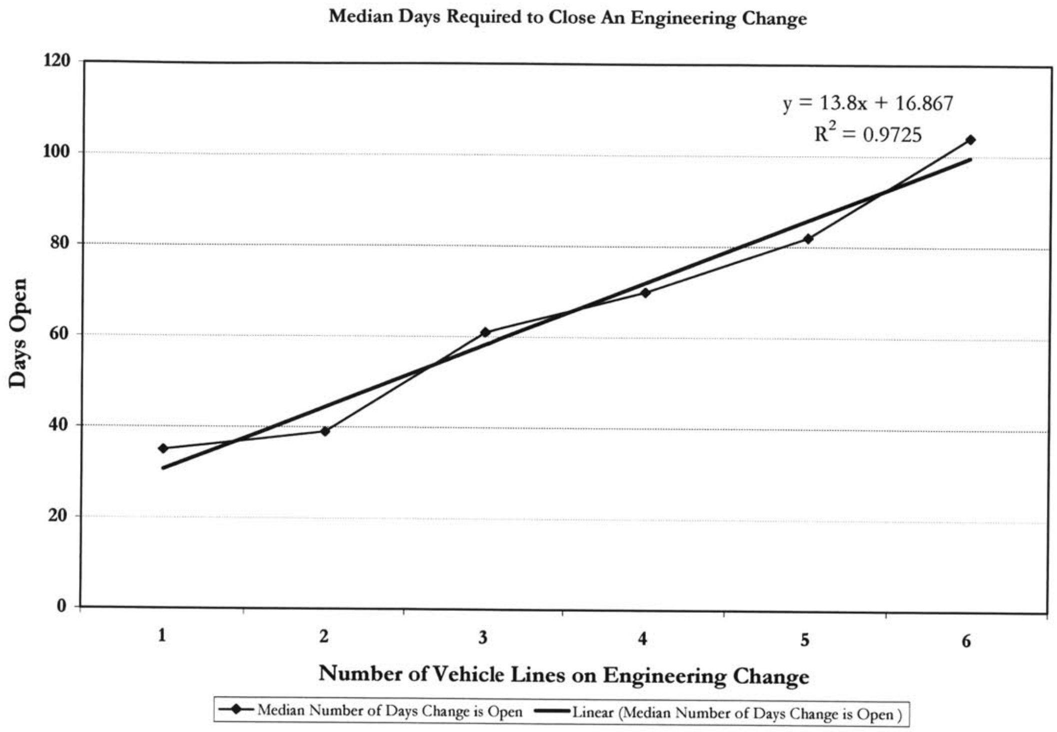

Figure 16: Median Days[94] Required to Close an Engineering Change

This plot shows that as each additional program team is added to an engineering change the median number of "days open"[95] increased by fourteen days. An engineering change that would affect multiple vehicle teams could be a material-related change. For example, a change to the material used to make seat belts (highly common company-wide) would typically impact all of the vehicle teams in a company. The more significant "cost" of executing a change actually comes from the increase in administrative time, not necessarily the people-hours needed to complete the work. Time is a non-renewable resource, and the pressure to meet deadlines and get new vehicles to market as quickly as possible limits the possible solution space for many of the "normal" problems that arise during the product development process. It is critical to acknowledge this as Clark and

93 Clark & Fujimoto, pg. 187
94 Median value used due to non-normal distribution of "Days Open" data. (see Note A, Appendix for additional detail)
95 "Days Open" refers to the duration of initiation of the engineering change to the point at which it is released for production.

Fujimoto have noted, "...design changes are the rule, rather than the exception...inasmuch as engineers tend to work and rework designs, as long as they are permitted to do so a design is never complete; the engineers simply run out of time."[96] Minimizing time to closure of an engineering change is especially critical if it is being made in response to a quality or safety concern. Each additional day the change is kept open results in degradation of the overall product and customer satisfaction. Companies can try to keep the time to complete an engineering change from climbing so rapidly by adding incentives or metrics to encourage the desired behavior, but outside forces are likely to prevent them from being completely effective.

In the engineering change study, OEM A had a product development organization that was set up to theoretically perform like the centered organization described earlier. In reality, the actual day-to-day operation was more like a program team organization with individual teams responsible for all functions required to complete the product development process. This may be the worst-case scenario since this type of organization is likely to have significant cross-platform communication issues. In any situation, inadequate resources, political posturing of program teams or even simple geographic barriers will cause changes of common parts to take longer than similar changes on the equivalent number of unique parts. To mitigate these effects, steps must be taken, and (more importantly) a company must factor these costs into the commonality strategy business case.

One cost that is difficult to quantify is the possible loss of reputation or weakened brand image that can accompany reduced product differentiation, especially when commonality is taken to its extreme limits or beyond. As mentioned at length, VW is a good example of a company incurring this type of cost. VW took its commonality strategy so far customers began to wonder why they would purchase vehicles from their high-end brand Audi, when many of the same components were

[96] Ibid, pg. 87

being used on the lower-priced Skoda equivalent. The impact of the loss of reputation varies by automaker and is highly dependent on the manufacturer's overall goals. In the case where an OEM wants to operate in the realm of the low-cost producer and its customers understand this as a prime attribute, the effects to their reputation only surface when their strategy goes beyond basic commonality and approaches badge engineering. Conversely, a luxury automaker would incur greater reputation damage as sales in this market are generally based upon the expected uniqueness in vehicle appearance and performance. Meyer & Lehner (1997) address the importance of balancing commonality and distinctiveness and understanding how a weak common subsystem can undermine the competitiveness of the entire product line, thus causing a broad array of products to suffer.[97] Here commonality is not impossible, but significantly more difficult to implement without damage to their reputation. In both instances, the level of commonality needs to be based on the maximum amount the customers will tolerate before sales are lost; this still allows each to obtain operational efficiencies, provided they are directly related to the automaker's corporate marketing, product development and manufacturing vision.

The final cost challenge we will discuss is the cost of "doing the right thing wrong" in the implementation of a commonality strategy. The most detrimental occurrence is, as suggested, commonizing to components or systems with poor quality (in terms of performance, warranty claims, etc...). The increases in warranty and loss of customer satisfaction will quickly overwhelm the economies of scale cost benefits. Additionally, erroneous decisions about the depth and timing of implementation of a commonality strategy can lead to over-spending of capital for unnecessary reorganization or redundant tooling. In either case, rigorous decision-making based on evaluations of a company's situation and a review of their Organizational Model and Cost Model (introduced in

[97] Meyer & Lehnard, pg. 59

the next section) will limit the cost risks while still allowing the potential to reap the cost benefits outlined above.

7.3 COST MODEL

Before implementing a commonality strategy, a company should establish a corporate vision based on the characteristics of the market segment in which it plans to compete. Only then can baseline Organizational and Cost Models be created that will aid a company in deciding the amount of commonality that will be pursued. In this section a Cost Model is introduced that demonstrates the cost benefits and challenges a company is likely to encounter with increasing commonality. The Cost Model shows the costs of commonization broken into two categories: the "hard" costs and the "soft" costs. The hard costs are those fixed costs that decrease as commonality increases, for example: piece price, tooling expenditures, warranty costs, R & D costs (engineering, design, and testing), service costs, and obsolescence costs. The soft costs are more nebulous, less easily-quantifiable resource expenditures that increase as commonality increases, such as: cost of communication, differentiation, reputation, administrative costs (not directly related to production or development), timing and political balance of power, internally.

The cost curves in the baseline model are defined by the hard costs that follow the economies of scale curve, and the soft cost line that reflects the behavior of a company trying to balance the aforementioned strategy benefits and challenges. The example shown in Figure 17 demonstrates the same baseline example described in the section on organization. The company shown here has a very "balanced" portfolio, it is not attempting to compete in any one market, but spreading themselves across as many as possible. This is illustrated best when comparing the examples of a luxury car producer and a low-cost producer, but can be generically described as a smooth curve where the hard and soft curves behave similarly to each other.

As mentioned previously, hard costs are closely related to economies of scale and therefore have a similar graphical representation. For this reason, the hard costs remain fairly consistent for any set of corporate goals, but as a company moves from being a low-cost to a luxury manufacturer, the soft costs change dramatically.

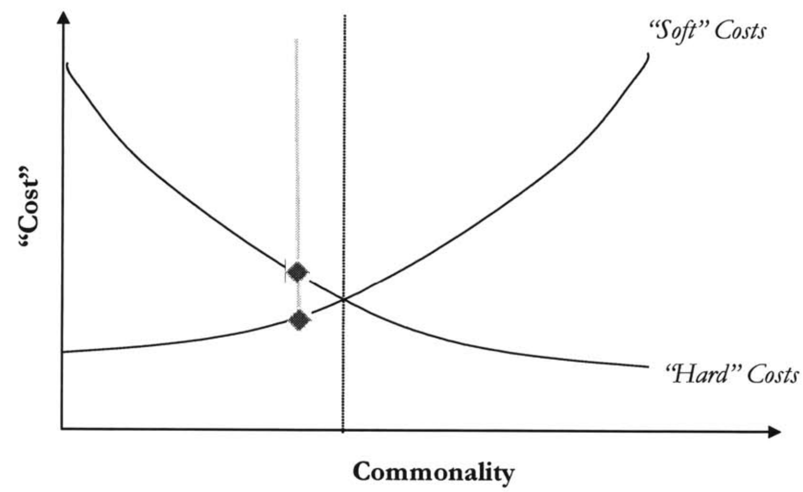

Figure 17: Cost to Company to Commonize

Figure 18 illustrates the difference in the cost curves for the luxury and low-cost automaker. For the luxury producer, the hard costs remain basically fixed, but the soft costs change significantly as part commonality is increased. The cost curve gets its shape because a luxury automaker will still derive benefit when a commonality strategy is executed with strict avoidance of critical appearance or functional components or systems. The soft costs increase as the company moves toward greater commonality, and away from its luxury "cues" by, for example, sharing parts with economy models at the same company) until it eventually experiences a loss of differentiation and its reputation and cache as a "premier" brand is weakened. We can see by placing the corresponding Organizational and Cost Models next to each other that the two have a similar resultant shape. This happens because the same factors that drive hard and soft costs also influence the difficulties of commonizing in the specific market segments.

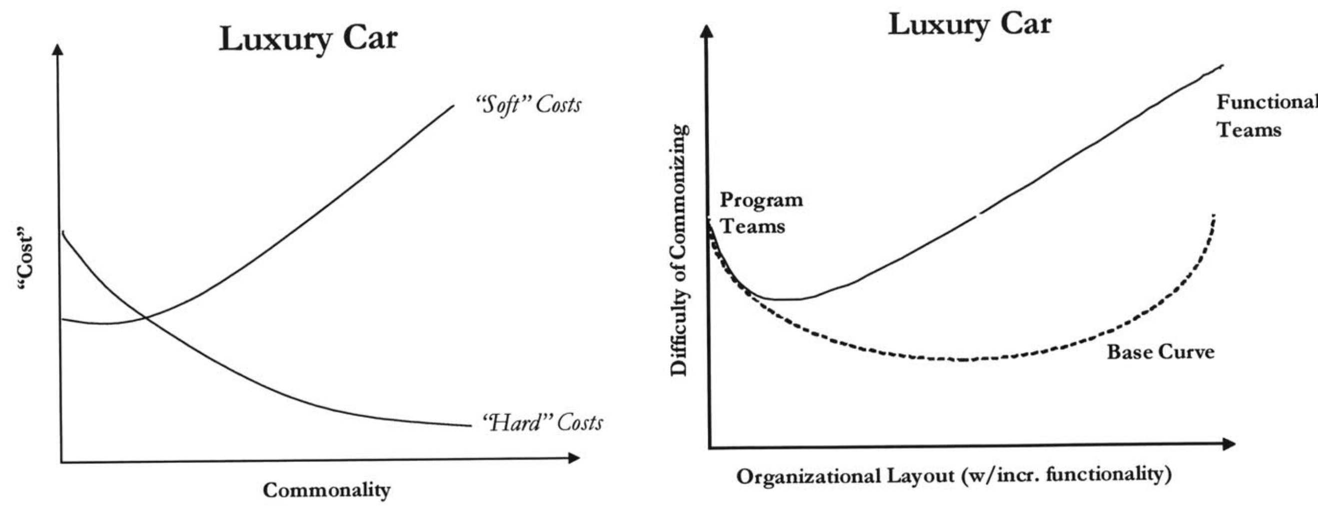

Figure 18: Luxury Car Cost & Organizational Models

Figure 19, the example of the low cost automotive producer, shows nearly the opposite behavior. This automaker strives to gain maximum benefit from commonality and has a customer base that cares primarily about vehicle acquisition cost, rather than distinctiveness. This customer will tolerate a much higher percentage of commonality in their vehicles, to the point where appearance and performance can be similar, and potentially compromised, provided the functional needs are being

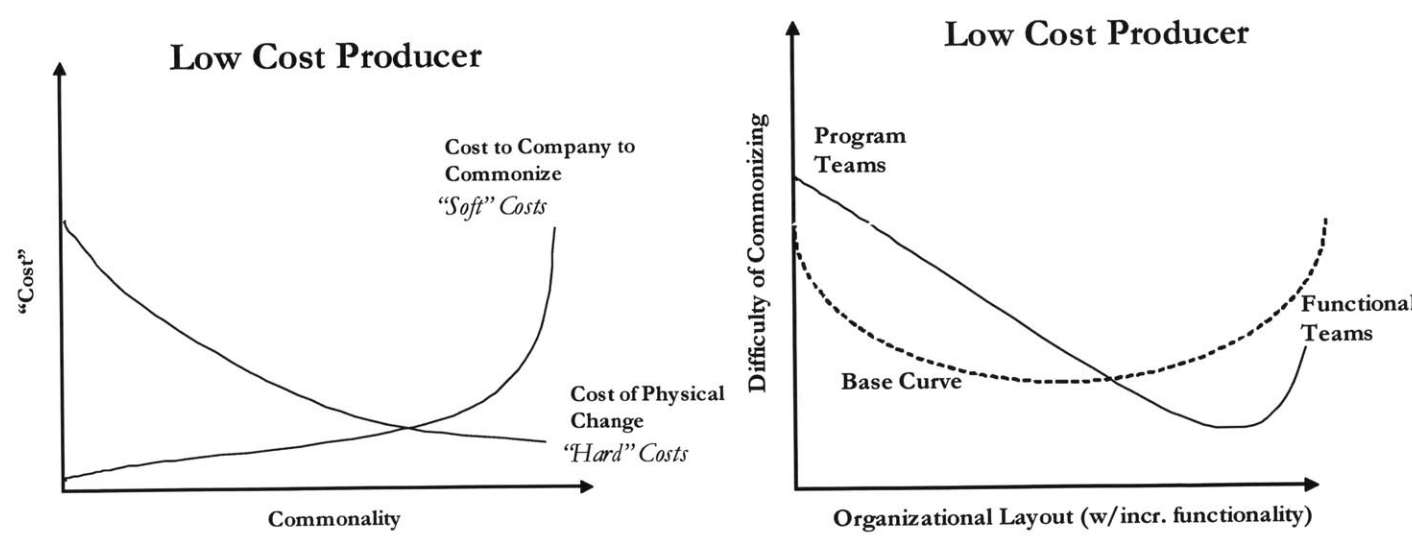

Figure 19: Low Cost Producer Cost & Organizational Models

met. Once again the hard cost curve is in the fixed location, but the soft cost curve demonstrates the tolerance of the customer for incremental commonality by the small slope that stretches across most of the model. Only when it approaches maximum commonality do the effects of timing and engineering change costs become a serious issue to companies in this market. Again, for the reasons mentioned previously, the Organizational Model corresponding to the low-cost producer follows a path similar to the cost model.

Both examples demonstrate that the shape of the curves depends strongly on a company's goals and strategies. This is also the same behavior exhibited by the "difficulty to commonize" curve in the Organizational Model, as a company alters its goals and strategies. Attempting to operate outside the area the Cost Model suggests will cause a company to incur additional costs. For any level of commonality a company undertakes, the minimal cost to commonize will be the sum of the lower and upper curve costs at the level of commonality with which it is operating. While the optimal operating point is at the point the two curves cross, a company is unlikely to know exactly where this point is and operational inefficiencies (related or unrelated to commonality) will likely drive it to a point above the curve. The optimal operating point is important to companies for reasons related to cost and also because operating at this level of commonality demonstrates perfect knowledge of the customer's expectations (soft costs) while gaining the maximum commonality benefits (hard costs). If a company, or even a portion of that company, decides to operate off the optimal point it will be subject to additional hard and/or soft costs, as shown in Figure 20.

Low Cost Producer

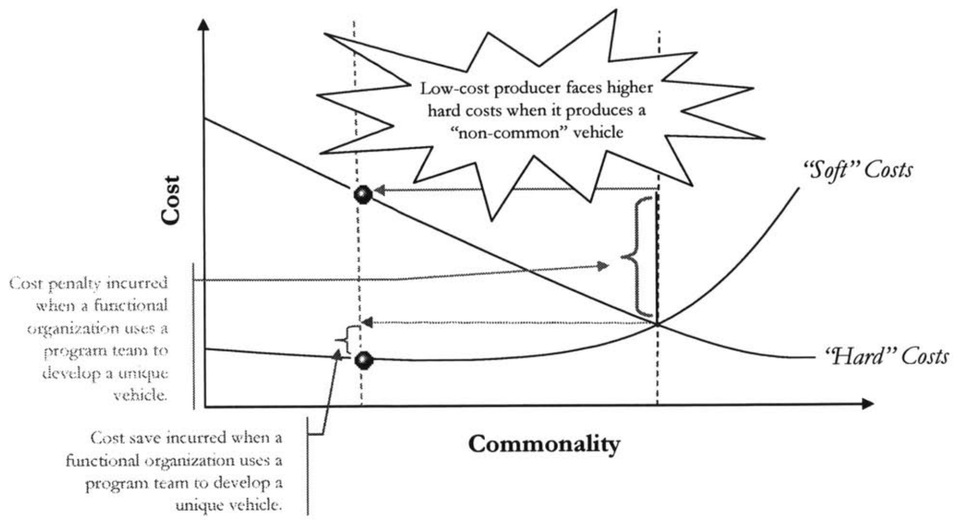

Figure 20: Low Cost Producer Operating Outside Core Competency

The models shown above should be developed and analyzed as the corporate strategy for commonality is developed. These initial examples are used to demonstrate how the model works; its intended purpose is to be used both before and during the product development process for preparation of a business cases. As an increasing number of decisions are made on the premise of using common components and systems, a company should be able to determine whether the Cost Model accurately predicts the cost benefits of commonality. This is be accomplished by comparing the variable cost reductions against customer satisfaction, or another similar measure. This simple verification of the model will allow the company to adjust its internal model via corporate strategy and/or organizational change.

8.0 CASE STUDIES

Having already discussed industry-wide practices and our strategic organization and cost models, this section will introduce two case studies conducted at OEM A to corroborate and validate our hypotheses. The case studies – based on a cross-platform subsystem study and a vehicle platform study – were developed using responses to questions asked of personnel (Note B, C & D, Appendix) involved in each respective initiative. These questions were tailored specifically to each study, but were also designed to gather generic information related to the issues that surfaced throughout our research.

Team members from engineering, program management, purchasing, and sales personnel from OEM A and several suppliers were interviewed to gather data for the subsystem and platform case studies as well as on general corporate commonality. The expectation was that the information gathered in these interviews would verify or refute the effectiveness of the models in determining the likely outcome of attempts to commonize at any level (be it component, subsystem, or platform). For general information on commonality strategy "best practices," and the company's strategic higher-level commonality challenges and goals, members of OEM A's executive management team were interviewed. A more in-depth review of each case study follows, including a correlation of the findings to the models previously discussed.

8.1 SUBSYSTEM CASE STUDY

The subsystem case study was developed and completed by interviewing team members (engineers, program managers, and purchasing managers from OEM A and several of its suppliers) about a common subsystem (henceforth, a "widget") on two different vehicle lines (henceforth, Vehicle X and Vehicle Y). The initial intent was to have a common widget in Vehicles X & Y; vehicles whose production dates were originally set to be only 8 months apart – a span considered close enough for concurrent widget development and technology transfer. Despite the platforms' architectural differences, the vehicle package and the widget's high-level functional requirements were similar enough to suggest the level of commonality between the two programs could, and should be high.

Although the widgets on each program were supplied by different sources, a minimum level of commonality was expected at the time of sourcing due to the level of expertise the supplier of Program A had in functional mechanisms. A commonality deep-dive study took place when Program A was in the final stages of defining the scope of its program and Program B was still attempting to determine some of its assumptions. In both cases, many of the initial program assumptions dictated by the individual platform teams were in place. The results of this case study and a comparison against the commonality strategy models follow.

The widget is a relatively complex system with many unseen structural components that provide the basic functions all widgets need to have. A widget is made up of many individual components that additively comprise approximately 5-9% of the vehicle's total material cost (with the variation related to vehicle options and/or content). For any given vehicle program, an automotive OEM generally has between four and 100 different widget combinations. At the time the deep-dive commonality study was initiated, both programs were facing significant gaps to the corporate cost target for widgets. When queried about the goal of the widget commonality study, most case study participants believed it was to close or eliminate the widget's variable cost delta (to the expected cost target) for both programs. Respondents stated that management believed there was approximately 10% to be saved and that it could be accomplished by achieving "as much commonality as possible." At the completion of the nine month investigation, Programs A & B and their suppliers calculated there was just over 1% of the componentry that could be common for a savings that was (coincidentally) also just over 1% of the average cost of a widget. After the study was completed and the teams went back to design the widgets for the two individual programs, the number of common parts fell to 0%.

Each case study participant was asked to describe the organization as it existed at OEM A when the widget commonality study was conducted. The overwhelming description was that it resembled a heavyweight program management matrix, with day-to-day operations using program teams. The link between the widget engineering teams on each vehicle platform was described as nonexistent, with the most interesting relationship depicted graphically by a widget supplier program manager. Figure 21 shows there is no perceptible link between the functional engineering groups, the program management groups, or even the program "owners" (believed to be the final decision-makers of the two vehicle programs in the study). Even the link between the two suppliers was stated to be forced, and not a "natural" partnership. This organizational arrangement created a situation where the independent teams were constantly jockeying for position to ensure their specific needs and wants were being met. This statement says nothing about the dedication of either group; nearly all the interviewees said the working level personnel was dedicated to completing the task and meeting the goal to the best of their ability. This is a powerful statement about the groups' inability to change the inertia of the organizational structure.

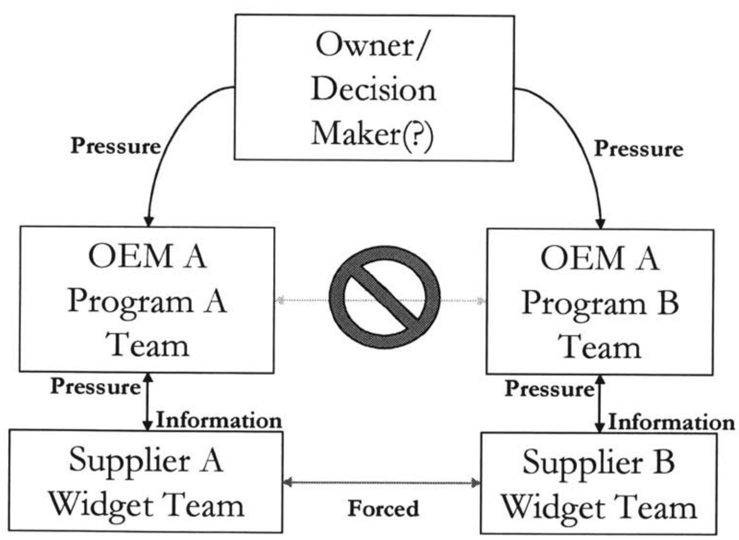

Figure 21: Supplier Perspective on OEM Organizational Structure

The Organizational Model, the Decision Making Flow Chart and the Balance of Power Model (Section 9.0) proposed in this paper would have been helpful to the teams investigating widget commonality. The outcome may have remained the same but the teams might have better understood the organizational hurdles they were facing and, thus, have been prepared to counteract them and improve their chances for success. Similarly, an understanding of the individual incentives in place and the issues related to balance of power might have provoked upper management to greater involvement in the decision-making process. Finally, any initiative without a goal, a strategy and a process to follow (that includes accountability) will always be difficult to execute successfully. This does not imply our flow chart would have led to success, but that any standardized process would have dramatically improved the odds. Our conclusion is that our models, when used together as a tool for strategic implementation, would have correctly predicted the outcome of the widget commonality study.

8.2 PLATFORM CASE STUDY

The platform case study was developed and completed by interviewing team members (chief engineers, program managers, and purchasing managers from OEM A) from three different vehicle models (each a different brand) based on one platform (henceforth, Vehicle 1, Vehicle 2, Vehicle 3, and Platform B) about their respective roles in the design of these similar vehicles. The initial program direction was that Vehicle 1 and Vehicle 2 would share a common development team and "launch" date (start of new model year production) while Vehicle 3 would be developed by a stand-alone team that would launch its vehicle approximately six months later. Generically (and realistically), commonality targets for different brands within a platform can be, by value, 60% or higher. The teams and brands involved in this platform case had worked together for many years creating vehicles for customers at different pricing/expectation levels; because of this, it was clearly recognized that the industry expectation for commonality was a possibility. In this instance, there was no commonality target related to either the base program or its new derivatives.

As in the widget study, there was no commonality strategy at OEM A during the time Vehicles 1, 2, and 3 were in development. No commonality targets were in place and, consequently, the program teams had no set process or incentives to drive any amount of commonality beyond that which happened out of coincidence. Decisions on common parts were addressed within each program team individually (Vehicles 1 and 2 together, and Vehicle 3 separately). As stated, the organization of the program teams was segmented in accordance with vehicle timing. Although located physically close to the other two programs, Vehicle 3 "required" a completely new team and operated completely independently of the other two vehicles. The organizational separation, as well as the eventual high percentage of new parts, resulted in significant development costs; an amount that was approximately ten times higher than those of Vehicle 1 & 2 (combined), despite all the vehicles being based off the same platform. This increase in development costs was a direct result of a dramatic decrease in commonality based on the initial program. While Vehicle 2 was reported to be as much as 90% common with Vehicle 1, Vehicle 3 had only 24% common parts by value.

The results of this case study are not surprising; use of our models would have predicted (at least directionally) the outcome. This is once again not an indictment of the program teams involved; several times in our interviews we were told that Vehicle 3 had the specific goal of significant differentiation so that it could compete in a completely separate market segment from the other two vehicles. The Organizational Model would have predicted, however, the extremely high level of difficulty of commonizing for a stand-alone development team (using an existing platform) within the boundaries of a company with an strategy that concentrates on operational efficiencies. A similar analysis could have been performed using the Cost Model; given the difficulty of commonization and the stated differentiation goal, a low percentage of commonality could have been predicted. Had this low level of commonality been assessed on the Cost Model curve, OEM A's bias probably would have been more toward operational efficiency rather than luxury automotive cues, and management would have recognized the need to contain fixed costs that would not be offset by the slightly lower soft costs (see similar example in Figure 20). What the cost model does is facilitate understanding of the potential for commonality and the potential for cost increases when commonality appears less likely.

We believe the two case studies validate the prediction capability of our models. In each case, a direct correlation can be drawn between the need for goals, strategies, and the processes to be in place to improve the likelihood of implementing a commonality strategy. Once the key elements are set, a company can determine what organization may be best for them (given its goals) and the cost ramifications related to those decisions. Issues related to the balance of power and intra-company politics (Section 9.0) need to be controlled through a widespread cascade of the corporate goals and the strategies used to implement them.

9.0 DECISION MAKING

Once company-specific organizational and cost barriers that inhibit the implementation of a commonality strategy have been identified, it is necessary to develop a more expansive, corporate-wide vision that includes commonality as one enabler to meeting the corporate goals. Another key component of that vision is the ability of the executive management to make and be accountable for the decisions that must be made to optimize commonality. Given the strategic variances and complexities of all the global automakers, it can be assumed that the definition of "tough choice" will differ at all levels – from company-to-company down to group-to-group within a single OEM. Inherent in all the difficult decisions are the trade-offs between customer needs and wants as well as the execution of these decisions that is needed to satisfy today's increasingly-sophisticated consumers. In this section a Balance of Power model will be introduced that demonstrates how and why the product development team relationship must be controlled to effectively implement a commonality strategy.

Just as there is not one single "right" corporate commonality strategy, an all-encompassing commonality strategy applicable to every component, subsystem, or vehicle platform within an automotive OEM also does not exist. Because a rigorous and consistent process for decision-making needs to be followed to determine when and where commonizing is appropriate, we recommend the use of a company-specific decision-making flow chart designed to aid component engineers or vehicle teams in evaluating the appropriateness of commonality, given a particular situation. Some of the key factors in an OEM's decision to commonize are: distinctiveness of appearance and brand differentiation, technology and technology transfer, program marketing wants and functional needs, and vehicle architectural functional requirements (i.e. safety/crash). Each of these elements is contained within the automotive manufacturer-specific flow chart proposed in this section. The flow chart suggested here is just an example of one that may be useful for assessing commonality in general, and as with the organizational structure model, it is flexible enough to accommodate changes in the industry and/or market fluctuations. The following sections offer a more in-depth look at the factors that constrain commonality implementation and discuss the Balance of Power, the Decision Making Models and the rationale for their development.

9.1 DECISION-MAKING FACTORS

To fully understand the decision-making process and the elements that must be addressed within it, the factors that influence decisions on commonality need to be addressed. The first and most influential factor is a vehicle's appearance. Early in the product development process, program teams and their styling groups decide what "emotions or feelings" they want to evoke with the new or revamped vehicle being developed. It is this point at which the vehicle obtains its personality, or the assignment of traits that will differentiate it from competitive and internal vehicles in the same market segment. This emphasizes the critical role the initial design phase plays in completing the entire product development process. Ultimately, the creation of components that support this vision is based on a customer's need to simply have a vehicle that is differentiated from their neighbor's. Commonizing around appearance expectations is an extremely difficult task, and not surprisingly, most will say that attempts at commonization should start with the parts that are not visible to the customer or critical to the appearance theme.

Brand image needs are closely related to appearance needs in that much of a vehicle's personality is rooted in the characteristics of the division whose brand is being developed. The difference is that brand image includes the appearance-related components *as well as* the functional characteristics of the vehicle. Examples of this include: an expected level of engine horsepower and torque, or the driving and riding characteristics associated with a specific brands' suspension. In many cases these product uniquenesses become so closely linked to a specific brand that the options can only be used in that particular application, thereby mandating (by default) a lesser degree of commonality. This generally does not hinder a commonality strategy since these differentiators are often very customer-specific components or systems that do not fit into the everyday wants of all vehicle buyers. The elements of appearance related to brand image are a larger barrier than functional elements, but handled the same as mentioned for other appearance needs.

Often functionality of the components or systems will be driven more by the vehicle segment than the brand. This creates another instance where functionality imposes constraints on the decision to commonize. In these situations it is the core customer for this segment that should dictate the need for particular components or systems. For example, a coupe body-style requires access to enter the rear seat without a door for entry, or heavy-duty trucks that require towing packages that can pull 10,000 pounds. In this situation, the possibility for commonality is not eliminated, but will be limited to vehicle lines that have similar brand image. The special features are often add-on items to basic packages where, minimally, the most basic components or even the engineering can be easily commonized. As with brand image, every attempt possible should be made to commonize with similarly-designed vehicle types to maximize total commonality.

When new safety or convenience technologies are introduced they typically cause a disruption in the automotive industry by creating new customer and government (regulatory) expectations that all OEMs are expected to meet relatively quickly. This can wreak havoc with the effort to commonize as attempting to meet the new customer regulatory demands can delay implementation of the commonality strategy. Automotive consumers are becoming increasingly sophisticated, noticing even the slightest differences between competitive vehicles. When a new technology is introduced that supercedes its lower-tech predecessor, customers expect all similarly-marketed vehicles to be updated with this feature and will search out the OEM that has done so – a good example of this in the migration of in-vehicle entertainment systems from VHS to DVD capability. Another example, this one from the past, is power features in general. In the 1970's nearly every vehicle was equipped with manual windows and door locks. As power functions became more common, customers began to expect at least this level of functionality to be made available to them. In today's U.S. market, it is much more difficult to actually find a vehicle with manual functions than without.

The global automotive industry is, as would be expected, highly regulated, with those regulations varying significantly by geographic location. Every country or region has its own set of domestic vehicle requirements with which automakers looking to sell there must comply. As these requirements change or new regulations are added, a commonality strategy can languish while the new technology required to meet those regulations is implemented. Because of staggered cycle plans and phased introduction of technologies, disruptions can alternately help and hinder the implementation of a commonality strategy. There will be initial delays associated with the disruption, but the demand for the new technology provides an excellent opportunity to commonize by phasing-in a single regulatory (or other technological) standard across the entire industry.

Every component and system in a vehicle interfaces with some other component or system; these interfaces are rooted in the basic vehicle architecture and can make commonizing parts difficult. A lack of standardized engineering practices or assembly processes only exacerbates the situation when the interfaces lack commonality. The result is extraneous design, development, and tooling expenditures so that the interfacing part(s) can be modified to accommodate the new common part. These unexpected outputs of time and money needed to adapt the system/interface will lead to near-term resistance to commonize as the feeling is often, "if we have to spend money anyhow, why shouldn't we just develop a new one?" Resolution of system interface issues can take five to ten years to resolve since it is likely they will require the adaptation of common vehicle architectures to platforms that already exist. Despite the fact that, long term, common components, systems, processes, engineering, and architectures will have cost and quality benefits, breaking through the short-term cost pressures that result from system interface issues will be a significant challenge.

Another decision-making factor with respect to commonality is the evaluation of a company's current organizational structure and deciding whether changes should be made to lower the cost/difficulty as defined in the organization section of the paper. As stated previously, organizational change is not required to successfully implement a commonality strategy, but it can expedite the process. Reorganizing is time and capital intensive. Changes of a company-wide magnitude should only be considered when they are accompanied by a strategy and plan that justifies the change. During the initial phase of a commonality strategy, corporate transformation should be at its peak, and major modifications to a company's organizational structure are best made at that time. As a company considers additional commonality, the organizational model should be reviewed in addition to the expected costs of operating outside of the initial strategy. If the cost difference is great enough, an organizational change might be prudent since it would pay for itself and provide some of the key ingredients to simplifying commonality. The new organization should provide better functional communication, which should lead to improved technology transfer and, eventually, increased functional expertise or expansion of core competencies. Due to the possible cost implications or operational shortfalls, organizational changes should not be viewed as trivial, and they should be made only when the total business case is reviewed and the opportunities outweigh the risks.

The final aspect of decision-making that will be discussed here is the political component of organizational control and the balance of power. Politics exist in every organization. Despite the desire for collective harmony between individual groups, there is always a struggle for control. The group(s) perceived as having control (regardless of reality) is more able to influence program/project decisions. Moreover, the group with the power is likely to vary by program or project phase, thus creating additional conflict. This is critical to a commonality strategy (or any type) because employees focus and act on things for which they are rewarded. Without balance of power, vehicle program decisions can, and are, made with too narrow a focus on the total vehicle objectives. It is therefore essential for any corporate strategy or process to be consistently interpreted and it is equally critical to have a balancing method in place. This is the one way to consistently evaluate the trade-offs in the product development process and choose the characteristics that best meet the vehicle objectives. The model shown in Figure 22 illustrates the product development relationship that will be used in subsequent portions of the paper to explain the forces that control (or help to control) the balance of power.

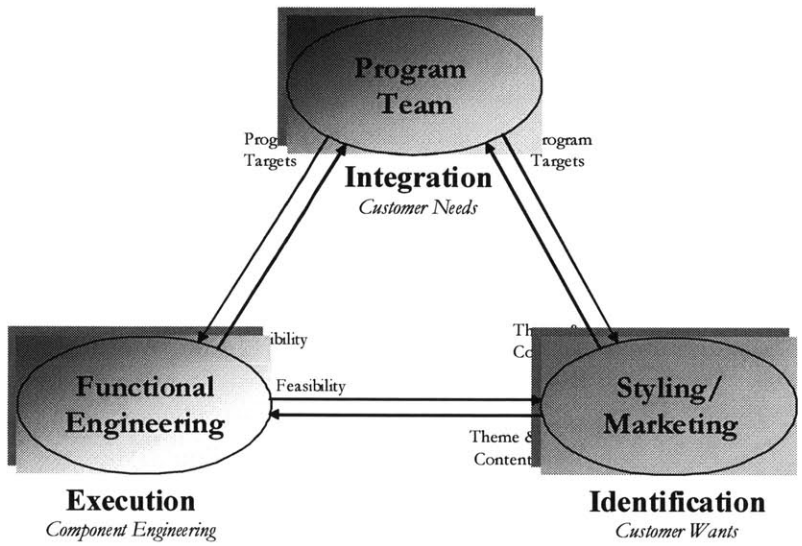

Figure 22: Balance of Power Model

9.2 BALANCE OF POWER MODEL

Regardless of the organizational type, every product development group has three functional areas with distinct (and different) foci:

1. Program Teams
2. Styling and Marketing
3. Functional Engineering

Whether they fit into one, two, or three different groups within an organization, each of these functional areas has a uniquely-defined set of roles and responsibilities that are critical to completion of the automotive product development process. Each group operates internally based on its expectations of (and deliverables to) the other two groups. Additionally, each has a specific external metric of high customer satisfaction met through quality, reliability, and consumer appeal. As shown in Figure 22, the individual requirements of each group create mutually-competitive, and sometimes conflicting forces that, if properly-balanced, will moderate the decision-making. This balance is necessary to ensure no single area dominates the development of the vehicle, thus skewing the final product away from meeting its original intent.

9.2.1. Organizational Elements of the Model

Regardless of organizational type or style, every automotive development project requires some form of a program team to set the basic functional requirements for a particular vehicle. The initial role of the program team is to set preliminary targets using the corporate variable cost and capital investment boundaries and guidelines set by the scope of the program (greenfield, minor freshening, etc...). The program targets are cascaded to functional engineering, styling and marketing for review and concurrence. Inevitably, these groups will ask the team to assess whether there is room for additional customer wants and if so, to investigate how they can be incorporated. Throughout the product development process the job of the program team is to evaluate the progress of the other groups and ensure that each functional area's end product fits into and meets the total vehicle requirements. The ultimate goal is to finalize a set of program targets that will, at a minimum, meet the customer's needs and be flexible enough to accommodate some "wants." For example, a basic mini-van or sport utility vehicle target might be: *seating for seven.* A customer <u>need</u> (and perhaps industry need, to sell in this vehicle segment) might be: *comfortable seating for seven with cargo space that is consistent with other seven passenger vehicles in this segment.* And lastly, a (bonus) customer <u>want</u> might be: *comfortable seating for up to seven passengers with a flexible package that allows for easy reconfiguration to maximize cargo space.* And, of course, all this must be achieved within the corporate investment guidelines for such features.

Styling and marketing are grouped together for the purpose of our discussion, not because this is normally the case (organizationally or even geographically), but because the groups have similar responsibilities and demands relative to the other two groups in the Balance of Power Model. Once the program team has given styling and marketing the boundaries in which they need to operate, these groups have the responsibility of creating a vehicle "personality" or theme, using features and styling cues that represent that specific brand. Preliminary identification of the customer wants is generally accomplished through market research and verified through customer clinics. This information is used to convey the market segment "must haves" to the program and functional teams.

This is where the power balance can shift since the "wants" may be in excess of the program's resources. Conversely, "the elimination of the market dimension may reduce organizational flexibility and sensitivity to the needs and desires of customers and consumers. In particular, it eliminates the role of marketing personnel as advocates of actual and potential customers and consumers."[98] Balancing power does not always suggest that a group will be acting in its own self-interest. For example, at Toyota "the styling department...has a checklist for the license plate well that contains plate dimensions, bolt-hole locations, regulations on tilt angles, and illumination for various world markets and restrictions on curvature radii."[99] By adhering to the standardized process, the styling group does not even consider feasibility of a design as a requirement of the functional engineering group; it is instead a deliverable to it. As part of the total vehicle team, the marketing and styling groups must work together with the program team to create the best way of meeting both the customer wants and needs while staying within the prescribed corporate boundaries.

In basic terms, the role of functional engineering is to deliver the designs of every component and system deemed necessary for the customer through the market research process. In more complex terms, the role of functional engineers in the product development process is much larger. Engineers are responsible for evaluating the early targets established by the program teams, and for working with styling and marketing to confirm the engineering feasibility of the customer wants and overall design. This includes the feasibility of the individual designs and their interfaces with other components and systems the engineering group delivers. This completes the balanced product development trifecta: program team targets must be balanced with styling and marketing theme and content direction, and both must be labeled as feasible by functional engineering. Once the targets/needs/wants package is finalized, functional engineering is expected to design and deliver each component and system per the proposed package, with the assumption that these support the customer and regulatory requirements.

9.2.2. Balance of Power Implementation

The three groups together, with a strong and consistent push from upper management, must understand how to use their power to ensure all corporate objectives, including commonality, are well-executed. This process will provide the power balance and hopefully assist in avoiding political gridlock. Mandated policies will almost always succeed at least temporarily, but without a complete understanding at the working level will lose its effectiveness before long. This happens because the workers never understand the need for implementation. There has to be unification on all fronts and widespread understanding amongst people at all levels of the company.[100] The group understanding of a corporate strategy coupled with the competing forces between the groups combine to enable the effective balancing of power in the organization.

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[98] Ackoff, pg. 240

> *"There is nothing more difficult to carry out, nor more doubtful of success, nor more dangerous to handle than to initiate a new order of things."*
>
> *– Machiavelli*[101]

Implementation of any change in an organization is difficult; adding intra-company politics related to the division of power significantly increases that difficulty. To execute any strategy, including commonality, each of the groups in the model must have a proportionate amount of power to address their responsibilities and concurrently demand accountability of the other two groups. Once a corporate strategy is established a company can determine what organization might be best and what controls need to be added to minimize the challenges associated with the new organization.

9.2.3. Power Distribution

The competitive nature of the business world requires a company to have the correct structure in place to balance the (marketing) need for uniqueness with manufacturing and product developments' desire for standardization to help drive costs down.[102] This may give one group more power than another, as is the case with matrix organizations that give disproportionate amounts of power to the program teams and functional engineering (heavyweight or lightweight program managers, respectively). But, in each case, it will be the result of attempting to meet a desired and established goal. Although power is unbalanced between the three groups, it is collectively focused on the execution of the strategy; this allows the three groups to optimize their total performance. This is best summarized with the quote, "there is an immediate and substantial payoff to the

99 Sobek, Liker & Ward, pg. 9
100 Schonberger, pg. 11-12
101 Ackoff, pg. 157
102 Martin, pg. 14

corporation when its parts focus on improving corporate, rather than their own, performance."[103] While it is difficult for any group to accept a reduction of control, individual groups must accept that it is not as important to be "in charge" as it is to have the power to effect change. Company-wide understanding of the benefits of an effective commonality strategy will drive each group to strive for that which is best for the company.

In the case where commonality is a key strategy to achieving corporate goals, the power must be balanced to enable it to be properly implemented. The means for executing a commonality strategy exist in the past, the present, and the future. Existing architectural constraints of platforms that are in production and those that have a significant portion of their useful life remaining will dictate much of the speed and effectiveness assumptions of a commonality strategy. Decisions that are made each day regarding current products and programs soon to be underway will drive the level of difficulty of implementation. Future cycle plans will constrain how quickly a company wants to, or possibly can, implement a commonality strategy and start to realize the benefits.

Power must be distributed so that program teams, functional engineering, styling, and marketing can make decisions based on the constraints identified near-term and the current needs and wants – all while knowing that the benefits will exist mostly in the future. Failure to do so will result in an outcome that is less than optimal, or a complete failure. At Toyota they concentrate on balancing power specifically to avoid making improper and potentially "costly" decisions. In their organizational structure "the limits on a chief engineer's power…are real, and the engineering expertise and equal rank of the general managers in charge of the functional areas can keep chief engineers from making potentially dangerous mistakes."[104]

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103 Ackoff, pg. 104
104 Sobek, Liker & Ward, pg. 6

In Section 8.1, a (subsystem) case study was introduced and summarized that is a good example of what can happen (translation: go wrong) if power is not correctly balanced. In this particular instance, OEM A had, in theory, established a centered organization to promote cross-functional communication that would result in "good" commonality levels, company-wide. In reality, the organization behaved like a program team because no controls were put in place within or between the vehicle centers to ensure the groups would work together effectively. In addition, the functional engineering teams were given the responsibility of proposing feasibility and customer trade-offs, without any input from the program teams. The result? A balance of power (shown in Figure 23) that shifted strongly to the functional teams within program teams with each team demanding that only the "best" (and newest) systems would satisfy the customer.

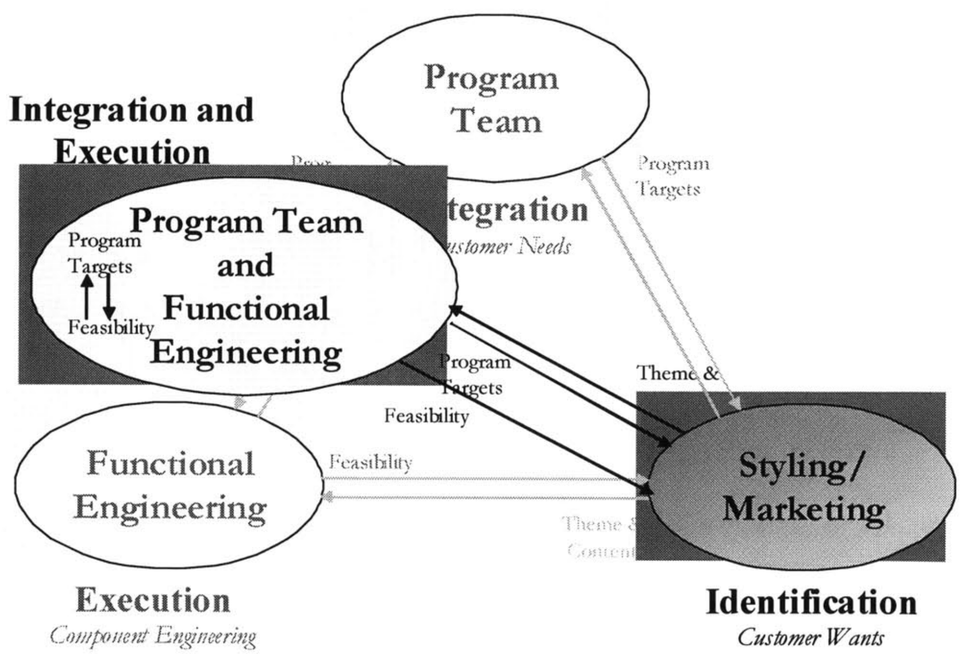

Figure 23: Modified Balance of Power Model

Without the presence of a balance between those responsible for creating and monitoring targets and those responsible for determining feasibility, the model collapses to an organization focused on meeting the customer needs and wants, while virtually ignoring the critical decisions related to execution. It is clear why the study of widget commonality was positioned to fail...there was not adequate power within the functional engineering group to support the commonality study's goals. In addition, a survey of the parties involved revealed there were seemingly *multiple* goals – varying by each groups' involvement. OEM A had no corporate commonality strategy at that time, so without the incentives and consistency of expectation that are the result of a well-implemented strategy, it is not surprising that little excitement was generated toward achieving the organization's expectations from the study.

It is unlikely any attempt at commonality that lacks a proper balance of power will be successful if it is either completely devoid of the support of a corporate strategy or there is ineffective implementation of the necessary organization or organizational controls. Both the implementation of and the decisions regarding a commonality strategy must be made in a rigorous and comprehensive manner with support from all levels of the company. Further, "those who are assigned responsibility for implementing a decision, if different from those who made the decision, should have direct access to the decision makers. It may be necessary to either get clarification of the intended effects of the decision to be implemented or to suggest how it might be improved."[105] Even with a strong directive that is properly communicated, management needs to be involved in the process to keep the focus on the eventual (successful) outcome. Only then can decisions be processed in a consistent manner to allow for continued and ongoing success of a commonality strategy.

9.3 DECISION MAKING FLOW CHART

One way consistent decision-making can be perpetuated at a company is by using a Decision Flow Chart, much like the one we propose here. We suggest this as a simple, general tool for making decisions on whether to commonize a component or system to something that presently exists, or to create a new "platform" from which future parts will be based. The Decision Flow Chart can be used for initial strategic decisions or in day-to-day product development process decisions. It would be a consistent process for everyone who uses it, therefore decisions can be made in a consistent and repeatable manner. What is important is that the decisions are supported throughout the organization and that a company-wide common process is used to balance power and make quality decisions. A simple flow chart or checklist can accomplish both of these actions. Our generic flow chart is designed to be a flexible tool created, in this case, for the automotive industry in its current state. In addition, it is based on a company that has a strong interest in commonality and a corporate strategy that fits well with commonality, or can be adapted to do so. The flowchart is meant to be dynamic and it is designed to be modified in the event that it does not suit a particular company as is, or as a company's goals change over time.

The goal of the flow chart is to supply a tool that helps to consistently implement commonality at the lowest working levels with the support of the highest levels in the organization. The Decision Flow Chart will help create and sustain an appropriate balance of power, because each group must be represented somewhere in the process to make the decisions required to address and implement commonality. In the following sections we will review our example and the critical factors that should be addressed when determining new or additional commonality initiatives.

9.3.1 Decision Making Sequence

The Decision Making Flow Chart starts with the definition of the component or system's functional and aesthetic properties (① in Figure 24). To make decisions on commonizing, those responsible for decisions must understand and agree upon the baseline characteristics and properties

[105] Ackoff, pg. 158

of the part (or system) that are and are not critical to its performance. The next step is used to determine whether the parts have critical functional or appearance-related elements that may create a barrier to commonizing (②, ③, and ④ in Figure 24). Here it is established whether the part is visible to the customer, so that parts with aesthetic barriers (versus those with brand specific functionality) can be separated. In each case, the decision-makers are expected to assess whether there are styling or marketing elements that are critical to the vehicle's appearance or brand identity. If "yes," the decision-makers are directed to re-evaluate the attribute and benchmark the competition (⑤ in Figure 24) to ensure the process robustly identifies all possible opportunities for implementation of common components or systems. In steps ⑥ and ⑦, the team must analyze the studies and determine whether uniqueness of this part is important to the customer, or if a functional or appearance trade-off can be made. If not, the functional engineering team should attempt to commonize these parts across brands, as appropriate. If trade-offs can be made, the evaluation should continue through the flow chart.

In the situation where appearance and functionality are not considered to be critical factors for commonizing, the focus shifts to technology. In step ⑧ the decision-makers evaluate the possibility that a short-term technology disruption may make commonizing difficult or useless at this time. A disruption can happen for many reasons; one of the most common is based on a new technology becoming available that changes the customer's expectations of standard content versus basic function. Another common disruption is a technology implemented to meet new government regulations. In either case, the impending disruption will create a barrier to commonizing since it is likely to change the near-term customer, consumer and/or government expectations. However, long term disruptions can actually enable commonality by setting a technology introduction cut-off point for all of an OEM's vehicles. If a disruption does exist, the decision makers should still determine the impacts to the Organizational and Cost Models to confirm whether any possible gains can be made by pursuing commonality for the parts being assessed.

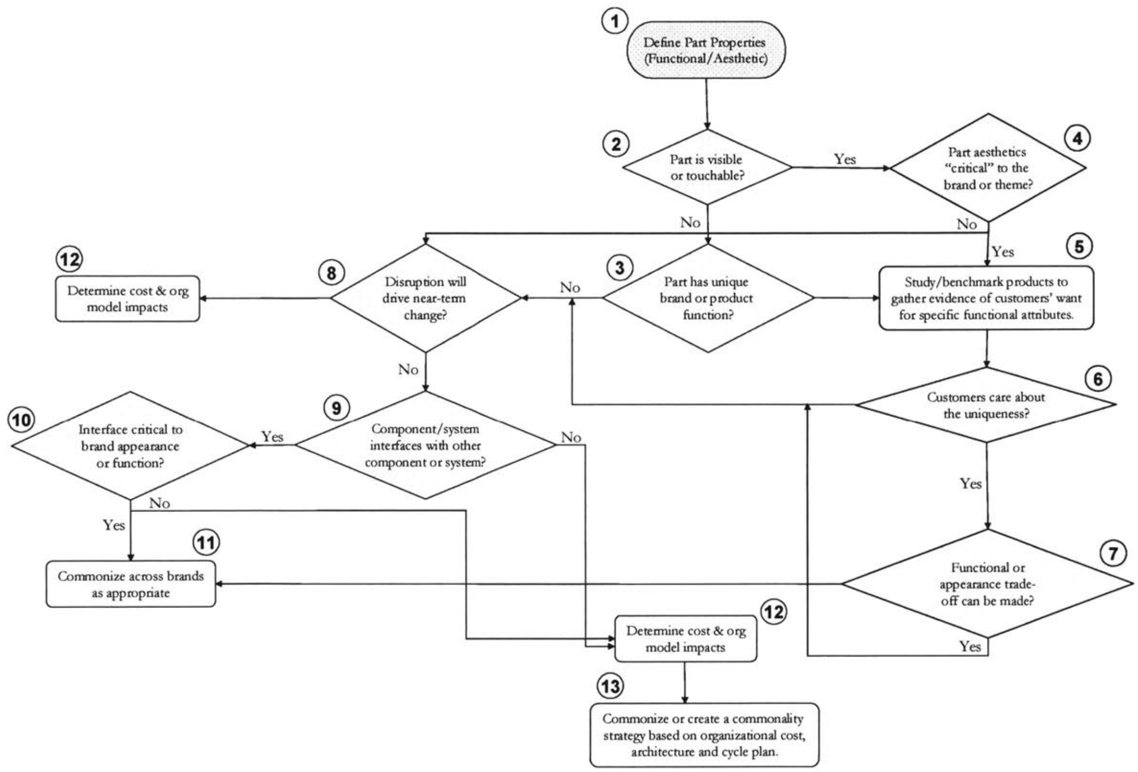

Figure 24: Decision Making Flow Chart

In the absence of a disruption, the decision-makers must evaluate the system interfaces to determine whether the present architecture supports commonization. If it does, then the decision is whether those interfaces have critical ramifications to brand appearance or functionality. A hood latch can be used as a good example for this scenario. If hood latches were to be commonized, but the new "common" latch design is not feasible for one of an OEM's "brand" of grilles, it might be best to commonize for just the other brands (and exclude the "odd" brand). Instead of changing all the grilles of the non-conforming brand, the functional engineering group should work with styling to maximize commonality where possible without sacrificing image. If there are no interface issues the decision-makers move to step ⑫ for the final analysis of cost and organizational impacts. Here optimal execution of commonality as it relates to the implementation of an entire strategy or just one incremental component or system would be determined (⑬ in Figure 24). Even after the decision-making process is complete, the result could be to not commonize parts. In effect, the Decision-Making Flow Chart is intended to consistently and rigorously determine feasibility of implementation, not to mandate its execution. Only an additional review of how the new level of commonality impacts a company's *initial* Organizational and Cost Models will generate the complete scope of implementation.

The Balance of Power Model and the Decision Making Flow Chart are critical to the successful implementation of a commonality strategy. Balance of power will help an organization not only execute, but maximize, the possible output of commonality. A rigorous and consistent process for decision-making helps sustain balance of power and allows the decision-makers to control many of the critical factors of commonality that could cause negative effects in the absence of such a process. It is still the determination of corporate goals and the resulting strategies that establish the initial Organizational and Cost Models. The models in this paper allow a company to identify and counteract the issues that inhibit commonality as the management considers how extensively, if at all, it will implement the strategy.

CONCLUSION

Implementing a commonality strategy has some definitive and quantifiable benefits: reduced variable costs, lower capital investment, and improved quality. Each of these elements has a monetary value associated with it and all contribute to improving operating efficiencies. As with any strategy there are also occurrences that can reduce or eliminate the return on the investment required to implement the strategy. Many of these challenges are related to the market in which a company is competing and the ability of the automotive OEM in accurately defining its goals and corresponding "matching" strategy that allows the company to meet those goals.

An OEM may decide that a widespread commonality strategy is detrimental to its brand image (due to the risk of brand "dilution"), and therefore inappropriate as a corporate strategy. However, it is likely that even the most elite automakers can benefit from efficiencies gained through commonization of processes, if not parts. It is true that companies dissimilar in size, market vision, customer base, and operating philosophy cannot (and likely should not) have the same strategy. All corporate commonality strategies (in any industry) will possess unique characteristics that are used to "customize" a base strategy – one whose foundation is comprised of benefits and challenges that support a company's commonality credo or philosophy. Our research of the automotive industry has shown a unique approach to the past, present and future commonality strategies for each of the OEMs. This uniqueness in approach is because commonality is not a necessity, but a tool or strategy that, if adopted, should be an integral part of a corporate vision that is tailored to help a company meet its long-term strategic goals.

Commonality appears to yield benefits that outweigh the challenges if the strategy is implemented with a consistent process, the "proper" organization, understanding of the hard to soft cost trade-offs, and with controls in place to eliminate or minimize the balance of power barriers. There is a strong link between the difficulty of commonizing and organizational structure. This difficulty, in turn, affects the costs (of all types) and the corporate balance of power. Companies must consider what organization is best for their total set of goals, but also understand where it may limit the possibility/benefits of commonality. Cost, often thought to be the key force behind the implementation of a commonality strategy can also be its biggest inhibitor. While a reduction in the hard (fixed) costs will always exist as an opportunity, a company pursuing a commonality strategy must understand the customer, administrative, and the political pressures to realize quick results that accompany commonality. Simply stated, companies have to make sure the commonality strategy is not executed by "doing the right thing wrong." Commonality is a long-term endeavor; it needs to be continually reevaluated to ensure maximum benefit is being captured and the strategy is being optimized.

The models presented in the paper, and the research that was used as input, suggest commonality can offer many benefits to an automotive OEM, but the conclusion is not that commonality is right, or necessary, for all companies. The models do offer companies considering commonality as a strategy a set of tools to determine what might be appropriate, based on the goals they have established. The two case studies introduced at the end of the paper demonstrate the power of the organizational structure and company dynamics and, more importantly, illustrate that the models we developed are valid and (accurately) predictive in nature. Commonality that is not well-managed can result in widespread usage of parts with mediocre quality and/or functionality. Commonizing products, engineering, and processes the "right" way, the way that fits a company's unique set of constraints, can be an effective way to improve product development cycle times, customer satisfaction, vehicle quality and engineering depth.

APPENDIX

NOTE A – EXPLANATION OF MEDIAN DATA USAGE

Reports of increases and decreases in home prices are typically quoted as changes in the median home price. This can be misleading because changes in the median price don't indicate how much appreciation or depreciation has taken place.

The median price is the price that is midway between the least expensive and most expensive home sold in an area during a given period of time. During that time, half the buyers bought homes that cost more than the median price and half bought homes for less than the median price.

Changes in median price measure changes in market activity. When there are more buyers buying less expensive homes than there are buyers buying more expensive homes, the median price falls. Conversely, when there are more buyers buying more expensive homes than there are buyers buying less expensive homes, the median price rises.

The median price indicates which price range is most active. Not all price ranges experience the same market activity at any given time.

So, when you read that the median home price increased 6 percent in the last year, this doesn't necessarily mean that your home increased 6 percent in value. It could have increased more or less in value. Likewise, if the median price were to drop 5 percent, this wouldn't necessarily mean that home values dropped by 5 percent. In fact, they might have dropped more.

NOTE B – CASE STUDY QUESTIONNAIRE: GENERAL CORPORATE COMMONALITY

1. Does/should your company have a standard commonality strategy? Why or why not?

2. What role do you play in the commonality strategy?

3. Are there goals or targets associated with using common parts across vehicle lines? Are there incentives associated with those targets?

4. If reorganization is needed to more effectively & efficiently implement a commonality strategy, describe that organization.

5. What barriers do/did you see to commonizing parts; also, what is the key to commonizing parts across the corporation?

NOTE C – CASE STUDY QUESTIONNAIRE: PLATFORM COMMONALITY

1. Does/did the company have a standard commonality strategy? If not, was there a commonality "mandate" in place for the Vehicle X program?

2. If so, describe how either process was implemented & followed.

3. Who are/were the key decision-makers in this process? How close were those decision-makers to the product?

4. What is your role in supporting/sustaining/achieving commonality on the Vehicle X platform?

5. Are there goals or targets associated with using common parts across the U152 platform? Are there incentives associated with those targets? If not, would it be beneficial to have them?

6. Although the Vehicle X/Y platform was a greenfield project, was a commonality assessment/study performed during its development? What were the findings? What was the goal of the study?

7. On average, what percentage of parts is common across common and similar platforms? On dissimilar platforms (i.e. front- and rear-wheel drive)? What programs were investigated for part-sharing?

8. Can you describe or classify these parts as a particular type (structural, functional, appearance, etc)? In your opinion, was commonizing parts easier or more feasible for a particular type?

9. Was the commonality goal (if one existed) realistic? Why or why not?

10. Rate your ability to make the process successful and/or improve it (1 - No effect, 3 - Moderate effect, 5 - Strong effect). If "3" or lower, who do you think is the person able to make an impact? Explain your rating.

11. Describe the organizational structure, as it existed when the Vehicle X family was developed. What, if anything, was different about the Vehicle X & Y teams versus previous/other program teams?

12. Was there a group whose responsibility it was to engineer common parts? If so, what was the mechanism used by the program team to ensure that this group was kept in the loop? How did the program team solicit these engineers for information? Is looking at off-the-shelf parts the first step or "last resort" for the program team?

13. What barriers do/did you see to commonizing parts? What was the perception by the engineers when the commonality strategy was mandated?

    a. Were cost of change or economies of scale factors in the success/failure of a communization effort? (NOT ASKED UNTIL ANSWER GIVEN)

    b. Do you think different functional areas (D & R, corporate design, marketing, finance…) have a unified commonality goal?

14. What is the key to commonizing parts across carlines?

NOTE D – CASE STUDY QUESTIONNAIRE: SUBSYSTEM COMMONALITY

1. What was your role in the commonality study? What is your perception of this role (i.e. what is its function in the overall plan)?

2. What was the goal of the commonality study? Was the goal of the study achieved? Was it realistic? Explain your answer (i.e. why or why not?).

3. Describe the process you followed for the study.

4. What percentage of parts is common in this particular instance? Is this typical? Why or why not?

5. What would/did make this process successful?

6. Can you describe or classify these parts as a particular type (structural, functional, appearance, etc)? In your opinion, is commonizing parts easier or more feasible for any particular type?

7. Rate your ability to make the process successful and/or improve it (1 - No effect, 3 - Moderate effect, 5 - Strong effect). If "3" or lower, who do you think is the person able to make an impact? Explain your rating.

8. Who are/were the key decision-makers in this process? How close were those decision-makers to the product?

9. Does/Did your company have a standard commonality strategy? Describe the processes in place to support that strategy.

10. Describe the organizational structure, as it existed when the study was conducted. What, if anything, was different about this particular team versus previous/other subsystem teams?

11. In the organization, was there a group whose responsibility it was to engineer off-the-shelf (common) parts?

12. What barriers do/did you see to commonizing parts? What was the perception by the engineers when the commonality strategy was mandated?

    a. Were cost of change or economies of scale factors in the success/failure of a communization effort? (NOT ASKED UNTIL ANSWER GIVEN)

    b. Do you think different functional areas (D & R, corporate design, marketing, finance…) have a unified commonality goal?

13. What is the key to commonizing parts across carlines?

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