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Modular Approach to Developing Platform Solutions across Multiple Brands and Segments

Amol Gulve Volvo Group North America

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Abstract

In today's era of rapid globalization and high consumer demand the automotive industry faces a major challenge to meet the growing demands for customized products, which suits the branding strategy, customer needs and industry trends. Modular approach to product development not only helps in reducing the product development time, but it also supports the automotive industry to customize the needs of consumers in an effective manner, create unique brand identity and reduce development cost. Product platform modularization is a great opportunity for the original equipment manufacturers (OEM's) to develop platform strategies across multiple brands and the ability to customize products. During current pandemic times with COVID-19, automotive manufactures will need to rethink their product strategies and focus on the platform mindset to deliver products that meet consumer demands. The paper provides a novel approach in developing modular platform solutions by defining guidelines for "Common" and "Unique" modules linked with critical interfaces. It also provides ways to keep "Brand" uniqueness by maintaining modularity with the systems. A theoretical process is described in the paper with few examples to illustrate the modular approach and branding strategy. The paper also provides a basic approach for all vehicle types to allow manufacturers to focus their efforts on areas where there is high degree of modularity and commonality using the branding strategy.

Introduction

With recent developments in new and emerging technologies such as electrification, shared mobility, autonomous vehicles and connectivity, it challenging to anticipate when, where and what the consumers will buy in the future. It is this VUCA (Volatile, Uncertain, Complex, & Ambiguous) environment that has brought spotlight on the modularity in the vehicles. Many original equipment manufacturers (OEM's) in the automotive industry manage multiple brands in their portfolio and offer various products in different application segments. Research and development cost is a key investment for many companies to stay competitive, especially when there are challenging environments like the one faced in 2020 Q1 related to COVID-19. Industrial trends are heading towards complete vehicle modularization to develop products with high degree of commonality and offer uniqueness to customer needs. More industries are facing difficulties in managing increasing product variations and model mix. A challenge for these companies is to find ways to replace existing products and occasionally, to expand product lines with innovative, high-quality models that minimize development and production costs. Many companies are pursuing modular product architecture design strategies in order to shorten the new product development lead time, to introduce multiple product models quickly with new product variants at reduced cost [1]. By following the modularity approach, the automotive industry can take advantage of the increased efficiency and part commonality leading to reduced investment costs such as development and tooling costs.

Manufacturing companies are always challenged with research and development costs by bringing efficiency in product development and reducing lead times. Because of the complexity in the product development cycle, the development process is fundamentally iterative [15]. Due to iterative nature of product development new information is available during the development and fed in to the design to improve performance. The iterative process can be incorporated by the companies to have a robust platform strategy. Modularity helps in reducing the development cost and achieve profitability by having common architecture solutions.

The automotive industry has significantly contributed to the technological advances since the industrial revolution, and it is not different with regards to adoption of modular strategy. The way automotive sector glimpses these opportunities as a competitive differential indicates that the sector behaves as a trend indicator. This leads us to credit such deed to the consumer demands, besides intense and constant competition in this segment, which drives the vehicle companies to constant evolution [2].

Modularity is an approach for organizing complex products and processes efficiently by decomposing complex tasks into simpler activities so they can be managed independently [3]. Modularity permits components to be produced separately and used interchangeably in different product configurations without compromising product system

can have approximately 74% common components across various segments or brands. This provides unique opportunity to the manufacturers to create various product solutions from the common platform meeting customer needs and expectations. Startup companies have the flexibility to start with this approach to build on a robust platform and evolve various variants or product lines, sharing common components with a modular strategy.

The benefits of this approach is significant when it comes to investment and tooling cost savings. With more burden on manufacturers to seek efficiency in research and development costs, the approach presented in the paper will provide long term cost benefits to the manufacturers. The cost savings are not quantified in this paper as it varies per vehicle type and the manufacturer's negotiation with its suppliers. Sharing unique modules between brands and reusing common modules will reduce the tooling costs.

Conclusion

The contribution of this paper is to focus on providing a novel approach to identify brand "Common" and "Unique" modules which can be applied in the product development process to secure a common architecture solution. The paper describes the details around the key areas of the common architecture frame work to develop the modularity strategy. The interfaces, key components and systems are key elements in defining the right strategy. If the interfaces are not properly defined, then it will create incorrect brand modules leading to increase in investment cost and product cost.

The modularity approach described in the paper fosters a clear differentiation between "Common" modules and "Unique" modules, thereby reducing the number of variants required to fulfill the customer needs. The common architecture framework also provides the design engineers an awareness of how customer requirements are satisfied by having brand common or unique modules across a product family. Typically, design engineers focus solely on the geometry of the components and their physical interactions. The details provided in this paper will enable the design engineers to properly distinguish between system, modules, interfaces and key components, which are critical to build the right modularity strategy.

Regarding the applicability of the approach mentioned in the paper, it should be valid for companies that must share common product and manufacturing technologies between variants and/or brands.

For future work, there are still new types of modules which needs to be investigated as the effort in this paper was to focus on certain mechanical components. Further work is needed on the chassis, powertrain, software and electrical modules, so the component architecture and modularity approach can be better utilized on the complete vehicle. The presented approach can be further investigated to correlate with the tooling investment savings and develop techniques to forecast long term cost benefits. Detailed study is required to collect more data from the manufacturers and see the benefits of the approach to the overall company's strategies, research and development cost savings, and improvements to manufacturability and supply chain.

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Contact Information

The author has over 15 years of experience in the automotive industry developing new products with platform strategy.

Amol Gulve, M.E.
amol.gulve@volvo.com
336-706-7674

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Definitions/Abbreviations

OEM - Original Equipment Manufacturer

IP - Instrument Panel

SUV - Sport Utility Vehicle

EATS - Exhaust after treatment system

BIW - Body in White

HMI - Human Machine Interface

LED - Light emitting diode

Appendix A: Application of Modularity and Branding Approach to All Vehicle Types.

System	Front End					BIW				Exterior							Interior								
Vehicle Type	Bumper & Spoiler system	Grille opening	Hood	Fender system	Lighthing System	Inner Structure	Floor	Door Closures	Roof	Exterior Ornament systm	Mirrors	Glass & Windows	Sealing system	Wiper system	Cowls	Side panels	Seats	Trim	Instrument Panel	HMI	Steering wheel	Climate System	Door panel &Trim	% C	% U
SUV	U	C	C	U	U	C	C	C	C	U	C	C	C	C	C	U	U	U	U	C	C	C	U	61%	39%
Truck	C	U	U	U	C	C	U	C	C	U	U	C	C	C	U	C	U	U	C	C	C	C	U	57%	43%
Sedan	U	U	C	C	C	C	C	U	U	U	C	C	C	C	U	U	U	U	C	U	C	C	U	52%	48%
Van	C	C	C	C	C	C	C	U	U	U	C	C	C	C	U	U	U	U	C	U	C	C	U	61%	39%
Coupe	U	U	C	C	C	C	C	U	U	U	U	C	C	C	U	U	U	U	U	U	U	C	U	39%	61%
Wagon	C	C	C	C	C	C	C	U	U	U	U	C	C	C	U	U	C	U	C	U	C	C	U	61%	39%
Convertible	U	U	U	U	U	C	C	U	U	U	U	C	C	C	U	U	C	U	C	U	U	C	U	35%	65%
Sports Car	U	U	U	U	U	C	C	U	U	U	U	C	C	C	U	U	C	U	C	U	U	C	U	35%	65%
Cross over	C	C	C	U	U	C	C	U	C	C	C	C	C	C	U	U	U	U	C	C	C	C	U	65%	35%
Hybrid/Electric	C	U	C	U	C	C	C	C	C	U	C	C	C	C	U	C	C	U	C	U	C	C	C	74%	26%