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Considering Life Cycle Engineering for Hybrid Lightweight Components While Making Design Decisions in the Automobile Industry

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Introduction

Consumer needs in the automotive sector are always increasing. In terms of fuel economy, safety, and comfort, each new vehicle generation is supposed to outperform its predecessor. As a result, vehicle weights used to rise with each generation. To combat this trend and meet regulatory emission targets, such as EU Directive 443/2009, lightweight techniques are used [1].

Description

This includes the creation of innovative automotive body concepts as well as the use of lightweight materials such as ultra-high-strength steels, aluminium, and fibre reinforced polymers (FRP). As traditional light weighting solutions for mass-produced car bodywork reach their limits, combining metallic materials and FRP on a component level in what is known as multi-material design or hybrid design is one possible path.

One of the main goals of vehicle development is to increase the vehicle's environmental performance over its lifetime. Break-even calculations based on life cycle assessment, such as commonly used to represent this. Design hotspots for novel lightweight materials are shifting from usage to raw materials procurement and manufacture, as well as end-of-life. The increased demand for energy and resources in the corresponding phases causes this. According to recent studies, the usage of carbon fibre reinforced polymers (CFRP) in automotive body components, in particular, results in much greater primary energy demands than steel or aluminium alternatives [2].

When exploiting the CFRP's mechanical benefits in component design, these additional impacts may only be compensated by using phase energy savings through weight reduction. Furthermore, the cost structure of the components, and hence their economic competitiveness, is intimately related to their environmental performance.

In light of this, a useful decision support system for multi-material design at the component level is required. This takes into account weight, mechanical performance, cost, and environmental impact. The examination of current automotive product development and its essential decision points is a foundational stage. Because large-scale vehicle development is often done through concurrent engineering, various stakeholders from across the value chain influence decisions. These interrelationships are addressed in the study presented here. Its goal is to define beginning points and needs for methodologies and tools that will provide useable and reliable decision bases throughout component development [3].

The concept of life cycle thinking allows for a holistic view of a product's life cycle, from raw materials to manufacturing, use, and finally disposal. This shifts a manufacturer's typical focus away from variables that have a direct impact on business performance, such as manufacturing costs or meeting external criteria. Engineering operations to operationalize this perspective in order to enable informed decision-making are described as life cycle engineering (LCE). Integration of LCE-oriented decision support into product development processes and the company's organization is a significant success element. The identification of improvement measures and the development of focused innovations are two important aspects of LCE. The current study focuses on the environmental impact of automotive body components throughout their life cycle. cycle of life As a result, LCE methodologies that integrate life cycle thinking into product development to support environmentally conscious product designs have been reported. Following the fundamental issue in product development, a gap can be seen between the early and later stages of product development in terms of determining and emerging of product impacts. The early stages of development span the time before the product specification is set, when the majority of product decisions are still to be made. One key result is that decision support should be implemented as soon as feasible to ensure that the product's environmental performance is influenced [4].

Nonetheless, it is noted that in the early phases, the availability and quality of essential data is poor. In contrast, as the project progresses, the level of engineering detail increases. As a result, significant changes to the product's and its components' environmental performance are unlikely to occur. The automotive value chain, which is structured into multiple levels, or tiers, must be considered while developing automotive products. On the superordinate level, the car manufacturer (OEM - original equipment manufacturer) is located. OEMs are often in charge of the complete vehicle, as well as its series development and final manufacturing, which includes the press shop, car body shop, paint shop, and final assembly. Developers and producers of modules (tier 1), systems (tier 2), and parts (tier 3) make up the supplier level, with the current study focused on the first two tiers. Tier 1 suppliers may potentially offer module integration as a service in the car. Suppliers have the ability to Suppliers can also play a role in the series development of automobiles as development partners. In this instance, they either build modules independently or develop modules under the OEM's direction. Furthermore, the use of a combination of technical services and contract manufacturing by suppliers is becoming more widespread [5].

Similar approaches of analyzing product development in the context of life cycle engineering have been for example, focused on environmental elements of product development in the electronic and electrical industries in Europe and the United States. As a result, a survey

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of 30 businesses was undertaken. These findings provide indications and fundamental understandings that must be evaluated or adapted for the investigated automotive car body design scenario. Differences in corporate position in the value chain, as well as the nuances of their decision-making processes, are only explored briefly.

Conclusion

Other approaches take these distinctions into account, but they don't address the issues of environmentally conscious product design. Presented a multi-layered product development method to take into account the various product development process specifics independently. The focus of the investigation is on the creation of a set of hybrid lightweight components for use in automobiles. The specification of the product, development on a concept and detail level, and lastly preparation for production are the three to four typical steps of automotive series development. Depicts a generic automotive development process.

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Conflict of Interest

None

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