How is the beauty standard affecting sustainability in the automotive industry?

An experimental research project based on comparing and measuring different drag coeficcents

Aarya Gopinath

Introduction

The intersection of aesthetics and performance is a longstanding debate within the automotive industry. With the increasing emphasis on efficiency, especially in electric vehicles (EVs), the question arises: How do beauty standards impact the design and efficiency of automobiles? Beauty standards are constantly prioritized as the industry balances form and function. Automotive companies do this to improve sales. However, they are hindering the development of more efficient vehicles. This literature review explores the existing research on how beauty standards influence vehicle design regarding efficiency.

Research Question

How is the beauty standard affecting sustainability in the automotive industry? More often than not, aerodynamic features that greatly improve efficiency are rejected due to a lack of social acceptance. Limiting the adoption of sustainable choices raises the following question: How is the beauty standard affecting sustainability in the automotive industry?

The hypothesis is that beauty standards negatively influence sustainable design. It does this by discouraging the use of aerodynamic features that reduce drag and improve efficiency. Consumers and manufacturers prioritize aesthetics over function, leading to design compromises that hinder sustainability.

The null hypothesis is that no aesthetic appeal affects sustainable car design. Instead, cost, manufacturing limitations, and structural integrity are the primary reasons for the rejection of some aerodynamic improvements.

Definitions

Aerodynamics: The study of the properties of moving air and the interaction between the air and solid bodies moving through it. Particularly how forces and motions occur when these objects move through the air; in automotive design, minimizing drag and enhancing fuel efficiency or range is crucial.

Drag Coefficient (Cd): A dimensionless number that quantifies the drag or resistance encountered by an object as it moves through the air. Lower drag coefficients indicate more efficient designs, which help reduce air resistance and improve overall performance.

CFD (Computational Fluid Dynamics): A branch of fluid mechanics that utilizes numerical methods and algorithms to analyze and simulate fluid flow, particularly air movement around vehicles. CFD is extensively employed in automotive design to optimize aerodynamics by virtually testing various shapes and configurations before creating physical prototypes.

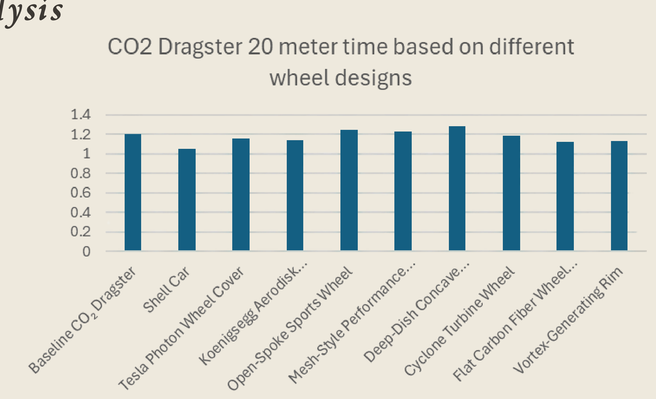
Background

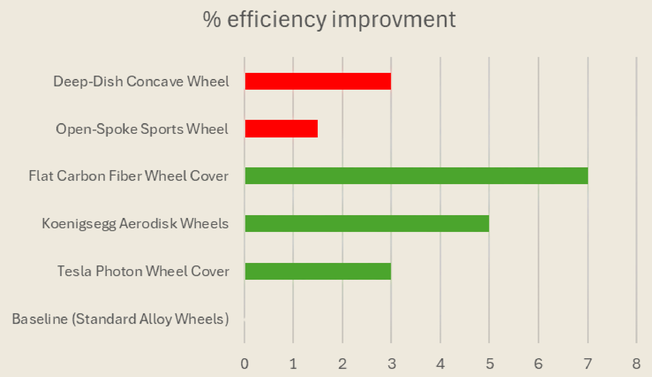
Throughout automotive history, design has been balanced between aesthetics and Functionality. While early automobiles prioritized reliability over appearance, the rise of consumer-based markets increased the emphasis on visual appeal. Eventually, automotive companies opted for streamlined aerodynamic designs. However, many efficiency-driven features were abandoned due to consumer preferences. Sustainability has become a key focus, especially with the shift towards electric vehicles. Regardless, wheel covers, tapered rear ends, and less sharp shapes are often omitted because they are perceived as unattractive. The aesthetics of a vehicle is a main selling point for most consumers, and with such, it drives manufacturer decisions, ultimately leading to a trade-off between efficiency and marketability. This study examined how beauty standards impact sustainability in automotive design and whether they impede future efficiency improvements.

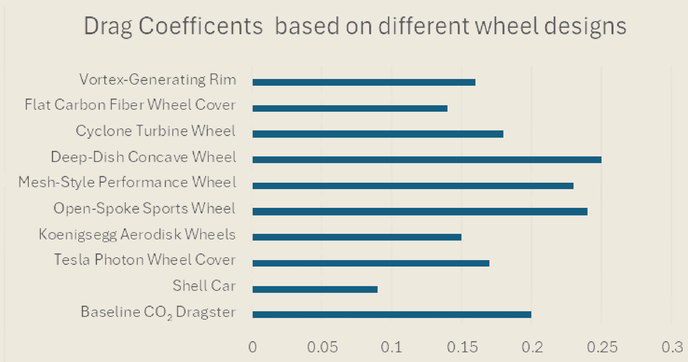
Methodology

The methodology consists of using CO2 dragsters as a baseline for testing. This allows for real-world and digital results, which can prove how aerodynamics could be improved with disregarded designs. The dragster's body and weight will remain a control variable. However, the wheels and spoke designs will vary. Popular rim designs will inspire some, and some will be taken after rejected designs such as the Tesla's photon wheel cover. By using real-world tests and digital simulations, the research will be able to find a correlation between disliked wheel designs and aerodynamic efficiency.

Analysis







Results and Findings

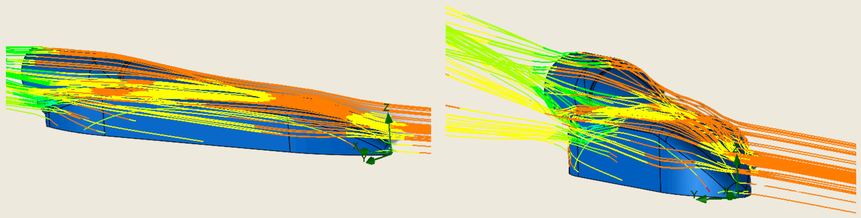
The data collected from real-world CO_2 dragster tests and digital simulations indicate a clear correlation between wheel design and aerodynamic efficiency. Wheels designed with aerodynamic principles, such as the Tesla Photon Wheel Cover (Cd = 0.17) and the Koenigsegg Aerodisk (Cd = 0.15), significantly reduced drag compared to popular aesthetic-focused designs like Open-Spoke Sports Wheels (Cd = 0.24) and Deep-Dish Concave Wheels (Cd = 0.25). The tests also demonstrated that wheel covers and streamlined designs improve efficiency by mitigating turbulence around the wheels, a major source of aerodynamic drag. These results support the hypothesis that beauty standards negatively impact sustainable vehicle design, as many efficient designs are rejected in favor of more visually appealing options.

Sales data further reinforces this issue. Despite the aerodynamic benefits of covered and turbine-style wheels, they remain niche, with significantly lower adoption rates compared to traditional open-spoke designs. Consumer preferences lean toward aggressive or sporty aesthetics, which manufacturers prioritize to maintain sales. This tendency confirms that aerodynamic inefficiencies persist due to market-driven decisions rather than technological limitations. If efficiency were the primary concern, more vehicles would feature optimized wheel designs rather than those dictated by conventional beauty standards.

Conclusion

This study highlights the conflict between aesthetics and efficiency in automotive design, particularly in the selection of wheels. The data confirms that consumer-driven beauty standards discourage the widespread adoption of more sustainable, aerodynamically efficient designs. While manufacturers continue to push efficiency improvements, market demand often forces them to compromise performance in favor of aesthetics. Addressing this issue requires a shift in consumer perception and industry priorities, promoting the adoption of efficient designs without sacrificing desirability. Future research could explore strategies to integrate aerodynamic improvements into aesthetically acceptable designs, ensuring that sustainability and marketability align more effectively.

Simulation model



Citations

Brandt, Adam, et al. "The Effects of Wheel Design on the Aerodynamic Drag of Passenger Vehicles." SAE Technical Paper Series, 2 Apr. 2019, https://doi.org/10.4271/2019-01-0662.
Klok, Chris. "Three Ways to Improve Range and Efficiency in EV | MacDermid Alpha Electronics Solutions." Macdermidalphaauto.com, macdermidalphaauto.com/our-insights/three-ways-improve-range-and-efficiency-ev.
Niedermeyer, Paul. "An Illustrated History of Automotive Aerodynamics - in Three Parts." The Truth About Cars, 3 Feb. 2012, www.thetruthaboutcars.com/2010/02/an-illustrated-history-of-automotive-aerodynamics-in-three-parts/.
"Optimizing Electrical Vehicles via Aerodynamics." E-Motec, 2 Sept. 2021, www.e-motec.net/optimizing-ev-aerodynamic.
RN 365. "Aerodynamics in F1." RacingNews365, 15 Sept. 2023, racingnews365.com/aerodynamics-f1.
Stromberg, Joseph. "Why Cars Went from Boxy in the '80s to Curvy in the '90s." Vox, Vox, 11 June 2015, www.vox.com/2015/6/11/8762373/car-design-curves.
Sun, Yicheng. "Aerodynamic Efficiency - an Overview | ScienceDirect Topics." Www.sciencedirect.com, 2017, www.sciencedirect.com/topics/engineering/aerodynamic-efficiency.