

# Effect of the Consumer on Automobile Design

A Research Paper in STS 4600


Presented to the Faculty of the School of Engineering and Applied Sciences  
University of Virginia • Charlottesville, Virginia

In Partial Fulfillment of the Requirements for the Degree  
Bachelor of Science in Mechanical Engineering

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May 10, 2021

On my honor as a University Student, I have neither given nor received unauthorized aid  
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## **Introduction**

Automobile companies are constantly redesigning their vehicles to meet consumer demands, consumer needs, and government regulations. Vehicle redesigns also serve to test new technologies that consumers may find attractive (Wardlaw, 2020). Market analysts and engineers are continuously adapting vehicle designs and features by redesigning the body for aesthetics to developing new technologies that make vehicles safer or improve acceleration. The implementation of rear wheel steering (RWS) technology is a prime example of automotive companies identifying and acting upon consumer demands for higher performance and safer vehicles. In fact, rear wheel steering has been implemented by many automotive companies on past and current vehicle models including the Honda Prelude, Nissan 300 ZX, Porsche 918 GT3, and Lamborghini Urus (Autocar, 2020).

Automobiles typically struggle to make tight, low speed turns common in parking scenarios and in town driving. At high speeds, the ability to quickly change direction to avoid a collision with another vehicle or animal is critical to vehicle performance. Most cars today are equipped with a mechanical steering linkage from the steering wheel to the front wheels that allows the driver to actuate the wheels. While this setup is adequate for many common driving scenarios, front wheel steering vehicles are typically unable to make tight low speed maneuvers or provide the handling needed for emergency or performance situations at high speeds. Many vehicles equipped with both front and rear wheel steering have therefore been designed and sold at a large scale. It is common to refer to a vehicle equipped with both front and rear steering as a “rear wheel steering” vehicle. Generally, the goal of rear wheel steering is to facilitate difficult vehicle maneuvers at low speeds, such as navigating a tight parking garage, and improve handling characteristics at high speeds, such as quick lane changes on a high way. By improving performance throughout the range of vehicle operating speeds, rear wheel steering solves the

problem of being unable to execute tight low and high-speed maneuvers. Rear wheel steering is the focus of my capstone project and will facilitate these improved performance characteristics. The implementation of technical systems in automobiles that are not fundamental necessities of standard vehicles but that improve consumer satisfaction through safety or performance means exemplify the effect consumers have on automobile design. The focus of this research is to identify and analyze specific affects consumers have on vehicle design and draw broader conclusions regarding consumers' impact on the industry. The analysis of the implementation of rear wheel steering and the marketing surrounding this technology is one example that will be studied in this research.

In addition to the technical aspects, specific examples of how certain consumer demands have affected the design of automobiles will be analyzed. This paper will be focused on the influence automobile consumers have on engineers' decisions throughout the vehicle design process.

## **Influence of the Consumer on Automobile Design**

I will structure my analysis using “The Social Construction of Facts and Artifacts” framework discussed by Pinch and Bijker (2012). The idea that social groups and individuals have a large and continuous impact on the development of technology is central to the SCOT theory and is in contrast with technological determinism. Recognizing the influence that automobile consumers have on the development of vehicles and then characterizing the scope and nature of this influence reflects SCOT theory’s central methodology for analyzing the development of technology in the context of outside societal influences. Through their primary example of the development and evolution of the bicycle, Pinch and Bijker discuss how various groups of people influenced almost every aspect of the bicycle’s design over time. Pinch and Bijker emphasize that often the technical workings and merits of a technology can be irrelevant to the success and adoption of that technology within society. They argue that for a technology to be accepted by society and therefore successful, many different forces, such as governmental regulations and different social groups’ perception of the technology, must act in favor of integrating the technology onto their society (Bijker, 2012). I am primarily focusing on how consumers affect the automotive industry’s design and engineering decisions, and the SCOT theory will be helpful in explaining the influence of different consumer groups. Specifically, the automobile is the artifact whose development will be analyzed in the context of influential consumers’ demands and needs.

Through analyzing design and marketing decisions made by individual automobile companies, the influence that vehicle consumers had on those decisions will be made apparent through the use of the SCOT theory. Pinch and Bijker examine bicycles designed differently for men and women riders and discuss, in the context of SCOT theory, the male and female social groups affecting those decisions. Because the social group of upper-class women that were

potential consumers of bicycles during their early development typically wore dresses on a regular basis, different male and female bike models were created. The female bicycles allowed for women to rest both of their feet on one side of the bike's frame, thus allowing them to wear dresses while riding. The effect on bicycle design by specific social groups was also exemplified through Pinch and Bijker's analysis of upper-class men who wished to use the bicycle as a status symbol in addition to an effective mode of transportation. The desire for the bike to elevate the rider high above pedestrians for the sake of bringing admiration to the rider contributed to the development and continued use of bicycles with very large front wheels even when superior riding characteristics and practicality could be achieved through less ostentatious designs. In summary, technologies don't succeed solely for their superiority from an engineering perspective but also and sometimes succeed only due to specific social groups' desire to possess and use such a technology for their own unique wants and needs (Bijker, 2012).

Similar to the effects of social groups on bicycle design by Pinch and Bijker, the engineers and managers making automobile design decisions do so with specific consumer groups in mind. Vehicles that are typically attractive to and purchased by certain social groups, such as middle-aged suburban mothers, will have certain features engineered into them, such as large cargo areas and intuitive handling characteristics, that are attractive to such groups. Through the lens of SCOT theory, a middle aged suburban mom is an actor who heavily influences the features of vehicles that cater to her needs. Rather than engineering and attempting to market a vehicle without making informed design decisions about features potential consumers of that vehicle demand, automobile companies are actively attempting to satisfy consumer demands by analyzing their preferences and implementing those preferences as vehicle

features. The Mercedes G Wagon, Lexus GS, and Chevrolet C8 corvette are vehicles that will be analyzed in this paper using SCOT theory.

## **Consumer Effects on Vehicle Design**

The implementation of rear wheel steering by automobile companies is a direct result of the companies meeting consumer demands for high performance and safer vehicles. Rear wheel steering therefore exemplifies the consequential relationship present between consumers and automobile manufactures that is being investigated. Characterizing the influence of consumers on vehicle design decisions requires an analysis of both the consumer wants that automotive companies cater to directly as well as the technologies that automotive companies anticipate a customer will benefit from or need but is not currently aware of.

Vehicles typically marketed towards wealthy individuals that are likely to desire a vehicle that reflects their wealth or status, such as a Mercedes G Wagon, are designed specifically to function as status symbols. Specifically, the G Wagon can be purchased with carbon fiber fender flairs for an extra \$3,000 (Mercedes-Benz, 2021). While a rubber or plastic fender flair is much more durable and of similar weight to a carbon fiber flair that would shatter if struck with a sizeable stone or chunk of mud, the carbon fiber flaps are still seen as an upgrade from the plastic flairs due to the widely held notion that large sheets of carbon fiber signify wealth and distinguishment. The G Wagon's design and features that are so heavily influenced by the wealthy rather than budget minded, practical consumer in mind, serve as just one example of consumer influence within the automobile industry that is ripe to be viewed within the frame of SCOT theory. With the G Wagon as the artifact and the wealthy consumer as a powerful social group influencing its design, it is evident that the G Wagon's features are influenced heavily by groups of consumers giving cues to Mercedes's designers and executives.

The direct response of automobile companies to consumer demands, in an effort to increase sales by satisfying the consumer, is exemplified in new and updated vehicle models each year. The new lineup of vehicles that automotive companies release and showcase annually

are an embodiment of the technologies and styles that they believe consumers demand. For example, the marketing surrounding the 2020 Lexus GS sedan highlights the many safety features engineered into the car's design (Lexus, 2020). The argument being made by Lexus is that their engineers have designed the GS model to be extremely safe and accommodating to driver demands. Lexus understands that the consumers of their vehicles place a high value on safety, which is therefore reflected in many of the GS's features. The GS has a 10-airbag system, GPS based roadside assistance, a dynamic backup camera, and dynamic variable traction control among many other features. Lexus is obviously attempting to persuade the consumer to be confident in their GS sedan by appealing to the importance of safety.

Another example of automotive companies designing for consumer demands is the shift away from mechanical rear wheel steering, which typically yields minimal performance benefits, to electronically actuated rear wheel steering, which is very effective in increasing vehicle performance. Specifically, Wan argues that this shift from mechanical to electronic steering is due to consumer demands for greater performance (Wan, 2013).

General Motor's 2020 C8 Corvette has many features that cater to consumer demand. While many engineering decisions for the C8 were made to satisfy their targeted consumer, features such as magnetic ride control and different operating modes, such as eco and race, particularly stand out. GM has obviously considered many consumer demands that affect the development of the C8, and the performance benefits and creature comforts gained by features such as magnetic ride control and driving mode selection significantly benefit the consumer. The different driving modes allow the driving characteristics of the car to be easily adapted instantaneously according to the experience the consumer demands, whether that demand is a cruise through town or laps on a race track (Tracy, 2019).



Automakers also implement certain technologies in their vehicles, the implementation of which are not directly motivated by current consumer wants but rather what the automaker believe could be necessary given the consumer's driving skill level or predominant demographic. The 2020 C8 Corvette also exemplifies many engineering decisions that account for the general consumer's driving skill level and age. As pointed out by John Fitzgerald, the marketing manager for Chevy performance cars, one in five buyers of the Corvette are age 65 and older (Chappell, 2013). This means that a significant portion of Corvette consumers will have slower response times to situations requiring fast reflexes, such as pushing a race car to its limits on a track or highway, compared to the average, middle aged automobile consumer. Also important is that the C8 Corvette is a mid-engine, high horsepower, race-oriented car at a relatively low starting price of \$59,995 compared to other vehicles with similar specifications (Cenizo). A significant portion of C8 consumers may have little to no experience driving, let alone racing, such a capable car due to its entry level price point. While engineering the C8, GM obviously considered the large portion older and unexperienced consumers present. For example, the new mid-engine C8 Corvette is intentionally designed to understeer, meaning it tends to not steer as sharply as the driver tells it to from the steering wheel during cornering (Fenske, 2020). The engineers did this largely because if they designed a car that oversteered (turns into the corner more sharply than commanded), or even if they designed a car that didn't over or understeer, the average consumer of the car would be very likely to crash because large amounts of racing experience is required to control such agile and aggressive steering setups.

## **Research Question and Methods**

The research question I will be answering is: what influence do automobile consumers have over engineers' decisions throughout the vehicle design process? Understanding how consumers affect automotive design decisions is important due to the large impact this influence has on automotive engineering decisions. These engineering decisions then affect the lives of millions of vehicle owner every day.

I will analyze how consumer needs and potential demands are identified by automotive companies and how such needs and demands affect vehicle design decisions. Rear wheel steering in particular will be discussed from a perspective that understands that technology satisfies consumer demands for increased performance (Kasliwal, 2019) and safety (The Pros, 2019). The design decisions that automobile marketing teams and engineers make with consumer demands in mind typically affect the features and capabilities of their vehicles. I will therefore investigate the nature and magnitude of the influence consumers carry on automobile design.

Evidence to support the analysis of this research question will be gathered from multiple sources, including automobile engineering literature, economics and business databases, and other consumer reports and surveys published online. To understand past and current consumer demands, consumer reports and surveys will be most useful. Analyzing the effects of these consumer demands is complicated due to the large number of factors affecting automotive design, including manufacturability, R&D budget constraints, and of course consumer demand. Therefore, consumer wants and needs gathered from consumer reports and surveys, while a critical factor affecting vehicle designs, must be interpreted from a holistic perspective considering the other factors influencing vehicle design decisions, such as annual automobile company budgets and long-term company goals. While companies do not directly publish their design decision justifications, engineering literature communicating design features of specific

vehicles and in some cases postulating why the company made such decisions will be useful in constructing an understanding of how consumer demands are satisfied by the final design.

To analyze this topic, I will view consumer influence on automobiles through the lens of the SCOT theory because it is useful in investigating the continuous and substantial impact that social groups and individuals have on the development of technologies. Using the SCOT framework, a model of the consumer's influence on automobile design will be developed. Specifically, the multidirectional model of artifact development Pinch and Bijker advocate in favor of is directly applicable to the artifact-influencer relationship between automobiles and consumers (Bijker, 2012). Also, any case studies or content analysis articles related to this topic will also be useful in analyzing the effects of consumer demands on vehicle design. Specifically, the influence of government regulation on vehicle design and the consumers' reactions to such regulation is discussed in "Review of European Regulations and Germany's Action to Reduce Automotive Sector Emissions" (Kotak, 2016). Another source of analysis focused on the automotive industry is by Santos and Paganotti. They argue through conducting case studies, interviews, and analyzing secondary sources that the direction of engineering R&D of new automotive technologies is typically influenced heavily by specific market demands (Santos, 2019).

## **Consumer Influence- Results**

Automobile consumers have a large but still finite influence over engineering design decisions throughout the vehicle design process. Through analyzing design features of multiple new vehicles, including the Lexus GS and Chevrolet C8 Corvette, it is apparent that consumer demands heavily influence the design decisions made by vehicle engineers and automobile executives. Due to other influences present, such as budget constraints and government regulations, consumers do not wield an all-powerful control over vehicle designs but do still heavily influence vehicle safety, marketing, and performance. Furthermore, many consumers desire certain performance characteristics from their vehicles, such as excellent crash safety, but do not know the specific technologies that will provide such safety. It is therefore typically the automobile company's prerogative to determine which technologies or features to implement in their vehicles in an effort to best satisfy consumer demand.

### **Lexus GS**

The implementation of certain technologies on the 2020 Lexus GS, including a dynamic backup camera and dynamic traction control, and the marketing surrounding such technologies as safety features signals that Lexus is making vehicle design decisions because consumers desire safe vehicles. As shown in a large international study of automobile consumers' perception of vehicle safety and their willingness to pay for added safety features, the vast majority of consumers believe vehicle safety features and ratings are very important and affect their decision to purchase a vehicle (Kaul, 2010). Kaul discusses that most consumers are willing to pay for safety features that aid the driver in difficult or dangerous situations, such as collision warning systems and advanced airbag systems, but most consumers are unwilling to pay the market price for technologies that actively control their vehicle, such as automatic collision

mitigation braking systems. The conclusion that consumers favor passive driving assistance features over autonomous systems such as automatic braking and steering was also reached by Consumer Reports through safety related surveys of automobile consumers (Barry, 2018).

Lexus is catering to the majority of consumers that desire passive safety technologies through the implementation of such systems rather than implementing autonomous systems that the majority of consumers do not favor. Specifically, some of the passive safety systems included on the Lexus GS include: a 10-airbag system, GPS based roadside assistance, and dynamic variable traction control. Therefore, Lexus has implemented certain safety features on the GS they believe will appeal to consumer demands in an effort to increase sales. Furthermore, Lexus markets many of the GS's advanced features, such as electronic rear wheel steering as a safety feature rather than a performance feature due to the large value consumers place on automobile safety (Lexus, 2020).

Another recent study, conducted in 2016 conducted by The Hartford and the MIT Age Lab, found that 76% of drivers over 50 years old will actively seek out high tech safety features (Cooper, 2016). Because the large majority of Lexus GS consumers are over the age of 50, this survey reinforces the fact that vehicle safety is a key consideration for current GS consumers. Furthermore, the technologies drawing the greatest demand from this age group are blind spot warnings systems at 87% and crash-mitigation systems at 85% of responses (Cooper, 2016), both of which are currently standard safety features of the Lexus GS (Lexus, 2020).

### **C8 Corvette**

While consumer demand for performance isn't as strong as demand for safety, consumers that desire faster vehicles with improved handling and more performance-oriented technologies

are still a powerful force in the market, especially within certain performance minded groups of consumers. Consumer Reports points out that generally, automobile consumers are much less interested in vehicle performance metrics, such as those communicated by horsepower and handling metrics, and tend to focus on vehicle safety and efficiency when purchasing a new vehicle (Plugins, 2018). While consumers as a whole don't value performance metrics highly, some subgroups of consumers, such as young adult males, highly value vehicle performance metrics (Vrkljan, 2011). This reality is reflected in 2019 C7 and 2020 C8 Corvette sales. In 2019, the last year of production for the C7, 17,988 C7 Corvettes were sold in the United States. In 2020, 21,626 C8 Corvettes were sold in the US (Chevrolet, 2021). It is also important to note that overall light vehicle sales in the US declined 14.7% nationally (Wagner, 2021). Especially in the context of decreased national vehicle sales, this massive 20% increase in total US Corvette sales from 2019 to 2020 is a reflection of the value some automobile consumers place on performance as well as General Motor's attempt to draw in a younger demographic of consumers to the Corvette model.

Comparing C7 and C8 performance metrics, such as 0-60mph times and lap times, the C8 is indisputably a higher performance vehicle (Gilboy, 2019). A major difference between the C7 and C8 Corvettes that largely affects consumer perception of the vehicle as well as performance is the fact that the C8 is the first mid-engine Corvette ever, meaning the engine is placed in the chassis behind the vehicle's occupant seats. The redesign of the Corvette to a mid-engine, even higher performance and track oriented vehicle reflects GM's attempt to broaden the consumer base of the Corvette and further appeal to performance minded consumers.

GM is attempting to shift the public's perception of the Corvette away from being an old man's weekend cruiser to a sporty and youthful supercar. Hence the mid-engine design, typically

associated with impressive European exotic, track oriented, supercars, is being leveraged by GM to broaden the appeal of the Corvette to younger consumers. While generally American consumers do not place a high value on vehicle performance metrics, GM has singled out a sub group of consumers to target with marketing for the new C8. GM's appeal to young consumers is exemplified in a CNBC interview with Steve Majoros, Chevrolet's Vice President of Marketing. Majoros stated that the new C8 Corvette was intentionally redesigned in an effort to "reach out to new types of buyers" and to "get stronger in markets like Miami and Los Angeles" (Brzozowski, 2020). While the majority of these potential young customers were not openly calling for a mid-engine Corvette, GM identified the young performance minded consumers as potential customers of a redesigned Corvette and reimagined the Corvette as a mid-engine track vehicle to court their demands. GM knew that falling Corvette sales and an aging customer base would not lead to long term success of the Corvette and thus designed the C8 in an effort to expand their consumer base by appealing to younger markets, such as consumers in Miami and LA.

### **Relevant Academic Research**

Further insight into consumer influence on automobile design is found in a study conducted by Santos and Paganotti, research professors in Brazil. They argue through conducting case studies, interviews, and analyzing secondary sources that the automotive industry largely has a culture of open innovation when developing new technologies. The studies and analyses were focused in the Great ABC region in Sao Paulo, Brazil. From data collected through interviews with 26 professionals in the automotive industry, Santos and Paganotti show that the direction that the engineering R&D of new automotive technologies is typically influenced heavily by specific market demands. These demands, which are collected from the consumer

using surveys or other consumer reporting methods, are analyzed by upper-level management at the company and then translated into requirements for R&D engineers to guide their work.

Santos and Paganotti also make clear that consumer demands are not the only factor affecting automotive R&D. The automotive industry also receives funding from the government and other funding agencies to perform R&D within certain specified areas of innovation. Secondly, Santos and Paganotti argue that the context of the engineer's education and background also affects what R&D is conducted and successful it will be. Therefore, it is clear that the consumer is far from the only influential factor relevant to vehicle design.

The idea presented by Santos and Paganotti that the demands of automobile consumers is similar to that of a control system feedback loop provides important insight into how consumers affect design. This feedback analogy shows that while the demands of the consumer of "fed back" to the automotive engineers in the form of requirements for innovation in certain area, the demands of the consumer are in turn affected by the products the industry produces. For example, if a company produces a car with an easy to use audio system, the consumer may demand that the company release in subsequent cars new and better versions of this system. Without the introduction of the audio system by the company initially, the consumers may not have demanded any improvements to audio systems. This feedback concept shows that consumer influence on vehicle design can occur either as a demand for continuation or improvement on an already well liked technology or feature or as a brand new design never before implemented.



## **Discussion of Consumer Influence**

Viewing the effect of consumer demands on vehicle design through the lens of the Social Construction of Technology theory highlights the major social groups within the umbrella group of consumers and how consumers act as a whole to influence design.

Through the analysis of the Lexus GS's advanced safety systems, it is clear that Lexus has intentionally implemented many high-tech safety features. Because the vast majority of consumers at large demand more numerous and more capable driver assistance technologies that increase vehicle safety, Lexus has heeded this demand throughout the GS's design. It is also important to note that Lexus markets many advanced features, such as dynamic rear wheel steering, as a safety rather than performance feature likely due to the much larger demand for vehicle safety rather than vehicle performance metrics. Through the analysis of the C7 and C8 Chevrolet Corvettes, the influence that subgroups of consumers, such as young adult males, becomes apparent. While overall the majority of consumers do not highly value vehicle performance metrics such as acceleration times or braking distances, many younger consumers place a much higher value on such metrics than other consumer subgroups. By reengineering the 2020 Corvette as a mid-engine, European supercar style vehicle, General Motors saw a significant increase in Corvette sales from 2019 to 2020 even while consumer automobile sales plummeted as a whole, thus demonstrating the power of appealing to the demands of certain groups of consumer's demands.

Analyzing the effects of these consumer demands is complicated due to the large number of factors affecting automotive design, including manufacturability, R&D budget constraints, and of course consumer demand. Therefore, consumer wants and needs gathered from consumer reports and surveys, while a critical factor affecting vehicle designs, must be interpreted from a

holistic perspective considering the other factors influencing vehicle design decisions, such as annual automobile company budgets and long-term company goals. Furthermore, quantifying the exact amount of influence consumer demands have on vehicle designs is nearly impossible due to the numerous factors affecting designs. A qualitative understanding, based on factual analyses of quantitative sales data and surveys of consumer preferences, has thus been developed to give insight into the nature of the consumer's influence.

By bringing to light the importance of social groups and their demands to the technical engineering aspect of vehicle design, it is clear that engineering design is always influenced by non-technical factors. While engineers may be capable of producing new and advanced technology, the success of that technology is typically largely dictated by the consumer. The technical brilliance of a certain system may be largely irrelevant to that technology's success if the end user doesn't favor using the technology for any reason, such as a confusing user interface or poor marketing. In engineering practice, it is therefore critical to understand and account for external, sometimes nontechnical factors that can heavily influence the success of the technologies being developed. Furthermore, catering to specific groups of consumers of the technology through features that are especially valuable to a certain group can be an effective method of increasing the chances of a technology's success. Therefore, a conscious understanding of the groups of individuals that interact with a technology is critical throughout the engineering process to create a technology that is fit for successful operation within the context of use and influence by certain social groups.

## **Conclusion**

The magnitude and type of influence consumers hold on automobile design has been investigated and characterized as significant but not all encompassing. Through this analysis, the implementation of many significant vehicle features can be understood from a Social Construction of Technology perspective in which consumer groups affect many aspects of a technology and ultimately determine the success or failure of the implementation of that technology within society. With an understanding of how consumers affect the design process, it may be possible for automobile companies to better cater to consumer needs. Furthermore, understanding the demands of specific consumer groups can allow companies to tailor their automobiles' technologies and features to appeal to those groups in order to expand their consumer base.

Ultimately, automobile companies typically must interpret general consumer demands to form them into specific and feasible technologies and features that will cater to those demands. To continue this research, further analysis of design decisions made by engineers and executives on specific vehicles based on consumer demands would provide a more concrete characterization of consumer influence.

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