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Summary

The purpose of this inquiry is to evaluate how automotive design will shape in the future. To develop a critical awareness of three important topics within car design and how those three will interchange with each other. Each topic will be broken down and explored to analyse their role in the future of automotive design.

Introduction

Automotive design is always looking forward, to see what can be possible in the future by reflecting, refining, and generating concepts. Throughout this inquiry, the aims are to prove and gain a critical awareness into three core values in the automotive design environment. This inquiry is important as the automotive industry is currently going through a substantial shift with a heavy focus on sustainability.

There needs to be a way to successfully incorporate functionality and artistic design with this shifting tide. In the past, design within the automotive landscape has had a primary focus on functionality and artistic design, going through phases with artistic design being important during the 1950s, functionality in the 1980s and now sustainability in the 2020s. Heritage is an important part of car design, and it is important to reflect on this. Heritage can have artistic qualities that have been around since a brand's inception, or advancements made to functionality that refines and pushes design forward. These two values have been core to modern car design, and with sustainability now entering the picture these three values must come together and harmonise to push the next step in car design and concept generation. By gaining enhanced understanding through interpretation, analysis and research, links can be made between the three values to look to what the next step of car design has to offer. Learning through developments of the past can open up a key to our understanding of the future, and from this inquiry there is the opportunity to make

several links between topics and interpret what future concepts could become. Further studies can be made off of this inquiry as the automotive landscape continues to change and new developments are made.

For me, cars have always been a part of my life. From childhood I was always drawing cars, watching cars race or driving them myself in video games. It has been a core value of who I am. I have always been intrigued by their design or fascinated with how they work. Then during the pandemic, I gained a new appreciation for nature. It was something unexpected being a petrolhead, but as I worked on and maintained a pond in the family garden and saw all the benefits to the biodiversity it had, I realised how important it is to encourage nature and reflect on the positive impact we can have. For me, it is important to develop a critical awareness into things I appreciated in the past, with what I appreciate now, and how they can come together to something for the future. With that in mind throughout the first topic I'll explore sustainability, looking into recent advances made and how those improvements reduce our impact on the planet and to marine ecosystems. Then exploring how sustainable practices can become a part of the design, to communicate sustainability through the medium of design. Then moving to functionality, it will focus on the importance of functional design and particularly exploring the automotive sector. Then finally the importance of artistic flair and its effects on human psychology with focus on anthropomorphism and design evolution.

Sustainability

In the automotive industry, there is an emergence of an environmental focus. The typical modern internal combustion engine would produce almost 250g of greenhouse gases per Km, compared to 80g from EVs. (Bieker, 2021, p. 2). With consensus growing of our environmental impact, countries are beginning to impose restrictions on what passenger vehicles can be sold, with the UK imposing its restrictions in 2030. (Department for Transport, 2020). These restrictions are forcing

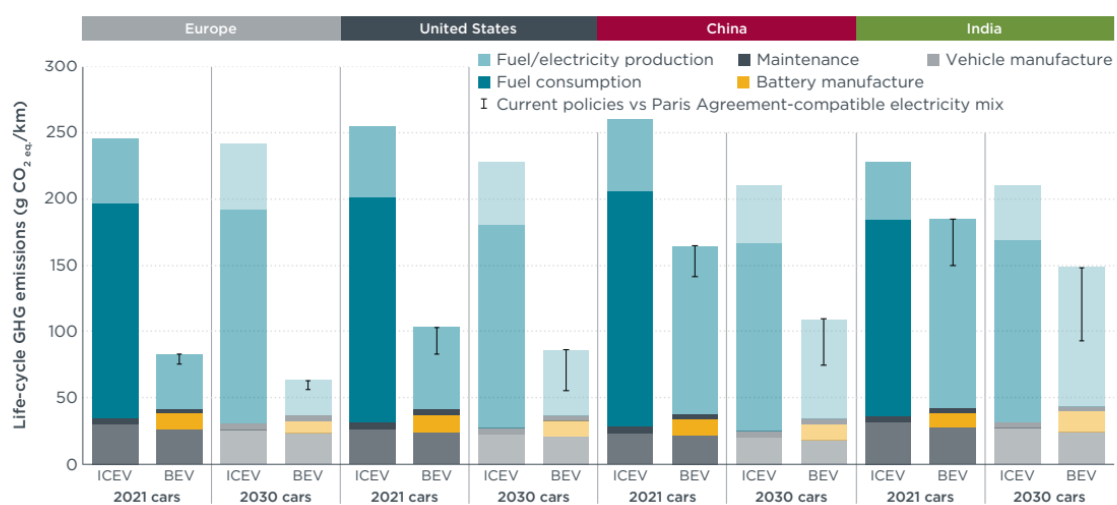


Fig. 1: comparison of emissions released by combustion and electric vehicles

automotive manufacturers to consider the impact they have on the planet and change commercial practices, resulting in growth of EVs on the market. However, switching over to EV is only the beginning of what can be done within the automotive industry to reduce its carbon footprint. It is important to explore what sustainability is, within and around the automotive landscape.

Sustainability is “Avoidance of the depletion of natural resources in order to maintain an ecological balance.” (Lexico, 2021) In the past, Automotive manufacturers have been destructive to the ecological balance, pulling resources such as crude oil from the seabed, mining the earth for rare ore materials, and using virgin plastics for components among others. This destructive cycle continues

through the combustion process by emitting greenhouse gasses, then into the end of life where materials fail to be broken down and recycled. In the assessment from the ICCT, it concluded “emissions over the lifetime of a average medium-size BEV are lower comparable to gasoline cars by 66-69% in Europe.” (Bieker, 2021, p.2) The data demonstrates the significant change EVs can make compared to their gasoline counterparts. With significant reductions emerging from reduced fuel consumption with zero emissions from the tailpipe.

Reduced carbon emissions have numerous benefits to the ecological balance, with a particular benefit to the oceans. As discussed in Ocean Acidification by Jean-Pierre and Lina, the ocean acts as a substantial store of CO₂ as the “ocean and atmosphere exchange massive amounts of CO₂.” (Gattuso and Hansson, 2011, p. 1) However, when there is an excess of CO₂ in the

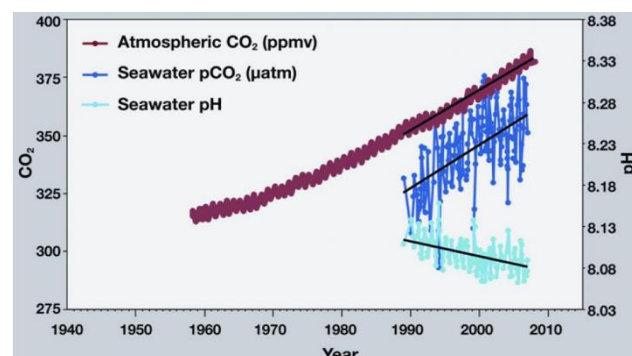


Fig. 2: relationship of CO₂ and pH in the oceans

atmosphere, the consequence is an increase to ocean acidification. The acidification of the ocean is “a reduction in the pH caused primarily by the uptake of CO₂.”

(Gattuso and Hansson, 2011, p. 2) As CO₂ binds to H₂O, it disrupts the chemical balance of the water and forms a “weak acid” (pg2). This further disrupts the ecology of the oceans as ocean acidification begins to effect marine life, through their “physiological processes such as ion transport, enzyme activity and protein function.”

(Gattuso and Hansson, 2011, p. 5) Disruption to these processes effect photosynthesis, a key process in the marine environment. Having a negative effect on the photosynthesis process would cause the effects to be felt by organisms such as phytoplankton. These single celled organisms would struggle to produce the vital

sugars needed to function and survive. As phytoplankton is a core species in the marine ecosystem, the effects felt from a reduction in their numbers would have effects on the whole food web. Secondary species such as juvenile fish would need to find alternative sources for their food in order to survive themselves. This could take the form of migrating to different locations or competing against other species on a similar level of the food chain, reducing overall the numbers of marine life on that level of the chain. With less biodiversity in the chain, the effect would be felt by apex species as their source of nutrition continues to wane. The continued effects felt would disrupt the entire balance of marine ecosystems, effecting their ecology and biodiversity. With the introduction of electric vehicles, as discussed earlier, the amount of CO₂ produced over the lifespan of the vehicle is significantly reduced. This means that less stress is placed on the oceans to uptake and exchange CO₂ from the atmosphere. With less CO₂ entering the oceans, the rate of ocean acidification is greatly reduced and so too is its impacts. By understanding the substantial difference one idea of sustainable practices can have to just one aspect of the ecology of the planet, it demonstrates the importance in continuing to explore other ideas of sustainable development in the automotive design landscape.

Although significant advancements have been made through the switch to electric powertrains, the automotive industry has more it can do to reduce its carbon



Fig. 3: Alfa Romeo Trefoil grille

emissions. In automotive design, each brand has their own DNA, their own take on what a car should be. An example of signature design DNA would be Alfa Romeo and their signature Trefoil grille.

This is an example of how the artistic form and functionality can be the two deciding

factors in car design. However, as awareness of our impact on the planet grows, sustainability in design is going to play an ever increasing significance. Asking questions such as how this feature can be designed, but in a way that uses fewer virgin plastics or uses more recycled content is key. The design and sustainability factor itself can be used as a platform to demonstrate how sustainability can be part of a brands design DNA, to create aesthetic sustainability. Polestar as an automotive brand has shown to the world what can be done by using design as a platform for sustainable change. The company is openly transparent about its impact “Ensuring a minimal impact of our actions never stops and we will never be finished. We are as transparent as possible in all our sustainability efforts and in our willingness to do the right thing.” (Polestar, 2021) The Precept is a concept from Polestar that demonstrates



Fig. 4/ Fig. 5: Polestar Precept and sustainable design

where the brand is going in its design philosophy. It is a concept which demonstrates a strong statement about the brands intent towards sustainability. Traditional materials such as leather, have been subsidised for materials which take a sustainable approach. Two examples from their Precept would be the recycled bottles used to make the seat materials and the use of natural fibre materials for the door inlays. It is the forward-thinking approach and integration of sustainable practices as part of the design process which is key to communicating sustainable design. As explored by Harpers in aesthetic sustainability, the success of a products design relies on decisions where “preferences are not rational parameters.” (Harper,

2017, p. 115) A design has to create an emotive response, “which is based on emotions and feelings”. (Harper, 2017, p. 115) When the consumer is made aware to the sustainable practices made by a company, and the design aesthetic is visually pleasing, it can create this emotive response that draws a consumer to a product. Being aware that as a consumer, they have made a conscious decision which has had a more positive impact on the environment, creates a positive connection to the brand and “allows users to experience its value.” (Harper, 2017, p. 117) The growing awareness to sustainability has made it more valuable to people as they make conscious decisions about products. This growing awareness is key to the success of future design within the automotive landscape. As discussed, combustion engine cars have had a significant impact to the environment, and this is a part of their legacy that will be felt for generations to come. However, by reflecting on lessons of the past, the shift to more sustainable power trains and use of sustainable materials is changing the image of the automotive industry. Changing it to an industry which is refining and making strides to a carbon negative future. This sustainable process presents value to a brand and in turn its customers, and will form part of automotive manufacturers design DNA with a focus towards aesthetic sustainability. This aesthetic sustainability will share as much importance to design as form or artistic expression.

Functionality

A successful product design takes advantage of remaining within the realms of functionality. A design can be conceptual and artistic, however if the design places too much focus on form over function it can be detrimental to the design, as the product would no longer “deal with real issues.” (Hallgrimsson, 2012, p. 7) When designing a product, it is important to remain forward thinking and aware of the target

audience. Ensuring in the forefront of the design process, that once the product has been designed it will be used by real people in the real world “there is also a real need to anticipate future consumer wants, needs and desires.” (Milton, and Rodgers, 2011, p. 30) This design process is important as a design can fail if people are



Fig. 6: Chevrolet SSR

unable to use it in the way that they intend to. An example of this would be the Chevrolet SSR, a convertible pickup truck from 2003. The design was a hybrid between a pickup truck and a convertible hot

rod. The design attempted to create a market which was not in demand. The design also felt underwhelming and could not shake its “inherent dorkiness”

(caranddriver.com, 2020) The vehicle failed to sell and was an example where General Motors had not correctly anticipated the needs of future consumers and then designed a product accordingly. It was a “an awkward-looking, underpowered, and overpriced factory hot rod that arrived just one year after the Prowler's death.”

(caranddriver.com, 2020) The Plymouth Prowler was a prior General Motors vehicle in a similar package that also failed to sell.

It is evident that research and development is an important process to forecasting a comprehensive design, “designers need to continually strive to understand what their current and target customers want.” (Milton, and Rodgers, 2011, p. 30) When people are considering buying an urban crossover, it is important that the vehicle meets the criteria and specification that makes a crossover. The design then builds on this, by critically analysing the consumer to predict what the future design could be and then designing accordingly. There would be no use in designing a crossover which has a limited boot space or only two front seats.

Although this may be perceived as radical and conceptual by some, the consumers would be uninterested in the product as the design does not meet their needs and is no longer functional, like in the case of the Chevrolet SSR. To ensure that this does not happen, product designers use a process of future forecasting. It is a process which enables designers “to identify emerging trends and extrapolate likely scenarios.” (Milton, and Rodgers, 2011, p. 31) Critically evaluating this forecast identifies trends that are emerging in the market and assess their “qualities and probable deployment.” (Milton, and Rodgers, 2011, p. 31) Understanding the properties of a trend identifies if it can be successfully incorporated into a brand. This is particularly prevalent within the automotive landscape, as brands have a history and design language that may need to be adapted to meet the new form. That is where evaluating the deployment of a trend is paramount to the success of a design. A performance focused brand such as Noble may struggle with adapting a crossover



Fig. 7/ Fig. 8: Lexus UX Crossover and Noble M600 Supercar

trend into its design. The brand is niche and, in the past, has only catered to high end sportscars and limited number supercars. A divergence as substantial as a crossover may negatively impact the brand as its consumers would potentially see this as only succumbing to a trend. The brand has never previously associated itself with this form, and the sporty design aesthetic and language of Noble may not lend itself well to this new crossover form. It is a situation where the form of a crossover may not fit within the Noble family line up, or the Noble design and aesthetic would

take centre stage over the functionality aspects of a crossover. This is a scenario where critical awareness of the brand and its relation to potential trends ensures that the design of the product can “deal with real issues” (Hallgrimsson, 2012, p. 7) Function has its place and should be respected to ensure its successful integration to a brand, however the functional element must balance itself with the form, as too much to either side may result in a product which is designed for nobody.

Functional design takes multiple forms within the automotive industry, whether that is the shape of the chassis, the ergonomic design of a seat or integration of structural components. However, there is a beauty to be found within functionality. Just because something is functional, it does not mean it has no form. There can be harmony between the two. Beauty is defined by “the quality of being pleasing, especially to look at, or someone or something that gives great pleasure, especially when you look at it.” (Cambridge dictionary online, 2021) In automotive design, components such as the suspension are hidden from observation. They are a piece of engineering and offer only functional value. As explored in the aesthetics of design by Jane Forsey, escaping traditional ideas of beauty expose us to the value of beauty being found in untraditional areas “the beauty of design is different from that of art and craft.” (Forsey, 2013, p. 2) The way suspension interacts and moves with the tarmac can be seen as an automotive form of expressionism. The non-



Fig.9: Push rod Suspension

the traditional form of expressionism, “can be highly intense and non-naturalistic,

naturalistic movement of the suspension between the road taking the free movement from the driver as they use the car as the paintbrush, with the tarmac as their canvas. This idea is not dissimilar to

brushwork is typically free.” (Tate, 2021) Exposing the suspension and the engineering at work by incorporating it into the design shows how functionally pivotal this component is, but also demonstrates the artistic form it possesses through its engineering. The beauty of design can be found in untraditional areas and expressed as a form of art. So, although Jane in the aesthetics of design explored the themes of how beauty in design is not the same as that of art, there is however art to be found and explored in design. As much as engineering is a science, it is also a form of art. The final design is the sum of its parts, composed of hours of research invested to create a piece that works in harmony. A symphony of components, that work together like an orchestra with the driver as the composer. Although these parts are purely functional, when they come together and form an emotional response it becomes something more. That is when functionality and form come together to form a symphony of beauty.

Artistic

A design needs to have artistic value in order to engage the attention of people. It relies on “captivating people in experiences allowing them to feel passionate and energized.” (Simeone, Secundo, and Schiuma, 2017) Without this quality, a design has the potential to fall into the background and feel uninspired. Thesketchmonkey described the real life examples of how this can happen within the automotive landscape. “Nobody is going to remember this new Citroen even a year from now.” (thesketchmonkey.com, 2021) There are challenges automotive designers must overcome to create



Fig.10: importance of artistic design

something with an artistic flair. Cars must follow a certain shape and set of rules as governed by manufacturing and regulations, however with too heavy a focus on functionality, there is the threat of cars all having “the same proportions and lines.” (thesketchmonkey.com, 2021) By thinking in an artistic manner design can break free from the subtle refreshes and become something striking and bold. The passion felt within the creative process would transfer into the final design. That is what engages the attention of people, by striking their emotional side and sowing the seeds of passion.

Volvo design conducted an experiment with individuals to identify the pre-frontal cortex brain activity of individuals in response to a series of images. A design which is conventionally considered beautiful caused “men to experience more emotion than they did whilst looking at an image of a crying child.”

(carbodydesign.com, 2013) This emotion was then questioned by the team conducting the experiment. The responses led to a figure where “60% of men claimed that driving a beautiful car makes them feel confident and empowered.”

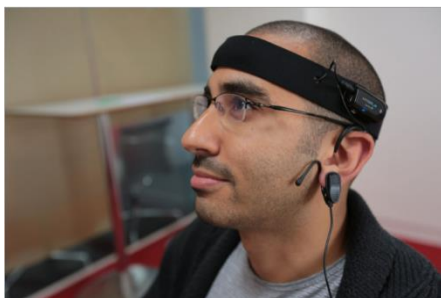


Fig. 11: testing of the pre-frontal cortex

(carbodydesign.com, 2013) To understand what aspect of the design was most significant they conducted further research and found that “the front of the car was the most attractive feature for men, in contrast to the reaction from women where the rear of the car scored the most highly.” (carbodydesign.com, 2013) This data demonstrates the value artistic design has within the automotive landscape. As a design which is artistic and considered beautiful can have a further and more meaningful impact on the individual. It can generate further emotions which

compound the overall connection to the design and the vehicle, as discussed by Dr David Lewis,

Appreciating an aesthetically pleasing design is an experience which combines understanding and emotions. These are so closely intertwined that it is impossible to distinguish between them. Aesthetic experience involves a unity of sensuous delight, meaningful interpretation, and emotional involvement. (carbodydesign.com, 2013)

It is important to consider this understanding when conducting designs, as a design which fails to ignite this spark would result in people not forming an emotional response to the vehicle. Subsequently, the design would be left for wanting more and end up feeling uninspired, which could have a detrimental impact on the brand and its commercial viability as fewer people draw that deeper connection with the car and the brand. The legacy of that connection could then be felt through future designs and have either a positive or negative lasting impact.

It is time to discover and understand what makes something artistic and aesthetically pleasing. The design process within the automotive industry revolves around preproduction and developing the aesthetics of a design. This development can range from visual design, to use of materials, graphic designs, patterns in upholstery and more. The aim is to take all these elements and infuse them into a brand's philosophy and explore applicable forms. These forms can be described as "the visual appearance of automotive design." (Moradi, 2014, p. 5) It is this connection to visual appearance which is found through anthropomorphism, "the showing or treating of objects as if they are human in appearance, character or behaviour." (Cambridge dictionary online, 2021) This can take the form of the face of a car, or the inspiration of its key elements displaying these traits. An economy car, for example the Fiat 500, has features such as a grille where the bottom tapers upwards to imitate the face of a person smiling. This presents the car as welcoming

and unthreatening, a trait that someone looking for a city economy car would be after. The smile behaves in an anthropomorphic way as if it was greeting you like someone familiar with a smile on its face. This conveys the sense that the car is welcoming and accommodating, and that creates an emotional connection to the individual. That connection takes the form that this car is safe and is happy to take you where you need to go. Whereas the other end of the spectrum would be something akin to the McLaren P1. The design with slim tapering headlights suggests something far more sinister and aggressive than that of the Fiat 500. This design is anthropomorphic in a way that is alert and is ready to pounce, as if it was on the hunt. It does not present itself in a welcoming way like the 500 as the form of the design is completely different, one is a small economy city car, whereas the other



Fig.12/ Fig.13: anthropomorphic design of the Fiat 500 and McLaren P1

is low hyper car built for performance. As a result, they have different human qualities and characteristics. The anthropomorphic design differences help to convey these features for both designs in a way which is aesthetically pleasing. The visual connection found through anthropomorphism can be made, and the emotional link to a design can be formed making it is easier to understand what the object is saying through artistic expression.

Throughout the existence of the automobile, designs have continued to change and evolve over time. There is an ever present need to refine and innovate,

to create something which is exciting that draws people in. A design from the 50s if left untouched would continue to look of its era, there are traits and tropes within that period of design which today would look out of place and obsolete, as if from a bygone era where, “a feature that excites today will inevitably stop being exciting tomorrow.” (Moradi, 2014, p. 2) Subsequently design has to think ahead and to create something for the future and make it a reality of today. Design therefore will continue to evolve into a form of artistic expression with an emphasis on being bold and conceptual as discussed in the thesis by Parisa “the sense of the wow-impact of the product is considered on a conceptual rather than on a feature level.” (Moradi, 2014, p. 2) This conceptual design approach will create bold exciting designs and create new trends and tropes that will excite people to come. With cars entering the electric era in 2030, the industry will enter a total shift of functionality, allowing new conceptual design languages to emerge where bold and exciting design will be paramount to seducing people to ditch their combustion vehicles in favour for the trend to electric power.

Conclusion

In closing, the topics explored throughout this inquiry have considered the value sustainability, functionality and artistic expression have with the automotive design process. Through critical evaluation and research conducted from a variety of sources, it has enabled the coherent understanding and development into several key questions surrounding each topic. Exploring the roles that each subject has to the ideals surrounding philosophical design.

With sustainability the research was conducted to explore the legacy that unsustainable design practices have had on the planet to support the design ideal of pushing towards sustainability, by understanding what solutions it can offer. The

ideal of switching to a more sustainable source of power would allow for the carbon footprint of a vehicle over the course of its life span to be reduced by two-thirds. This solution demonstrated the substantial impact it would have at benefitting ecosystems, particularly that of marine life through reducing the impacts of ocean acidification. Further exploration was conducted into how sustainability can become intertwined with the design DNA of a brand, and how it can be part of the design to elevate the practice of sustainability and avoid becoming detrimental to the outcome of the final product. These ideals showed how important sustainability is to the core design philosophy of the automotive industry, and how its importance will only continue to grow on the practice of automotive design, as the sector continues to clean up the legacy of its former years.

Exploring functionality was about understanding the importance of a functional design. Within the automotive landscape, a design must have the correct balance between form and function. A design must deal with real issues and be used by real people, and research explored why this is important. It investigated how within the automotive design practice a design must anticipate the needs of future consumers and be designed accordingly. It also explored what functional design can be. Just because something has function does not mean it cannot be artistic. There is a beauty found within engineering, and in design there is the opportunity to celebrate that and showcase it through an expressive form. The ideals investigated within the inquiry are impactful on automotive design due to demonstrating the balance between form and function and how important that balance is to create a successful design.

Artistic expression was investigating the emotional qualities that an artistic design has. Exploring the importance of something being visually pleasing on the

human brain and how this is important to the automotive industry. The feeling and emotional weight something beautiful can have on an individual compounds to a sense of confidence and empowerment. There was also the link to anthropomorphism within the automotive industry to consider. How a design can have very human like qualities and the message that this can convey, to further form a deeper emotional link. There was also the research into how artistic design changes through eras, the idea that something may be considered beautiful today can become obsolete into the next. These ideals showed how artistic design is always changing and evolving, and that within the automotive design practice there is always that consideration into what the future of design will be, and how to continue delivering that wow factor again and again.

These were important inquiry statements that helped to develop a more comprehensive understanding into the design process and the impact these solutions will have within the design space. They demonstrate the practices that are important as philosophical design ideals, ensuring that future design practices consider these ideals and build off of them. There is the realm within this enquiry to make further studies that build and continue to critically evaluate processes that take place within the automotive industry as it goes through this transitional period. The electric era has great potential for the future of automotive design, where designs are bold and visually appealing. They make use of function to demonstrate artistic form, with an emphasis on aesthetic sustainable design.

Bibliography:

Bieker, G. (2021) *A global comparison of the life-cycle greenhouse gas emissions of combustion engine and electric passenger cars*. Available at:

https://theicct.org/sites/default/files/publications/Global-LCA-passenger-cars-jul2021_0.pdf (Accessed: 5 November 2021).

Cambridge Dictionary (2021) *Cambridge Dictionary Online*. Available at:

<https://dictionary.cambridge.org/dictionary/english/beauty> (Accessed: 8 November 2021).

Cambridge Dictionary (2021) *Cambridge Dictionary Online*. Available at:

<https://dictionary.cambridge.org/dictionary/english/anthropomorphism> (Accessed: 4 December 2021).

Caranddriver (2020) *20 Biggest Automotive Flops of the past 30 years*. Available at:

<https://www.caranddriver.com/features/g23827306/biggest-automotive-flops/> (Accessed: 4 December 2021).

Carbodydesign (2013) *Volvo researches the emotive power of car design*. Available at: <https://www.carbodydesign.com/2013/11/volvo-researches-the-emotive-power-of-car-design/> (Accessed: 3rd December 2021).

Department for Transport (2020) *Government takes historic first step towards net zero with end of sale of new petrol and diesel cars by 2030*. Available at:

<https://www.gov.uk/government/news/government-takes-historic-step-towards-net-zero-with-end-of-sale-of-new-petrol-and-diesel-cars-by-2030> (Accessed: 5 November 2021).

Forsey, J. (2013) *The Aesthetics of Design*. Oxford: Oxford University Press.

Gattuso, J-P. and Hansson, L. (2011) *Ocean Acidification*. Oxford: Oxford University Press.

Hallgrimsson, B. (2012) *Prototyping and Modelmaking for Product Design*. London: Laurence King Publishing Ltd.

Harper, K.H. (2017) *Aesthetic Sustainability: Product design and sustainable usage*. Wolverhampton: Taylor & Francis Group.

'How to Build British: BAC'. (2021) *How to Build*. Series 1 Episode 9. More 4, 30 November.

'How to Build British: Jaguar'. (2021) *How to Build*. Series 1 Episode 7. More 4, 16 November.

Lexico (2021) *Oxford English Dictionary*. Available at: <https://www.lexico.com/definition/sustainability> (Accessed: 7 November 2021).

Milton, A. and Rodgers, P. (2011) *Product Design*. London: Laurence King Publishing Ltd

Milton, A. and Rodgers, P. (2013) *Research Methods for Product Designers*. London: Laurence King Publishing Ltd.

Moradi, P. (2014) *The use of emotional design for automotive design*. Unpublished PhD thesis. Faculty of Razak School of Engineering and Advanced Technology.

Simeone, L. and Secundo, G. and Schiuma, G. (2017) 'Arts and Design as translational mechanisms for academic entrepreneurship: The metaLAB at Harvard case study', *Elsevier*, 23rd October. Available at: <https://www.sciencedirect.com/science/article/pii/S0148296317304010> (Accessed: 20 November 2021).

Tate (2021) *Expressionism*. Available at: <https://www.tate.org.uk/art/art-terms/e/expressionism> (Accessed: 8 November 2021).

Thesketchnmonkey.com (2021) 'The Problem with Car Design', *thesketchnmonkey.com* [blog] 18th January. Available at: <https://thesketchnmonkey.com/blogs/news/the-problem-with-car-design> (Accessed: 20 November 2021).

List of Illustrations:

Figure 1: Bieker, G. (2021) *A global comparison of the life-cycle greenhouse gas emissions of combustion engine and electric passenger cars*. [Graph]. Available at: https://theicct.org/sites/default/files/publications/Global-LCA-passenger-cars-jul2021_0.pdf (Accessed: 5 November 2021).

Figure 2: Smithsonian Ocean (2018) *A More Acidic Ocean*. [Graph]. Available at: <https://ocean.si.edu/ocean-life/invertebrates/ocean-acidification> (Accessed: 5 November 2021).

Figure 3: TheAuto.eu (2018) *Alfa Romeo Giulia and Stelvio in B-tech special edition*. [Photograph]. Available at: <https://www.theauto.eu/alfa-romeo-giulia-and-stelvio-in-b-tech-special-edition/> (Accessed: 7 November 2021).

Figure 4: Polestar.com (2020) *Precept*. [Photograph]. Available at: <https://media.polestar.com/uk/en/media/photos/504279> (Accessed: 12 November 2021).

Figure 5: Polestar.com (2020) *Precept*. [Photograph]. Available at: <https://media.polestar.com/uk/en/media/photos/504283> (Accessed: 12 November 2021).

Figure 6: Caranddriver (2020) *20 Biggest Automotive Flops of the past 30 years*. [Photograph]. Available at: <https://www.caranddriver.com/features/g23827306/biggest-automotive-flops/> (Accessed: 4 December 2021).

Figure 7: Newcomb, G. (2020) *2020 Lexus UX 250h*. [Photograph]. Available at: <https://uk.pcmag.com/infotainment-systems/128443/2020-lexus-ux-250h> (Accessed: 4 December 2021).

Figure 8: Autocar.co.uk (2013) *Noble M600 review*. [Photograph]. Available at: <https://www.autocar.co.uk/car-review/noble/m600> (Accessed: 4 December 2021).

Figure 9: Tuningblog.eu (2021) *The pushrod suspension- the most important information about it!* [Photograph]. Available at: https://www.tuningblog.eu/en/categories/tipps_tuev-dekra-u-co/pushrod-suspension-345901/ (Accessed: 5 December 2021).

Figure 10: Thesketchnmonkey.com (2021) *The Problem with Car Design*. [Photograph]. Available at: <https://thesketchnmonkey.com/blogs/news/the-problem-with-car-design> (Accessed: 20 November 2021).

Figure 11: Carbodydesign (2013) *Volvo researches the emotive power of car design*. [Photograph]. Available at: <https://www.carbodydesign.com/2013/11/volvo-researches-the-emotive-power-of-car-design/> (Accessed: 3 December 2021).

Figure 12: Carbuyer.co.uk (2014) *Fiat 500 range revisited for 2014*. [Photograph]. Available at: <https://www.carbuyer.co.uk/news/141698/fiat-500-range-revised-for-2014> (Accessed: 4 December 2021).

Figure 13: Matthews, J. (2013) *McLaren P1 (Ultimate Guide)*. [Photograph]. Available at: <https://www.supercars.net/blog/mclaren-p1-ultimate-guide/> (Accessed 4 December 2021).