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Technical Report

Introduction to Automotive Engineering (ACHA4009)

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April 2022

Contents

1	Introduction	1
2	Impact of the Topics.....	2
2.1	Materials	2
2.2	Manufacturing	2
2.3	Sustainability.....	3
2.4	Aerodynamics	3
2.5	Computational Methods.....	4
2.6	Control Systems	4
2.7	Mathematics in Engineering	4
2.8	Hybrids	5
3	Current State of the Industry	6
4	Conclusion.....	7
5	References	8

1 Introduction

This report will study the varied disciplines required in the field of Automotive Engineering to design and develop the recently released Peugeot 308 Hybrid. The 308 requires an in-depth study of the development of materials and manufacturing styles, the effect of aerodynamics across the body of the car, the mathematics required, the control systems and computational resources available, propulsion options and the environmental and economical sustainability of operation. Furthermore, to the detailed study of the Peugeot, an analysis of the current road and car racing industries will be carried out to recommend any required developments needed to project an overall sustainable future.

2 Impact of the Topics

2.1 Materials

The use of materials has developed alongside the evolution of mankind. Ever since the stone age, humans have learnt how to change the characteristics of materials (K. Tudor, 2022). For a long time in 2.5M – 3000 BC humans learnt to use easily accessible materials such as wood and animal hide/bone to help with survival (K. Tudor, 2022). Then in the Bronze Age humans developed the idea of using temperature to change the use of materials to produce clay ceramics and gold (K. Tudor, 2022). Furthermore, using temperature to combine elements into a new useful material, for example combining copper and tin to produce bronze (K. Tudor, 2022). These simple experiments continued over thousands of years through the Iron Age, Middle Age, Industrial Era, all the way to the Information Age and Present Day (K. Tudor, 2022). More and more materials have been developed and discovered to provide a magnitude of different tensile, stress and strain characteristics (K. Tudor, 2022). Some key materials such as Steel, Aluminium, Magnesium, Titanium, Carbon Fibre and Plastic all require extremely in-depth machine processing showing how far the development has come and much more can be done (K. Tudor, 2022).

Across the Peugeot 308 Hybrid a large number of different types of materials have been utilised (Peugeot, 2022). When designing the 308, the balance of comfort and user experience compared to performance and sustainability needs to be precisely managed (K. Tudor, 2022). The industry analyses each component used in the car and determines which material is best suited. Potentially a more expensive or heavier/stronger material would be used because the characteristic of the material provides more positive safety aspects than the minor decrease in car performance. (K. Tudor)

2.2 Manufacturing

There are a wide range of material manufacturing techniques to change the properties of raw materials to be better suited for its responsibility as well as allowing different production options for engineers (K. Tudor). The use of heat, compression, electricity, or drilling can be used to cut, layer, and shape the material for different price points as well as different quality and wastage levels (K. Tudor). Peugeot and manufactures will produce a large number of cars in its factories so the use of a developed Henry Ford's original assembly line would increase production speed as well as lowering production costs (K. Tudor). Further along the assembly line, once the material has been manufactured into shape, the vehicle body travels into the paint shop where it is cleaned and prepped, sprayed with several layers of Anti Corrosion Chemicals, Paint Primer, and Paint, before finally being dried, inspected and waxed (K. Tudor). This process is completely automated meaning Peugeot can have the process running 24/7 without having to worry about employees or any human errors (K. Tudor). Manufactures use different final assembly techniques to achieve the complete result. Tesla uses a largely automated system with limited human input, Harley Davidson and Morgan use a more retro technique of quality hands on workers, while Ferrari uses a completely unique, consumer personalised experience in which every car is hand crafted to the customers specifications (K. Tudor).

2.3 Sustainability

The European Union first came together in 1982 to set up a mandatory emissions regulation (A. Summerfield, 2022). The first cap of emissions lasted for 10 years before being regulated further in 1992 (Euro 1) to almost 10% of what was previously allowed. Euro 1 restricted tail pipe emissions to 2.72 CO₂ grams per km travelled (A. Summerfield, 2022). Further agreements across the E.U to impose emission restrictions continued to drive down the CO₂ limit to just 1.0 g/km in 2014 (Euro 6) (A. Summerfield, 2022). Additionally, to the development of improving engine ecoefficiency, industries and regulators discovered the harmful effects of Hydrocarbons, Nitrous Oxide and Particulate Matter, emission regulations for all were introduced in the year 2000, at regulation set Euro 3. These also received further restrictions throughout the following set of regulations (A. Summerfield, 2022). Unfortunately, as manufactures and cars developed and became heavier and more powerful, these regulation tests become less realistic to the present driving environment. Also due to the tests set run plan, manufactures found ways of purposely defying the tests and falsifying results. Although the car would suffice the required restrictions, in the real-world cars were found to be producing up to 40 times more pollution (A. Summerfield, 2022). Due to the NEDC tests ultimately failing, governments and world leaders agreed to use a new regulatory system, the World Harmonised Light Vehicles Test Procedure (WLTP) (A. Summerfield, 2022). The WLTP is 150% longer than the NEDC, it covers higher average speeds, more drastic accelerations and decelerations and many other points to provide a test for a wider variety of driving conditions, as well as providing a test with unpredictability, eliminating the opportunity for manufactures to 'cycle beat' the test (A. Summerfield, 2022).

Just as any other vehicle the Peugeot also had to undertake the same WLTP emissions test. With the latest regulation of CO₂ emissions being 80g/km, the 308 completed the WLTP Test using both the petrol engine and the electrical battery powered motor to measure at only 25g/km (Peugeot, 2022).

2.4 Aerodynamics

When designing cars, the shape and bodywork is determined by a balance between the theory of aerodynamics and comfort/aesthetics (T. Tudor, 2022). Bernoulli's principle can be used to determine how the velocity of air across the car's surface can increase or decrease the pressure applied (T. Tudor, 2022). The different air pressures can produce drag, lift or downforce. Drag is a negative product of increasing the cars speed, however, can be reduced and converted into a positive impact based on the shape of the bodywork (T. Tudor, 2022). Usually, the importance of using aerodynamics to increase downforce and grip for the tyres is a large focus in improving performance of race cars, meanwhile, aerodynamics is important for road cars such as the Peugeot because too much opposing drag force will reduce the efficiency of the engine/motor (T. Tudor, 2022). Additionally having too much lift across the car could provide issues with steering and stability, which in turn would be unsafe for the occupiers at higher speeds (T. Tudor, 2022). Any form of manufacture of vehicles, including race and road cars would use computers and simulations to predict and plan what affects the air will have across the vehicle in different environments and different air velocities, this is known as CFD. This is a cost effective and quicker process to help with adjusting the vehicles design (T. Tudor, 2022).

2.5 Computational Methods

With modern vehicles becoming more and more complex, different components are supplied to manufactures by smaller suppliers (A. Noble, 2022). When designing or developing a car, manufactures will use computational methods to virtually create a change or part, then test the affects in a virtual environment (A. Noble, 2022). The use of Computer Aided Design (CAD), Computer Aided Engineering (CAE) and Computer Aided Manufacturing (CAM) allows for rapid testing and development without having to use physical resource producing prototype parts (A. Noble, 2022). Each piece of software provides the opportunity to simulate each aspect of production. CAD provides the facility to design, assemble, and optimise components. CAE allows for detailed analysis of stresses and strains as well as fluid flows and the interaction of components. Finally, CAM simulates the environment in which the production process can be planned, controlled, and refined for limited material wastage (A. Noble, 2022). Using these software's to design the 308 Hybrid would allow for Peugeot to accurately predict the assembly, quality, and safety of the car before any production starts, this reduces the chances of amendments or corrections, as well as reducing the chance of recall or failure (A. Noble, 2022). Any sort of common failure could cost Peugeot a lot of money in potential sales. Computational methods also don't just focus on the car development but also a lot of race teams use simulators for drivers to practice/prepare as well as to simulate race strategies (A. Noble, 2022).

2.6 Control Systems

The ever-increasing demand for the latest technology forces manufactures to continually develop their latest road car. More recently the vision of autonomous cars has become more and more possible with the accessibility to cars with automated systems for lights, wipers, gearboxes and more recently cruise control and lane assist (A. Gibson, 2022). Some manufactures have managed to release vehicles which have active driver assists with even some cars being fully autonomous (A. Gibson, 2022). The Peugeot Hybrid 308 has a large number of electronic control systems ranging from Automatic Gearbox with Auto-Lights and Wipers to Lane Positioning Assist and Adaptive Cruise Control with Stop&Go feature (Peugeot, 2022). The variety of technological features improves car efficiency as well as driveability, comfort, and safety (A. Gibson, 2022).

2.7 Mathematics in Engineering

Sensors are fitted all over different aspects of cars to record and identify any changes (R.Sutton, 2022). Some changes are good, and some changes are bad, the rate of change for example in the compression of suspension needs to be monitored at all times so that engineers can identify what adjustments need to be made to the dampening (R.Sutton, 2022). Calculus is the analysis of change and using derivatives to create and evaluate functions (R.Sutton, 2022). The manufactures must use these functions and equations to determine the required damping affect for the suspension springs. Having different damping levels can affect how the spring oscillates after a compression (R.Sutton, 2022). Completing these calculus functions correctly will help in perfecting performance. Peugeot must run simulations and tests to accurately set up the ride suspension of the 308 to provide a balance of comfort and performance (R.Sutton, 2022).

2.8 Hybrids

The history and evolution of propelling a person from A-B has been forever developing (M. Sandford, 2022). In the 1800's people would use horses and carriages. Unfortunately, horses require a large amount of maintenance as they are living animals (M. Sandford, 2022). The first idea of replacing the horse with an alternative power source came in 1888 (M. Sandford, 2022). As more and more inventors and scientists worked on developing the electric power supply, the internal combustion engine (ICE) became the better option at storing more Joules of power in a smaller space (M. Sandford, 2022). In 1908, the model T made transitioning to a horseless motor affordable for the majority with the power being supplied by an ICE (M. Sandford, 2022). Over the next 100 years the development and evolution of the engine continued with some still analysing and researching the possibility of electric powered vehicles (M. Sandford, 2022). The elite world of Formula 1 needed to remain the pinnacle and future of cars and racing, so predicated the use of hybrid electric and engine powered cars, introducing the option of a hybrid battery powered boost that would recharge under the extreme braking forces (M. Sandford, 2022). The ICE wastes up to 70% of energy with noise, heat, and vibration, as well as emitting toxic gasses (M. Sandford, 2022). The electric motors and batteries are massively being developed by manufactures to try and keep up or get ahead of the competition (M. Sandford, 2022). The Peugeot 308 Hybrid provides consumers with the opportunity of traveling on either hybrid or even full electric for up to 37 miles (Peugeot, 2022). This is a major feature that, due to political and social pressures, the current market is now looking for (M. Sandford, 2022).

3 Current State of the Industry

As consumers, political leaders and health organisations increase pressure for the automotive industry to supply more environmentally greener options. The industry of car production must change supply and manufacturing techniques to increase safety, efficiency and provide any additional features to compete with competitors, while still being able to reduce costs and meet the environmental demands.

4 Conclusion

The Peugeot 308 Hybrid is a modern-day family road car with a huge number of features providing a premium quality, comfortable, safe, and efficient car. For racing, a lot of Peugeot's investment into features would be removed as they are not necessary. Yet the car is a very good base of a race car for its category, the hybrid option increases acceleration and lap time performance, the stable aerodynamics and suspension provide an easier experience for the driver to push the limit, as well as the sustainability of producing and running the car would comply with a majority of racing regulation series.

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