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Triumph Street Triple

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Introduction To Automotive Engineering ACHA4009

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1 - Introduction

The Triumph Street Triple Range has been a staple in the world of motorcycles since its debut in 2007. With its sleek design, powerful engine, and impressive performance capabilities, this bike has captured the attention of riders and enthusiasts alike. Since its introduction, the Street Triple has undergone numerous advancements and upgrades, cementing its position as one of the most sought-after bikes in its class. In this report we will examine the impact of various topics discussed in lectures over the term and apply them to the development of the Street Triple Range. Specifically, we will explore how advancements in technology and design, as well as environmental challenges faced by Triumph, have influenced the evolution of this iconic motorcycle. Additionally, we will investigate the Street Triple's use in its own racing series and discuss how the engine is being used in Moto 2, demonstrating its versatility and adaptability. Through this analysis, I hope to provide a comprehensive understanding of the Street Triple's success and enduring popularity in the motorcycle industry.

2 - Impact of topics

2.1 - Manufacturing Processes Cast vs Forging

(Triumph Motorcycles, 2023) Advertise that they cast many of their main components used on the Street Triple model such as cast alloy wheels, a cast aluminium alloy swingarm and a two-piece high pressure die cast rear subframe.

(Casting vs. extrusion vs. forging 2022) suggests that some benefits to casting is that it's able to provide light, complex, thin wall thickness designs that require less machining than alternative methods and have the ability to insert sand cores or voids to give hollow sections. Modifying the mould for part design is also quick and less costly than other processes.

(United Global Sourcing, 2018) suggests that casting is generally more porous than forged parts and is more common to have unintentional voids, casted items cannot withstand the same pressure of impact or frequency as forged parts can, and maintaining a high quality of part requires more monitoring and interaction from the operator. Particularly with die casting, tooling is generally more expensive than forging.

I believe Triumph could improve its wheels by forging them in the manufacturing process, (United Global Sourcing, 2018) implies that forging alters the grain structure of the material to provide superior structural integrity and increased mechanical strength, forging involves less labour and a reduction in wasted scrap material, pores, cavities and voids are eliminated whilst providing increased consistency in reliability, ductility, strength and known yields.

Triumph would be able to produce a stronger wheel with less weight if they opted for the forging process rather than casting.

(Drop forging 2022) show that the grain flow on a forged part has directional alignment throughout deliberately oriented for maximum strength shown in Figure 1.

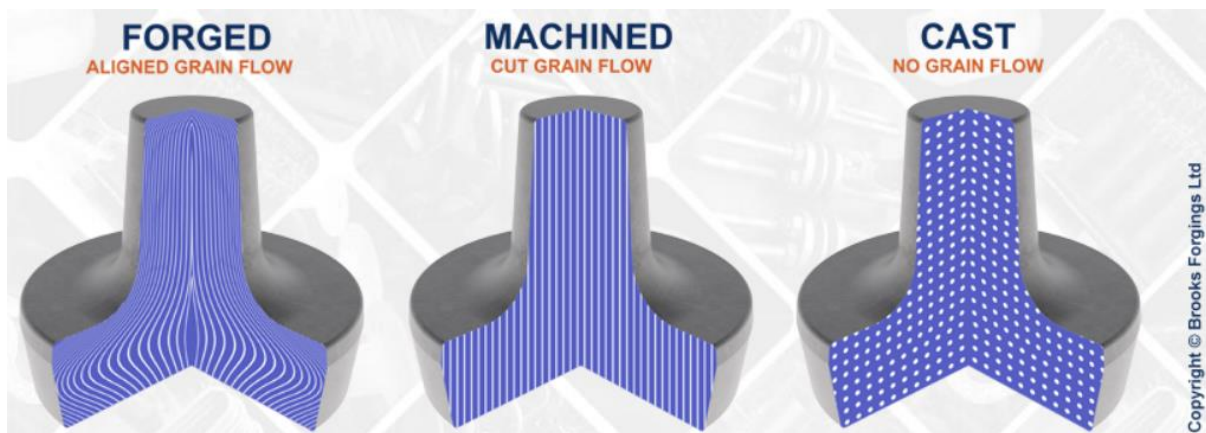


Figure 1 grain structure (Drop forging 2023)

2.2 - Emissions

Starting from January 1st, 2021, the motorcycling industry in the UK was obliged to comply with stricter environmental regulations, requiring all newly sold motorcycles to meet the Euro 5 emission standards. This regulatory shift reflects the increasing pressure to reduce air pollution and promote sustainable practices across industries.

(Honda Motorcycles UK, 2021) imply that in the euro 5 legislation there are 4 different exhaust emissions covered, and their requirements are as follows, 1000mg/km of carbon monoxide, 100mg/km of hydrocarbons, 60mg/kg of nitrogen oxide and the latest additional requirement, 68mg/km of non-methane hydrocarbons.

How did this affect Triumph? (Armitage, 2023) suggests that the 2020 model Triumph Street Triple engine became Euro 5 compliant by utilising two catalytic converters in the exhaust system.

The addition of secondary air injection has been utilised shown in Figure 2, (Triumph Motorcycles UK, 2020) this system has the intent to promote further combustion in the exhaust system after the spent combustion gasses have exited the combustion chamber, this will reduce the possibility of any remaining pollutants such as hydrocarbons in the exhaust gases exiting the system.

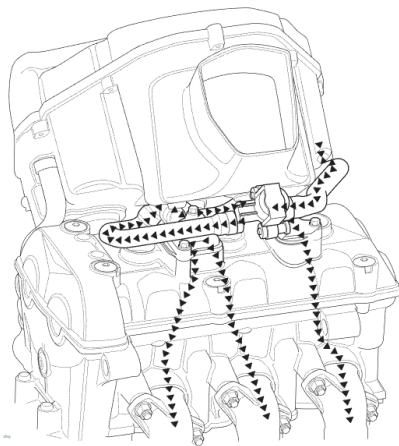


Figure 2- Street Triple, Secondary Air Injection (Triumph Motorcycles UK, 2020)

(Triumph Motorcycles UK, 2020) indicate the introduction of an evaporative canister shown in Figure 3, The purpose of this canister is to control the evaporation of fuel vapour into the atmosphere. When the engine is stationary, any change in ambient temperature will cause fuel vapour to pass down a breather hose into a carbon filled canister, the vapour is stored until engine operation resumes, which can then be released under its own vacuum via an ecu controlled purge valve under certain conditions.

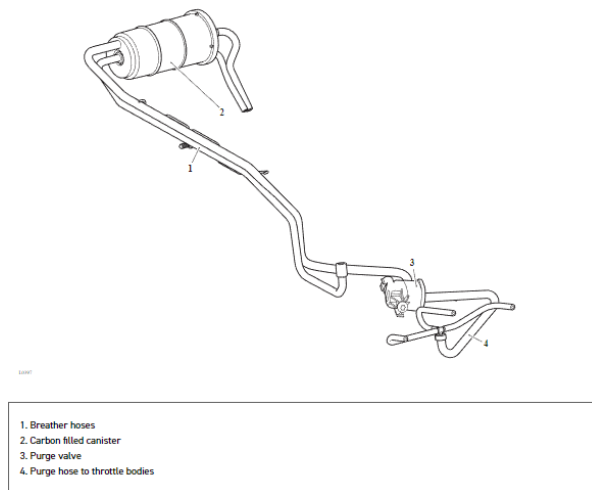


Figure 3 - Evaporative Canister (Triumph Motorcycles UK, 2020)

2.3 - Powertrain

When selecting a powertrain for a new motorcycle, manufacturers must carefully consider several factors to ensure that the final product meets the intended requirements and appeals to the target audience. Among these considerations are the performance levels required, the fuel efficiency and emissions standards to be met, the overall cost of production, the vibration characteristics of the engine, and the brand identity.

Triumph Motorcycles has achieved significant success with their decision to employ the inline 3-cylinder engine configuration across multiple models in their line-up, ranging from adventure bikes to high-performance offerings like the Rocket 3, as well as in the competitive short circuit racing class of Moto 2. This engine configuration has proven to be a versatile and effective choice for Triumph, providing both exceptional performance and unique power delivery.

One of the key advantages of the inline triple engine is its balance between the smoothness of a four-cylinder engine and the responsiveness of a twin-cylinder engine. This is achieved through the engine's unique firing order, which produces a distinctive sound and power delivery that is highly sought after by motorcycle enthusiasts. Additionally, the engine's compact size and light weight contribute to the motorcycle's overall agility and handling, making it an ideal choice for the street triple platform.



Figure 4 - inline 3-cylinder street triple engine (Staff, 2018)

2.4 - Aerodynamics

Motorcycles are not very aerodynamic and produce a lot of drag, with the rider constantly exposed to the elements and being sat on top of the chassis rather than inside the chassis like a car, it's easy to start visualising where drag will occur, very few surfaces on the street triple are continuous or smooth, and with the rider being directly above the engine heat dissipation for rider comfort on motorcycles can be problematic.

The street triple is an upright and relaxed style bike with minimal fairing, this presents not just the motorcycles drag, but also the drag of the rider's body being exposed, (Bradley, 2003) suggests that the clothing a rider is wearing can have up to a 15% increase in drag on wind tunnel tests.

Puig published a CFD flow simulation on the rider for the current 2020 – present street triple model, this model shows the standard front fairing and how this affects the rider compared to having a screen installed shown in Figure 5. (Puig, 2022) implies that against the standard model, a 25% aerodynamic improvement will be made with this screen, and 2.96 kilograms of force will also be reduced from the torso of the rider shown in Figure 6.

Although Triumph could have improved rider comfort by adding a screen or fairing, they made a deliberate decision to produce a motorcycle tailored to the naked market with the Street Triple consumer in mind.



Figure 5 - CFD Flow simulation, screen installed (Puig, 2022)

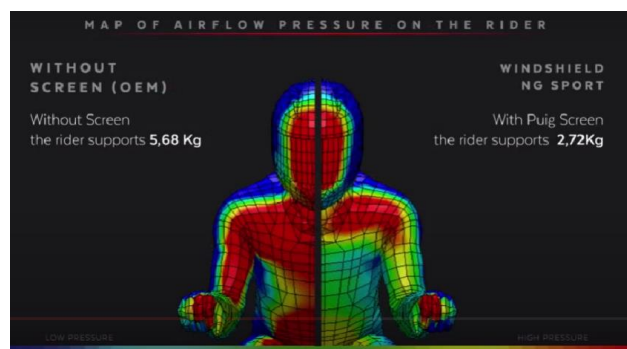


Figure 6 - 2.96kg force removed from rider (Puig, 2022)

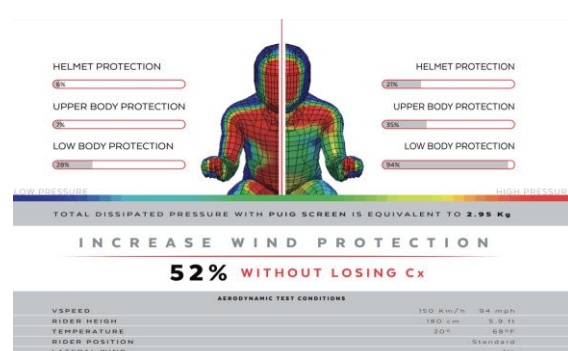


Figure 7 - 52% Wind protection (Puig, 2022)

2.5 - Data Analysis

The Triumph Street Triple started in 2007 with no electronic aids, (Triumph Motorcycles, 2023) suggests that the latest model has optimised lean sensitive traction control and anti-lock braking to always give optimum performance.

By using electronic sensors such as front and rear wheel speed, lean angle, twist grip position and throttle position, Triumph can gather data on how the rider is using the throttle and how the bike is responding.

It is then possible to view this data using various software packages such as Motec i2 Pro, (Harrison, UWTSD, 2023) Supplied this data from a test day in Cartagena, using the data file, the relevant channels can be selected and studied.

As can be seen from Figure 6, the rear wheel is rotating 17.7Km/h faster than the front wheel, the throttle grip input from the rider is 100% and the throttle bodies are open 100%. This may be okay on a racetrack but on the road, this would be an area that Triumph could refine by reducing the amount the throttle bodies are open until the wheelspin is reduced to keep optimum traction, this would enhance the overall safety and riding experience.



Figure 6 - Wheel Speed F&R, Slip, Tps, Throttle Grip (Harrison, UWTSD, 2023)

2.6 - Damper Systems

Dampers are used throughout the automotive industry and control the oscillatory movement within a system, referring to Figure 7 (Trevitt, 2008) suggests that spring constant = K , the distance = X and the damping value = C .

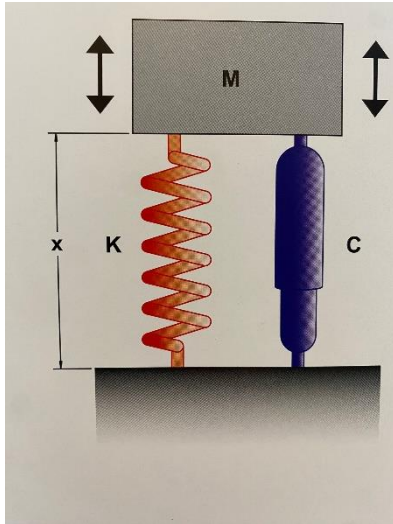


Figure 7 - Damper System (Trevitt, 2008)

According to Sutton (2023), there are three primary types of damper behaviour, overdamped, critically damped, and underdamped. Overdamped systems return to rest slowly, while underdamped systems oscillate and overshoot the rest position multiple times before settling. Critically damped systems provide the best balance, returning to rest quickly without overshooting the position.

To ensure good vehicle stability, balance, and tire contact patch, damping must return to rest position promptly. Therefore, the automotive industry strives for a balance between underdamped and critically damped systems. Employing calculus, Triumph can calculate the damping value, which depends on the force-to-velocity ratio, which has been used to develop and enhance their suspension systems across all their models.

3 - Current state of the industry

Moving forward the motorcycle industry is going to need to overcome its own environmental impact, this being from the internal combustion engine's emissions, as concerns about climate change and air pollution grow, there is an increasing pressure on the industry to transition to a more sustainable and eco-friendly future.

(European Commission, 2022) suggest the aim and deadline is to have a climate-neutral economy by 2050, (Transport, 2023) released that all new cars, vans and L-category vehicles sold by 2035 will have to comply with 0 emissions at the tailpipe shown in Figure 8.

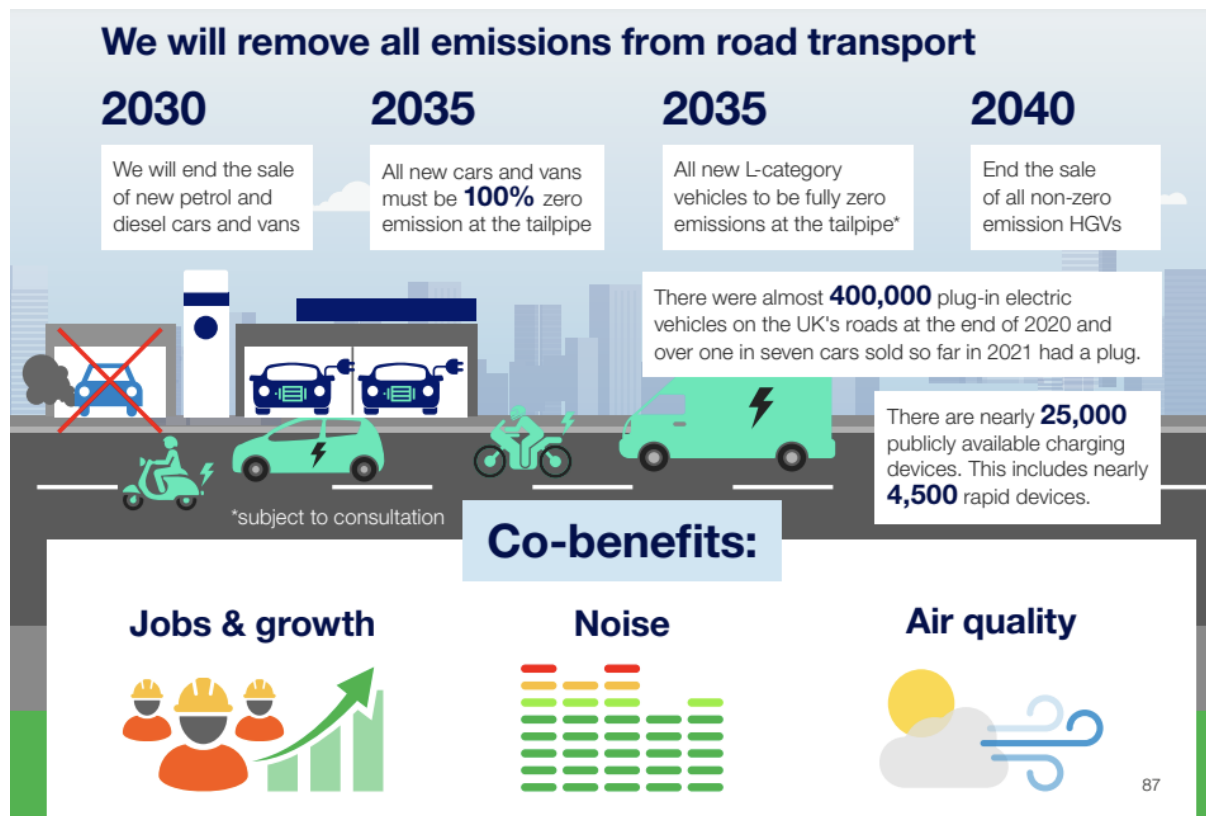


Figure 8 - Deadlines in place for 0 emissions (Transport, 2023)

(The Motorcycle Industry Association Limited, 2023) suggest that currently the motorcycle market is dominated by Internal Combustion Engines, Figure 9 shows 5,563 vehicles sold that use ICE as their powerplant in the month of January 2023, when comparing that to the 201 electric vehicles that sold in the same month. It's clear to see that the motorcycle industry has not and is not ready to convert to electric just yet.

Figure 9 - Sales Figures Jan 2023 vs 2022 (The Motorcycle Industry Association Limited, 2023)

POWERTRAIN	Jan 2023 MTH	Jan 2022 MTH	% Change
ICE	5,563	5,691	-2.2%
ELECTRIC	201	496	-59.5%
TOTAL REGISTRATIONS	5,764	6,187	-6.8%

When the Street triple was first launched the cost of this bike was £5349, the bike was very basic with no riding aids and no additional electronics or features, the latest street triple is £10,995. The demand over the years for more rider safety, technology and comfort has seen prices rise dramatically, Heated seats, heated grips, adaptive cruise control, blind spot detection and electronic suspension are just to name a few causing the costs of modern motorcycles to spiral out of control.

4 - Conclusion

In conclusion, it's clear to see that the triumph street triple has been evolving and adapting to new regulations, environmental pressure and consumer preferences since its launch in 2007 and has had a significant impact on the motorcycle industry, setting a new standard for the naked bike category with its versatility appealing to a broad range of riders from seasoned enthusiasts to newcomers.

Triumphs dedication to innovation and providing riders with the best possible experience on the road has cemented them as a leading contender in the highly competitive motorcycle market.

As the industry continues to evolve, it will be exciting to see how Triumph and the Street Triple continue to push the boundaries of what is possible in motorcycle design and performance.

References

- Armitage, M.N.& M. (2023) *Triumph Street Triple 765 RS (2020 - 2022) review*, MCN. Bauer Media. Available at: <https://www.motorcyclenews.com/bike-reviews/triumph/street-triple-765-rs/2020/> (Accessed: March 27, 2023).
- Bradley, J. (2003) *The racing motorcycle: A technical guide for constructors*. York: Broadland Leisure Publ.
- Casting vs. extrusion vs. forging (2022) *Casting Metal | Metal Extrusions | Manufacturing Metal Parts*. Available at: <https://www.deecometals.com/casting-vs-extrusion-vs-forging> (Accessed: March 26, 2023).
- Drop forging (2022) *Drop Forging - The UK's Leading Drop Forging Manufacturer | Brooks Forgings*. Available at: <https://brooksforgings.co.uk/processes/drop-forging> (Accessed: March 27, 2023).
- European Commission (2022) 2050 targets, European Commission. Available at: https://commission.europa.eu/energy-climate-change-environment/overall-targets-and-reporting/2050-targets_en (Accessed: March 28, 2023).
- Harrison, A. (2023, March 23) Introduction to Automotive Engineering [Lecture] ACHA4009, Data Analysis, University of Wales: Trinity Saint David.
- Honda Motorcycles UK (2021) *What euro 5 means for UK motorcycles: Honda engine room, What Euro 5 Means for UK Motorcycles | Honda Engine Room*. Available at: <https://www.honda.co.uk/engineerroom/bikes/what-euro5-means-for-uk-motorcycles/> (Accessed: March 27, 2023).
- Sutton, R. (2023, March 31). Introduction to Automotive Engineering [Lecture] ACHA4009, Applying Calculus to Automotive Systems, University of Wales: Trinity Saint David.
- Staff, R.A. (2018) *New triumph moto2 engine tested in Aragon*, RideApart.com. Available at: <https://www.rideapart.com/news/252687/new-triumph-moto2-engine-tested-in-aragon/> (Accessed: April 19, 2023).
- Transport, D.for (2023) Transport decarbonisation plan, GOV.UK. GOV.UK. Available at: <https://www.gov.uk/government/publications/transport-decarbonisation-plan> (Accessed: March 28, 2023).
- Trevitt, A. (2008) “Chapter 3 Basic Principles and Theory,” in Sportbike suspension tuning: How to improve your motorcycle's handling and performance. Phoenix, AZ: David Bull, pp. 25–28.
- The Motorcycle Industry Association Limited (2023) *Press statistics: MCIA, Motorcycle Industry Association*. Available at: <https://www.mcia.co.uk/press-statistics> (Accessed: March 28, 2023).

Triumph Motorcycles (2023) *Street triple specification*, *Triumph Motorcycles*. Available at: <https://www.triumphmotorcycles.co.uk/motorcycles/roadsters/street-triple/specification> (Accessed: March 23, 2023).

Triumph Motorcycles (2023) *Technology*, *Triumph Motorcycles*. Available at: <https://www.triumphmotorcycles.co.uk/motorcycles/roadsters/street-triple-765/reasons-to-ride-street-triple-765/technology> (Accessed: March 26, 2023).

Triumph Motorcycles UK (2020) *Street Triple 765 RS Service Manual*, Triumph Technical Information. Available at: <https://triumphtechnicalinformation.com/document/6335721d61e05920b5d895dd/1538335499-23> (Accessed: March 27, 2023).

United Global Sourcing (2018) *The Pros and cons of casting vs. forging*, *United Global Sourcing*. United Global Sourcing. Available at: <https://www.unitedgs.com/blog/outsourcing-manufacturing/the-pros-and-cons-of-casting-vs-forging/#:~:text=The%20Cons%20of%20Casting&text=Casted%20parts%20aren't%20as,prevent%20defects%20and%20maintain%20quality>. (Accessed: March 26, 2023).

Windshield new generation sport for motorcycle triumph street triple 675 R 2020 (2022) *Puig Hi-Tech Parts*. Available at: <https://puig.tv/en/tuning-motos/windshields-specific-for-non-round-headlights/new-generation-sport?bike=27470> (Accessed: March 24, 2023).