



University of Wales Trinity Saint David
Wales Institute of Science and Art

Introduction to Automotive engineering
GA36a

Jake Davies

2205290

04/2023

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Introduction

My vehicle of choice is the Yamaha R1M, the reason I chose this bike as it is the first generation of advancement above the stock R1 which I think is impressive, it also comes with lots of upgrades and cool features that make it a clear improvement from the R1. The aim of the project is to show how a select few topics affected the R1M in production and when it is out for sale. The topics of choice will be aerodynamics, Materials, Sustainability, Crash testing, Computer aided design, and innovation. The second aim is to give a understanding on the current state of the motorcycle industry and show that it is a growing market at quite a fast rate but also showing the struggles that the companies have to keep improving there machines and work structures.

Impact of the topics

Topic 1: Aerodynamics

The drag reduction on the R1M is impressive as they built a streamlined body kit for the bike that will help the motorcycle glide through the air instead of it being block like structure, this will help increase the bikes top speed and acceleration. Downforce is the force that pushes the bike down towards the ground, the R1M is vastly equipped with features to increase downforce such as winglets, front air ducts and a tail cowl. All these features help the bike out with traction and stability especially when cornering or breaking and when the rider is accelerating more aggressively. Cooling is a big aspect of aerodynamics as these bikes generate a lot of heat as they have a powerful engine so the aerodynamic features such as air ducts and cooling vents help the bike take in cold air and stop the bike from overheating. The placement of these features is key as they will need to be in a place that will give direction straight to the engine, the brakes, and the tires to stop them all from overheating as efficiently as possible. Stability is a big factor for having a smooth riding motorcycle so having the air flow over the bike be consistent and smooth it will reduce turbulence and shakiness of the bike overall.

Topic 2: Materials

The R1M is made up from a lot of carbon fibre as it is a very lightweight material but also very durable the areas it has carbon fibre are the fairing, front fender and the rear seat cowl this will save a lot of weight whereas some other bikes consist of heavier weaker materials such as plastics. Carbon fibre also increases aerodynamic efficiency as it is difficult to bend and move so it holds its position when going at higher speeds. Cast Aluminium is used to make the chassis and swingarm, which provides a high rigidity and a high torsional stiffness this will help the manufactures increase handling and stability at high speeds and harsh breaking zones whilst also keeping the weight as low as possible. The exhaust is made of titanium as it helps to reduce the weight and produces a distinct sound and increases the overall performance. The engine is made up from high strength steel as it has a high melting point so it can withstand the harsh temperatures inside the engine giving the bike good durability, but it also produces stiffness which is wanted in a high-performance motorcycle.

Topic 3: Sustainability

Yamaha take environmental sustainability very seriously taking it all the way back to the factory of manufacturing where they use a biomass boiler that burns woodchips to heat up the factory rather than using the tradition fossil fuels. Relating more to the motorcycle itself the Yamaha R1M has high tech fuel injection systems which constantly adjust and optimize fuel flow rates to achieve the most optimal performance and emissions output. The bike also has a eco-friendly mode which reduces the engine output to conserve fuel and lower emissions for when the rider is doing city riding as it tends to be more stop start which is worse for the environment so the eco-friendly setting is good for this aspect. Yamaha as a company also insist that that their riders recycle old and other products to reduce waste and they can also make new parts through this recycling system. With the R1M using very lightweight materials it not only increases performance, but it also costs less energy to produce and transport and contribute to a better fuel economy. The Yamaha factory has very strict waste management to minimise the effects on the environment. The bike uses aluminium and titanium which is known for being more environmentally friendly than others such as steel and plastic.

Topic 4: Crash Testing

The Bike must be testing crashed lots of times to make sure it reaches safety regulations that are set, and it also is a piece of verification that the bike is durable for on the road and on the track riding. There is a series of tests that this consists of. Impact testing is where they will crash the motorcycle into a stationary object at different angles and speeds to simulate a real-world crash. The second part is dynamic testing where there is a dummy rider on the bike and the safety features are tested. Stability testing will be run in different conditions such as dry and wet, fast, and slow. Crash simulation is run via software used to replicate how the motorcycle rider and the bike would behave based on different scenarios and events.

Topic 5: Computer Aided Design

CAD was used extensively in the design phase of the R1M as it gives them a powerful tool to create, modify and analyse the design in a virtual environment. This helps as it reduces waste as you can build the virtual model before building the physical model. This also allows a lot more freedom with design as you are not using any physical models so you can try different configurations, components, and materials until you find what works best.

The use of CAD technology also allowed the Yamaha engineers to simulate various riding and environmental scenarios and evaluate the performance of the R1M components, such as the suspension, brakes, and engine. They could also analyse the aerodynamic properties of the bike which is crucial considering it can reach speeds over 180mph. overall Cad is a very useful tool when it comes to designing a new vehicle as you can save lots of time and money with trial and errors in a virtual scenario rather than physical ones.

Topic 6: Innovation

Carbon Fibre Bodywork: The R1M features lightweight carbon fibre bodywork like the material used in Formula 1 cars. The use of this material in motorcycle design is a significant innovation as it provides higher strength, rigidity and allows for complex shapes to be formed, leading to improved aerodynamics, handling, and balance.

Electronic Suspension System: The R1M is equipped with an advanced electronically controlled suspension system - the Yamaha Electronic Racing Suspension (ERS). It adjusts the damping and spring rate settings up to 1000 times per second, leading to improved handling, stability, and rider comfort.

Advanced Riding Assistance Systems: The R1M also incorporates several advanced riding assistance systems. For instance, it has a quick-shift system that provides seamless up and downshifts without the need for the clutch lever. The motorcycle also comes with a sophisticated traction control system that can detect slippage levels and adjust power delivery to maintain traction.

Cross plane Inline-Four Engine: The R1M utilizes an innovative cross plane inline-four engine that provides exceptional power output, torque, and throttle response. The engine is designed to mimic the firing sequence of a V4 engine, leading to reduced rear-wheel slip and providing smoother acceleration.

Aerodynamics: The R1M features a cutting-edge aerodynamic design with the fairing, windshield, and tail section designed to provide maximum airflow efficiency. The aerodynamic innovations reduce overall air resistance, leading to higher top speeds and improved handling performance.

Current State of The Industry

The use of motorcycles has had a noticeable rise in the UK as it has gone up by 5% from 2019-2021. This growth can be assisted by covid-19 as friends could go out on rides together and still be socially distanced. The sales of motorcycles did not reinforce these statistics as sales dropped in the second quarter of 2020 during the first lockdown but then they rebounded at a quarterly expenditure just below 200million pounds. Scooters were the leading type of motorcycle in 2021 as they are ultra-low emissions this bracket was closely followed by naked bikes and the most common engine size was 51cc-125cc. there were 40700 units sold between January and December in 2021 of this engine size. The least popular motorcycle was the 0-50cc class with only 10400 units being sold in that year. Honda were the most successful company with a sale peak of 19.1k in 2021 and in second place was Yamaha with much less at 12.9k. the bikes with lower emissions such as scooters and naked bikes had a combined sales peak of 50.6k in the UK alone. The motorcycle market size was valued at 105.52billion USD in 2021 and is projected to reach 233.51 billion in 2031. It is also becoming increasingly harder to improve motorcycles with the constantly updating emissions regulations as seen in some companies such as Suzuki where they haven't made a new GSXR 1000 since 2016 because for them it stopped being profitable to keep making bikes as they couldn't reach the new regulations.

Conclusion

In conclusion, aerodynamics is a big part for making a high-performance motorbike as it needs to glide through the air and be stable under acceleration and braking. Innovation plays a big roll within making all new vehicles as you constantly need to find new solutions to problems and improvements to old technology. Crash testing is a must do test as it proves that the vehicle is safe enough to be sold to the public and if they want to take their bike to the race track it must be able to withstand the increased forces put through it when it is being rode at much higher speeds and intensities. CAD is a huge part of modern engineering as it is a much more environmentally friendly way of testing ideas and concepts as you do not need to waste materials and must power big machinery to make those items as it can all be done in virtual software. Materials used in making a vehicle will decide what performance level the vehicle is intended to be as some are more lightweight than others, also with new regulations companies need to find more environmentally friendly ways of producing these materials and producing less greenhouse gasses.

References

cycles, T. text provides general information S. assumes no liability for the information given being complete or correct D. to varying update and Text, S.C.D.M. up-to-Date D.T.R. in the (n.d.). *Topic: Motorcycle industry in the United Kingdom*. [online] Statista. Available at: <https://www.statista.com/topics/5221/motorcycle-industry-in-the-united-kingdom/#editorsPicks> [Accessed 23 Apr. 2023].

Allied Market Research. (n.d.). *Motorcycle Market Share, Size, Trends, Analysis, Sales, Value*. [online] Available at: <https://www.alliedmarketresearch.com/motorcycle-market-A31857>.

Davies, P. (2021). *Everything We Know About The 2021 Yamaha YZF-R1M*. [online] HotCars. Available at: <https://www.hotcars.com/everything-we-know-about-the-2021-yamaha-yzfr1m/> [Accessed 23 Apr. 2023].

www.dekra.com. (n.d.). *Crash Testing / DEKRA*. [online] Available at: <https://www.dekra.com/en/crash-testing/>.

English, T. (2020). *How CAD has Transformed the Engineering Design Process*. [online] interestingengineering.com. Available at: <https://interestingengineering.com/innovation/how-cad-has-transformed-the-engineering-design-process>.

