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Technical Report on the Volkswagen Golf

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1. Introduction

The Volkswagen Golf started production in March 1974 with the mk1. It continued to make its petrol and diesel versions until Volkswagen released it would be ending production of the Golf with the mk8 petrol and diesel models. Production will be running until 2027-2028. However, full electric versions of the Golf are still being produced with no intention to stop production. With nearly 50 years of the Golf being produced with many engine developments, styling changes, and safety regulations, it has been difficult for Volkswagen to keep up with supply and demand. Being a massive icon of British roads, it is sure to be a car known within every household across the county.

1.1 Aims

This report will aim to understand why the Volkswagen Golf was so popular and has been for a long time and how the topics below have impacted Volkswagen Golf over its production period.

2. Impact of the topics

2.1 Materials and manufacturing

The start of the production of the Golf offered very different options compared to the choice there is today. This comes down to the tooling and materials that were around at the production time when the Golf was first released in 1974. For example, a boot spoiler was an optional extra for the mk1 GTI Golf. This was made from very high-density foam, but when ordering a Golf from a showroom in the 21st century, optional extras such as a carbon fibre spoiler are now offered. As times have advanced, engineers have created more materials that are stronger and lighter weight making them more appealing for cars of the modern era.

A common material used in many cars, not just Golfs, is leather. Leather is usually used for seats, door cards, and armrests. Although leather is an excellent material for making upholstery, it is starting to get phased out because of its environmental impact. Some examples are water pollution caused by dying it and the non-ethical way cows have been treated to produce it. This is why Volkswagen has come up with their “vegan apple leather...a sustainable leather alternative that is partly made from apple-juice waste such as the cores and skin from the fruit” (Living, 2023). This would not have been used or even thought about in the early generations of Golfs, which is one of the many ways Volkswagen are keeping up with current trends.

2.2 Car testing and safety

Golfs have developed tremendously over the last 30 years with safety features. The first golf did not have a single airbag until 1994 when, “Frontal airbags for both the driver and passenger were introduced as options” (safety, 2023) in the car compared to the mk8 golf, which has eight airbags as standard. As safety regulations changed as times moved on, cars had to start to comply with much stricter regulations. The Golf inherently got quicker with more significant engines and faster 0-60 times, meaning they had to stop quicker, and if they couldn’t stop they would have to be able to protect the passengers as much as possible from impact. Figure 1 shows the mk2 Golf crash test done in 1997 which was awarded a score of M (Marginal), compared to Figure 2 which is the mk7 Golf, “the new Golf was awarded the maximum five stars following the crash tests” (Oagana, 2019). You can see in Figure 1 how the impact from the front has caused the car to crumple up to the front of the rear doors, causing significant disruption to the interior cab of the car. Whereas in Figure 2 the impact is absorbed completely into the front engine bay of the car causing little to no disruption to the front cab of the car. Also, in Figure 2, there is the use of side curtain airbags “Curtain airbags – deploy from the roof or headliner above the doors and windows to protect people’s heads” (RAC, 2021) compared to Figure 1, which have the use of passenger airbags and drivers airbags that were an optional extra on the build of the car.



Figure 1- MK2 Golf Euroncap crash test



Figure 2 MK7 Golf Euroncap crash test

2.3 Aerodynamics

The aerodynamics of the Golf has changed dramatically over the generations starting with the mk1 and mk2 golfs, which were quite boxy with sharp body lines and square body panels, then moving onto the mk3 and four which began to become more rounded and smoothed. Figure 3 shows how the styling of the Golf has developed over the generations, finally ending on the mk8 which is a far sleeker and more aerodynamic car than the mk1. Volkswagen started to realise that customers were becoming very interested not only in how their new vehicles looked but also in how cheap they would be to run with fuel consumption, along with the government putting pressure on car manufacturers to reduce car emissions and the impact they were having on the environment. This is why Volkswagen started to do a lot more testing in wind tunnels and real-life road tests to help Volkswagen develop the Golf to a point where it would still be stylish and catch the eye of the customer, but also be more efficient to drive without too much compromise. "Climate change and CO2 reduction have garnered enormous quantities of press coverage in both industry and general media. As a result, we are witnessing today a heightened public awareness" (Benz, 2007).



Figure 3- Volkswagen Golf models through the years

2.4 Emissions

"Although The UK's territorial greenhouse gas emissions have fallen by roughly 50% since 1990" (Tiseo, 2023), 66.6% of annual greenhouse gasses are produced by cars. This can be seen below in Figure 4. This is why car manufacturers like Volkswagen are so desperate to try and reduce the number of emissions their cars produce. Volkswagen is constantly developing new ways to make the Golf more efficient, mainly by developing stop-start systems, direct injection, variable valve timing and turbochargers in combustion engines. This is to keep up with the constantly changing and demanding MOT regulation changes for the number of emissions cars produce. Volkswagen did try one technique where the vehicles "were programmed to recognise that they were being tested and... it is possible that the cars could have been programmed to emit less NOx under test conditions". (Brignall, 2015) However, Volkswagen got caught and ended up paying upwards of \$75 billion (£20 billion) in the United States, causing Volkswagen stocks to plummet. Volkswagen has recently said, "Volkswagen Passenger Cars wants to build only pure electric cars in Europe from 2033 at the latest. Brand CEO Thomas Schäfer" (Randall, 2022). Investing and transforming Volkswagen to producing only full electric cars.

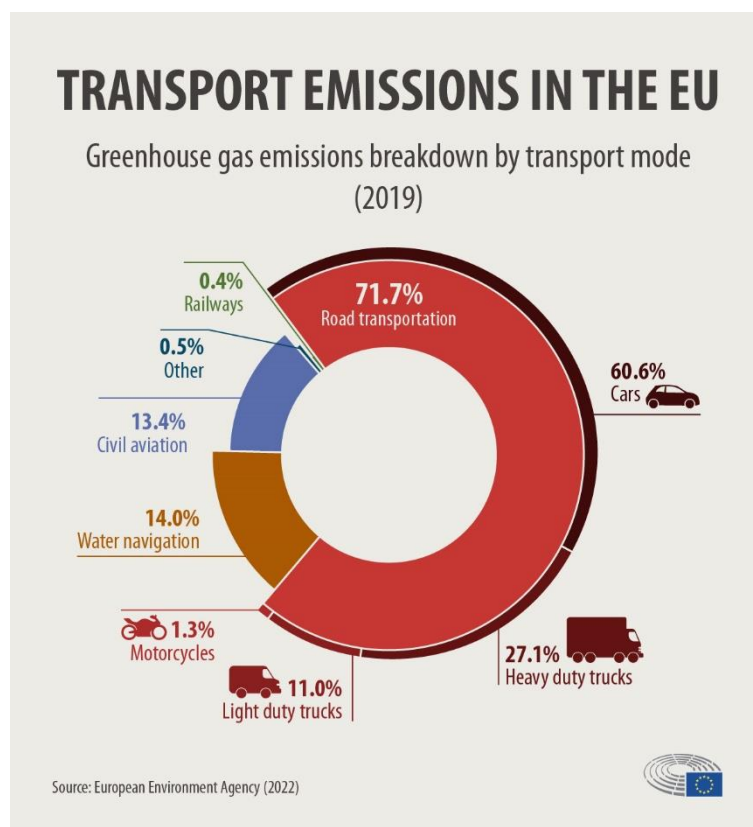


Figure 4- Transport emissions in the EU 2019

2.5 Car efficiency's introduction of hybrid and electric

"During the 1950s and 60s, a cottage industry grew up in the United States producing very small runs of electric cars and vans" (Hayes, 2014), showing that although not popular, Volkswagen was experimenting with creating electric cars but with heavy batteries and limited top speeds of 30mph and battery life of 40 miles meant that this attempt of electric cars was not a success. Later in 2006, Volkswagen introduced BlueMotion "BlueMotion is Volkswagen's diesel eco-friendly marketing brand" (Sanders, 2023). Then in 2014, releasing the first of its hybrid range, which with an mpg of 235mpg, makes it extremely popular for customers looking for an eco-friendly version of the Golf, compared with the mpg of an mk1 being 26.1-36.2mpg shows how much Volkswagen has managed to improve their engine's performance and efficiencies over the years. Volkswagen recently realised that they would "phase out petrol and diesel golf models to focus on electric cars" (Reeves, 2023) this being there most significant transformation to date with investments of "28.1 billion euros over the next few years" (Gislam, 2019). This is the Volkswagen Audi groups attempt to reduce the global co2 emissions emanating from cars.

2.6 Failure Modes and Effects Analysis (FMEA)

“(FMEA) is a systematic, proactive method for evaluating a process to identify where and how it might fail and to assess the relative impact of different failures to identify the parts of the process that are most in need of change” (Improvement, 2023). FMEA is used for determining possible failures with components and preventing them before they have a chance to fail. Figure 4 below shows what a FMEA table looks like. It starts with diagnosing the problem, then onto the potential effects of the problem, then moves onto ways to solve the problem. FMEA tables are an excellent tool for Volkswagen to use when designing and prototyping the Golf. For example, finding issues and resolving them before the specific model would go into full production.

POTENTIAL FAILURE MODE AND EFFECTS ANALYSIS Front Door L.H.													FMEA Number 1450				
FMEA Type						Page 1 of 1		Prepared By J. Ford - X6521 - Assy Ops					FMEA Date (Orig.) 3/10/2015 (Rev) 3/21/2015				
Item 1.1.1 - Front Door L.H.	Process Responsibility Body Engineering																
Model Year(s)/Vehicle(s) 20XX/Lion 4dr/Wagon			Key Date 3/10/2015														
Core Team A. Tate Body Engrg, J. Smith - OC, R. James - Production, J. Jones - Maintenance																	
													Action Results				
Name / Function	Potential Failure Mode	Potential Effect(s) of Failure	SEV	Classification	Potential Cause(s) of Failure	OCC	Current Process Controls (Prevention)	Current Process Controls (Detection)	DETI	RPN	Recommended Action(s)	Responsibility & Planned Completion Date	Actions Taken & Actual Completion Date	SEV	OCC	DETI	RPN
Requirements																	
1.1.1 - Front Door L.H.																	
Op. 70 Manual application of wax inside door/ cover inner door, lower surfaces with wax to specification thickness.	Insufficient wax coverage over specified surface	Allows integrity breach of inner door panel. Corroded interior lower door panels. Deteriorated life of door leading to: - Unsatisfactory appearance due to rust through paint over time - Impaired function of interior door hardware	7		Manually inserted spray head not inserted far enough	8		Visual check each hour - 1/shift for film thickness (depth meter) and coverage.	5	280	Add positive depth stop to sprayer.	Mfg Engrg - 3/10/2003	Stop added, sprayer checked on line.	7	2	5	70
											Automate spraying.	Mfg Engrg - 3/10/2003	Rejected due to complexity of different doors on same line.				
									Spray head clogged- Viscosity too high- Temperature too low- Pressure too low.	5	Test spray pattern at start-up and after idle periods, and preventive maintenance program to clean heads.	Visual check each hour - 1/shift for film thickness (depth meter) and coverage.	5	175	Use Design of Experiments (DOE) on viscosity vs. temperature vs. pressure.	Mfg Engrg - 3/10/2003	Temp and press limits were determined and limit controls have been installed - control charts show process is in control Cpk = 1.85.
				Spray head deformed due to impact	2	Preventive maintenance program to maintain heads.	Visual check each hour - 1/shift for film thickness (depth meter) and coverage.	5	70						2	5	70

Figure 5- FMEA Failure Modes and Effects Analysis Table

3. Current state of industry

Currently, the car industry is recovering from a supply shortage of microchips. This impacted car manufacturers significantly, causing some to bring their production lines to a stop. Microchips are used in every electric component of modern Golfs, and without these, they simply cannot be produced. Going forward, Volkswagen has announced they will be aiming 100% of their production cars, including the Golf, to be fully electric versions, and with still a shortage of microchips this is going to be a real test to see if Volkswagen can still keep build slots and car production at a steady rate, releasing their complete electric range “ID” even bringing back an electric version of the Volkswagen camper/bus. Figure 4 shows the new Volkswagen ID range, which is their "biggest transformation to date" (Gislam, 2019). This will be an eye-opener to the way Volkswagen are aiming to head into the future.



Figure 6- Volkswagen ID electric range

4. Conclusion

The Volkswagen Golf is an icon for the hot hatch worldwide, selling over 35 million units. With a massive array of models, designs, engines and specifications, it is understandable why the Volkswagen Golf is so popular. With progression over the generations, attempts to manufacture the Golf as well as keeping it efficient and stylish demonstrates how well Volkswagen has developed the Golf over the decades. Improved safety achieving five stars in the Euro ncap latest tests and its flawless stylings and recent offers of models with engines capable of 235mpg, shows there is no surprise this car is one of the most popular and well known and will continue to be.

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