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A Technical Insight into the Ford Sierra RS Cosworth

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1 Introduction

This Essay will look at various areas of the Automotive Industry, chosen from lectures given at UWTSD. The topics chosen will relate to the Ford Sierra RS Cosworth and how each topic impacted the design and development of this vehicle.

The Sierra RS Cosworth was Fords attempt at rebuilding their reputation in motorsport. This Sierra was the first Ford to wear the Cosworth badge after a 25-year partnership between Ford and Cosworth. Overseen by Lothar Pinsky of Ford's Special Vehicle Engineering Division, a total of 92 modifications were made to the original bodywork (Ware, 2020). Ford also took advantage of homologation rules by taking advantage of the FIA's 10% "evolution rule" (Ware, 2020), building the RS500, which became a successful touring car in various championships around the globe.

2 Impact of Topics

2.1 Aerodynamics - Tim Tudor

From the “jelly mould” nickname of the original Ford Sierra through to the famous “whale-tail” spoiler on the RS Cosworth and RS500, aerodynamics played a big part in the design of the entire Sierra range. Arguably, this became more important when Ford needed the Sierra to compete in Group A, under its Cosworth badge.

The original Sierra hatchback generated significant aerodynamic lift even at low speed. The designer for the Cosworth, Lothar Pinske, was all too aware of its downfalls. This resulted in the Sierra being researched extensively at the MIRA facilities combined with test days at the Nardò circuit in Italy. The outcome was 17kgfm at 200km/h compared with 52kgfm without the rear wing, a significant net difference of 69kgfm (Illuis, 2016). The large whale-tail wing was not accepted by Ford's management originally, while dealers raised concerns that it was an unsightly addition, but with a top speed of 149mph (reference), the tried and tested rear wing was effective at making the car stable at high speeds, thanks to an extra 20kg of downforce at 112km/h, the wing remained. It was later improved upon with the RS500, which added a Gurney Flap on the trailing edge of the whale-tail. There was also an additional wing on the back of the tailgate, increasing the downforce to 100kg at 160km/h (Vivian, 2020).

2.2 The Internal Combustion Engine - Dr Owen Williams

The Cosworth YBB Engine was built with road and racing in mind. Cosworth engineers had already independently developed the YAA Engine, a twin-cam 16 valve engine based on the Ford Pinto.

The road going YBB engine was a 2 litre, DOHC (dual overhead cam), turbocharged, four cylinder which produced 201bhp and 276nm of torque. The Engine was placed at the front of the vehicle and sat longitudinally rather than transversely to suit the Sierras' original rear wheel drive set up. Built from a cast-iron block in the UK then shipped to Genk, Belgium. Its racing equivalent, the YBC, was easily capable of producing much higher number of horsepower, earlier race cars produced around 375bhp, and this number went up quickly grew (Beaumont, 2018).

The later RS500 came with an upgraded YB engine named the YBD. Although the output was only marginally higher than the standard Cosworth at 224bhp and 279nm of torque (encyclopedia.com, 2022). The upgrades it received meant it was capable of being. Using a larger T04 Garret turbocharger, uprated fuel, oil and cooling systems. The engine block was built stiffer and the YBD featured an eight-injector manifold (King, 2021). Due to these upgrades, the racing variants were capable of 485bhp with a different engine map, due to the RS500s inactive secondary injector system, once active, it did not take long before the racing variants achieved 525bhp (Beaumont, 2018).

2.3 Manufacturing – Dr Kerry Tudor

The Sierra RS Cosworth, aside from being built to race, also needed to sell, Ford were efficient enough in the build to undercut the equivalent German cars of the era. Ford did not have the facilities to make the exhaustive list of changes to the RS500, meaning after it was built as a standard RS Cosworth in Belgium, then shipped to Tickford in Bedworth. The Cars which were sent from Belgium to Essex where they were stored in an outside compound, this created issues with bodywork, leaving a difficult de-waxing procedure as the first stage of the process when it arrived in Bedworth (Walton, 1987).

At that first workstation, the rear spoilers are extended with a Gurney Flap and a lower boot spoiler. The second procedure was to remove and replaced the YBB with the more powerful YBD engine. The altered front spoilers and bumper units are fitted. All the standard components, incidentally, including the basic removed YBB Cosworth engine, were returned to Ford for spares. The next stage seen the larger T04 turbocharger bolted onto the new engine. The final stages were devoted to applying RS500 badges on both sides, plus the tail badge.

There were two stages of quality control, neither staffed by Ford but inhouse by Tickford (Walton, 1987).

2.4 Emissions - Abi Summerfield

The strict emissions regulations we are familiar with today did not exist in 1985 when the Sierra RS Cosworth was released. Emission regulations only became mandatory in 1982 (Summerfield, 2022), leaving very little time for it to make an impact on the earlier models. Summerfield goes on to say, in 1992 the regulations were updated because of the European Union's involvement, leading to 'Euro' regulations that are used currently. Although this was too late for the earlier models, losing out to the North American market due to its high emissions, resulting in the 3 door Cosworth never being sold in the USA (Supercarnostalgia, 2022).

Year of Regulation	CO (g/km)	HC & NOx (g/km)	HC (g/km)	NOx (g/km)
1982	20.7	5.8	-	-
1992 (Euro 1)	2.72	0.97	-	-
1996 (Euro 2)	2.2	0.5	-	-
2000 (Euro 3)	2.3	0.35	0.2	0.15
2005 (Euro 4)	1.0	0.18	0.1	0.08
2009 (Euro 5)	1.0	0.16	0.1	0.06
2014 (Euro 6)	1.0	0.16	0.1	0.06

Figure 1 - Petrol Emissions (Introduction to Emissions, Summerfield, 2022, p3)

As seen in *Figure 1*, the acceptable number of harmful gases is reduced dramatically when "Euro 1" is introduced. Also, Hydrocarbons (HC) and Nitrogen Oxides (NOX) were not measured independently until 2000. Showing a change in how things were measured. Looking at other forms of measuring emissions, the current day "simulated test cycle" in *Figure 3* compared to one published by Ford in 1985, shown in *Figure 2*. The modern-day cycles are longer, more stringent and carried out at higher speeds giving a more realistic insight to how the car will perform.

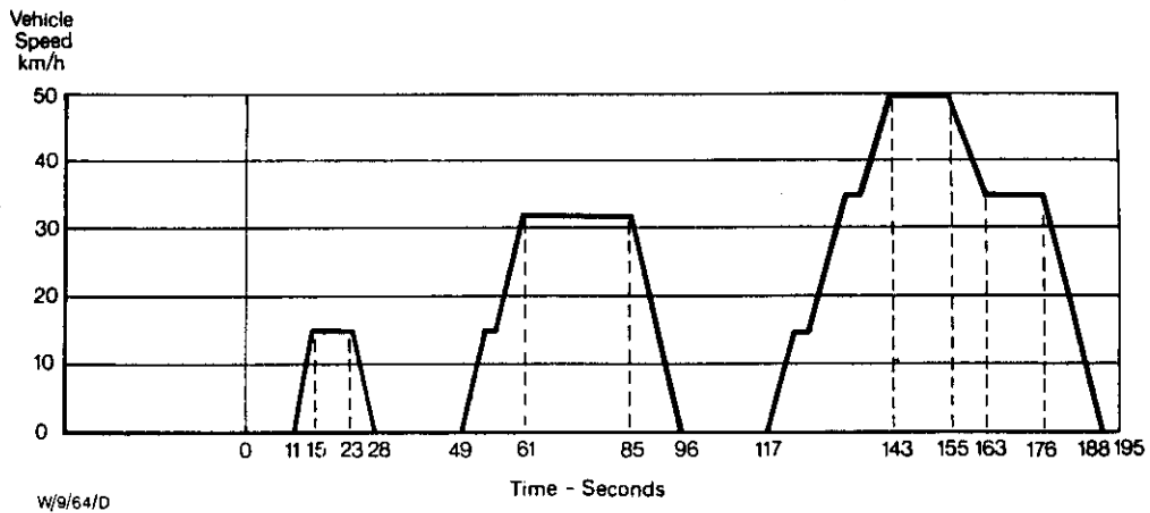
SIMULATED URBAN DRIVING

Figure 2 - Ford Sierra RS Cosworth Simulated Driving Cycle (Service Training Programs, 1987, p544)

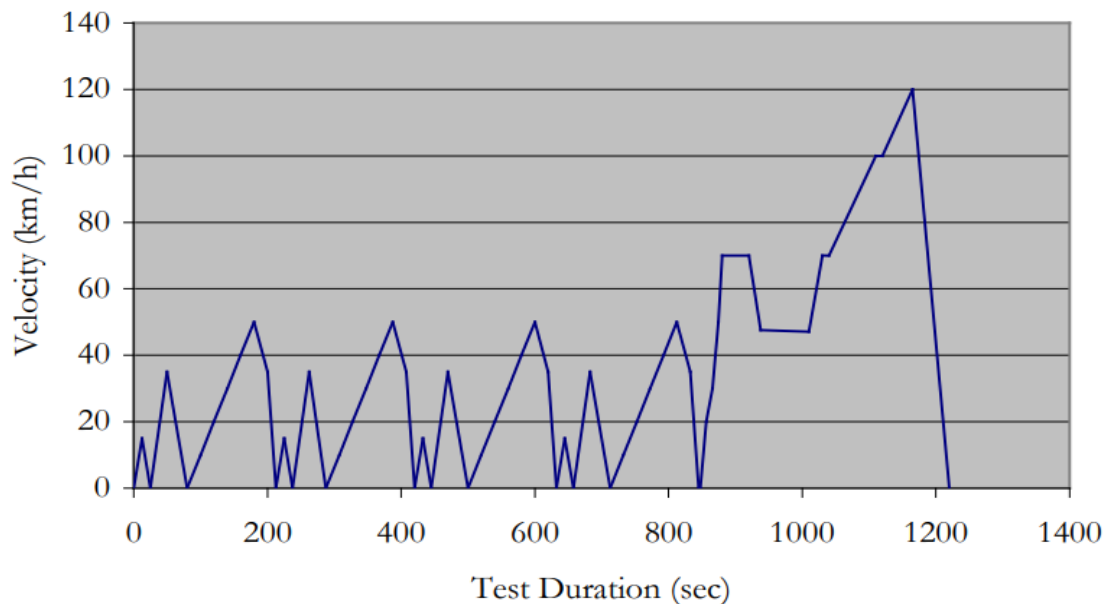


Figure 3 - Modern Day Petrol Emissions Test Cycle (Introduction to Emissions, Summerfield, 2022, p6)

2.5 Control Systems – Andrew Gibson

The Electronic Control System (ECU) placed into the original Sierra Cosworth was considered advanced for 1987. Consisting of a fuel injection system by Weber and an ignition system by Marelli (Goode, N.D). Although Ford was already running an electronic fuel injection system on other models at the time, the Sierra Cosworth system was far more advanced.

From Boost pressure, air/fuel ratio, through to the timing of the spark. These were all controlled by the ECU. One of the most importance electronic systems on the Cosworth was the injector system, which controlled each of the four injectors individually (Ford Workshop Manual Volume 1, 1987), later with the RS500 Cosworth, this system became even more advanced due to its 8-injector system. The secondary injectors were not activated in cars sold to the public, meaning the RS500 could meet emissions standards but when needed, the ECU was chipped for competition use,

gaining use of the secondary injectors and pushing close to 400bhp before any further modifications were done (Walton, 1987).

The ECU came with damage limitation systems in place along with diagnostic capabilities., allowing to test various sensors within the vehicle, such as the engine coolant temperature and the inlet air temperature (Service Training Programs, 1985, p51). Compared to the code reading capabilities of today, self-testing was slightly more time consuming and carried out via timed electronic pulses, as shown in the *Figure 4* below.

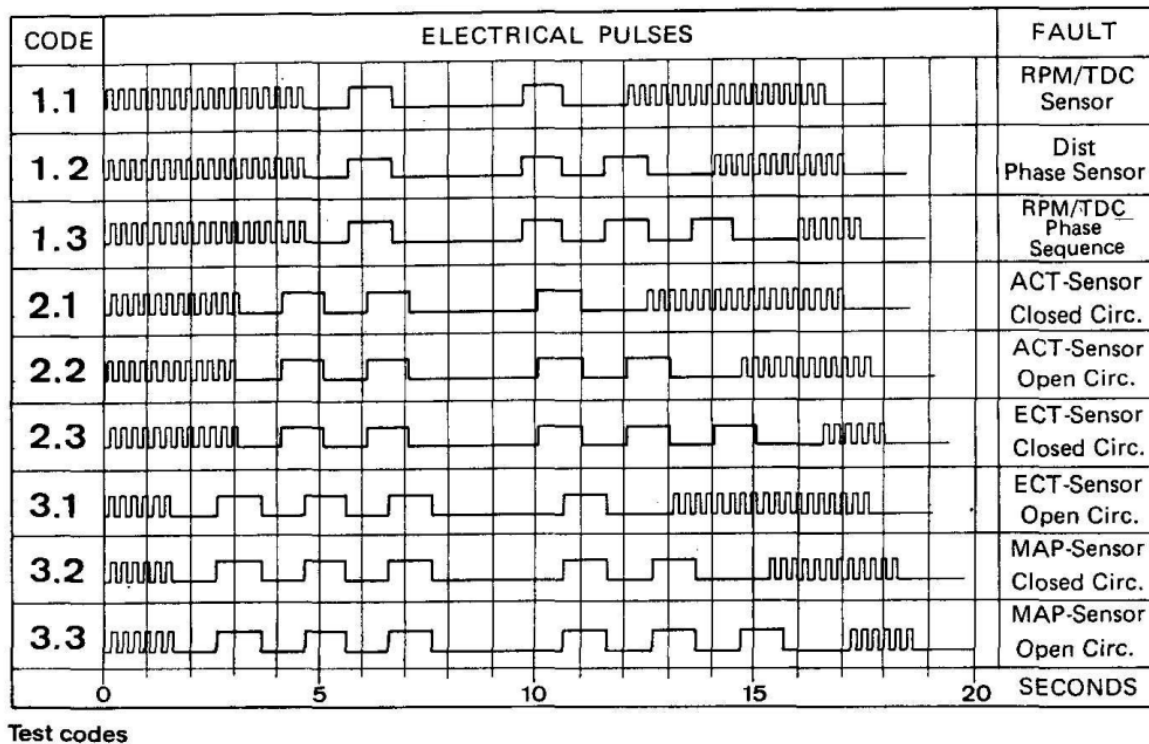


Figure 4 - Engine Diagnostic Pulses (Service Training Programs, 1985, p51)

2.6 Materials – Dr Kerry Tudor

The RS Cosworth, being an upgraded version of the original Sierra, and the rs500 complying with rules on homologation, the monocoque remained the same and was made from steel. A tried and tested material and method of production. The disadvantage of steel being its strength to weight ratio, meaning it was heavier than an aluminium or magnesium equivalent (K Tudor, 2022).

While Cosworth did make various changes to the original 2.0 Ford engine, apart from the cylinder head being changed to a light alloy head, the main block remained the same. Being a cast iron block, the cost of having an aluminium block would have been too expensive and while aluminium is very durable, an iron block retains advantages such as quicker cooling and better cooling margins (Nally, 2022), something that would play a key role when the Sierra went racing.

Cosworth then changed then added an aluminium cylinder head, uprated the pistons to Mahle pistons with forged steel connecting rods. A special cast aluminium sump as also added (Supercarnostalgia, 2022).

When the rs500 was designed, it was decided it would need a stronger engine block to cope with the racing variants and their higher power outputs, a thicker walled engine block was designed (Newton, 2020) resulting in a stronger and stiffer unit which could handle the group A requirements.

2.7 Engineering Requirements - Andrew Noble

The Sierra was already an established vehicle within Fords fleet, so with many changes being made to an already existing model, Ford had to be sure their changes would keep up with the standards already in place. Drivers and consumers knew the Sierra as a company car that could reliably drive up and down the country, meaning the consumer has created requirements for the manufacturer (Noble, 2020), that would then have to be met, in terms of reliability.

While some responsibility lay with Cosworth for the reliability of the engine, the rest of the chassis had to be ready to take on the extra horsepower and speed required for a high performance model. Ford used other models at their disposal to make this happen, such as using parts from the Granada and Scorpio.

- In the list below, front axle and suspension components, which are reinforced or modified in comparison to the Sierra, are marked with "Sierra RS Cosworth". Scorpio components which have been carried over to the Sierra RS Cosworth are marked with "Scorpio" (refer to illustration on page 66).
- | | |
|--|--------------------|
| 1 = Spring | Sierra RS Cosworth |
| 2 = Strut | Sierra RS Cosworth |
| 3 = Hub | Sierra RS Cosworth |
| 4 = Brake disc | Sierra RS Cosworth |
| 5 = Front wheel bearings | Scorpio |
| 6 = Protection cap | Scorpio |
| 7 = Toothed rotor (ABS) | Scorpio |
| 8 = Grease seal | Scorpio |
| 9 = Crossmember | Sierra RS Cosworth |
| 10 = Spindle carrier | Sierra RS Cosworth |
| 11 = Stabiliser bar, 28 mm diameter | Sierra RS Cosworth |
| 12 = Bush | Scorpio |
| 13 = U-Clamp and fixing | Sierra RS Cosworth |
| 14 = Anti-lockwheel sensor with fixing | Scorpio |
| 15 = Lower arm | Sierra RS Cosworth |
| 16 = Attachment-lower arm to crossmember | Scorpio |
| 17 = Rear cover | Scorpio |

Figure 5 - A list shared components which are used in the Sierra suspension set up (Service Training Programs, 1985, p66)

Having a better understanding of the products life cycle (Noble, 2020) meant Ford and Cosworth could concentrate on making specific changes for the RS Cosworth knowing the rest of the car would be up to the task, as seen in Figure 5, even looking at one section of the cars overall set up, it can be seen it has many newly manufactured parts, mixed with existing parts.

2.8 Interpretation in Engineering – Ryan James

The RS500 Cosworth was very open to interpretation due to the fact it was a homologation car. 500 production cars were built so Ford could race in the Group A Touring Cars (historicdb.fia.com, 2022). While a 400bhp saloon car would be considered dangerous on the public roads in 1985, with lack of electronic aids and lower safety standards. 400 bhp in a group A race car was only a starting point. Ford then had to find a way to keep the power balanced on the road car but high in the race car. The Sierra could have followed in the footsteps of the rally cars of the same era and had a variable air inlet, cheating the system by taking the restrictors off when it was ready to race (James, 2022). Ultimately, Ford decided upon an 8-injector system, which would lay dormant until the ECU was programmed to do otherwise. Meaning the road car had an 8% power increase over the standard RS Cosworth but when it was racing in Group A the same engine was pushing 500bhp. Something that would later be exploited by the modding community, with road legal Cosworths hitting figures like 800bhp and over 200mph (spec-r.co.uk, 2022).

3 Current State of the Industry

The Ford Sierra RS Cosworth could be considered the first mass produced “Fast Ford” and its legacy still stands today, The Cosworth partnership continued with the Ford Escort RS Cosworth which, like the Sierra, was a homologated car. Although, it did not the same success as the Sierra when it came to racing it was certainly a success for Ford, resulting in the RS name being continued. The current Ford Focus RS being the most recent in the line-up, although more closely related the Ford Escort RS Cosworth, it could be considered a direct descendant of the original Sierra, a fast, turbo charged car with a track orientated focus, that still manages to undercut its rivals when it comes to price (Moss, 2016).

Just like the Sierra of the time, the Focus RS refuses to be left behind, with a Hybrid RS being designed for 2022, a bid from Ford to tackle the ever stricter fleet CO2 regulations imposed on manufactures (Rendall, 2020). The question will remain if cars like the RS will exist after 2030 when new vehicles must have zero emission capability (Owen, 20202), will there be a market for performance equivalents of regular cars.

4 Conclusion

To conclude, it is unlikely the Ford Sierra RS Cosworth would be built in today's environmentally conscious world, with the original vehicle struggling to meet the more lenient regulations of 1985, the unrefined engine, with its large turbo would be unlikely to match the CO₂ outputs expected of today's production cars. The market would also be shared with the Sierras previous rival, the BMW M3, a car that has already established itself in the high-performance saloon car market. Failing to mention how many cars now fall into this category, the Ford would possibly struggle to keep the costs low with the same success it originally had in the 1980's.

The RS500 version of the Sierra would meet a similar fate, with homologation cars a rare sight and now unnecessary with current racing divisions, the homologated RS500 would have no real reason to be designed and manufactured today.

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