Competing Grand Prix technologies of the past

In 2014, when the FIA Formula 1 engine of the 3rd Pressure-Charged (TurboCharged) Era will be so closely specified, even down to the diameter of the valve stems, that it seems likely that only company-specific detail drawing standards will produce any differences ("*electrickery*" apart), it is interesting to recollect some of the great technical duels of the past century of Grand Prix racing.

- In 1912 at the French Grand Prix, run under *Formule Libre*, 14.1 litre FIATs battled with 7.6 litre Peugeots having a more advanced specification and they just lost. The Peugeot introduced Double Overhead Camshafts and this became the valve operating mechanism of choice for nearly all subsequent racing engines and now is commonplace in ordinary production cars.
- Over 1934 – 1939 the front-engined IL8 and V12 Mercedes-Benz and the mid-engined V16 and V12 Auto Union cars, built firstly to the 750 kg empty and then the 3 litre Pressure-Charged (PC) / 4.5 litre Naturally Aspirated (NA) rules, fought tooth-and-nail for supremacy. This was a German internecine rivalry, perhaps sharpened by geography as Swabia (Stuttgart) versus Saxony (Chemnitz). Mercedes, with about twice the expenditure of Auto Union, beat them over the 48 races which they both contested by 27 wins to 17. Alfa Romeo wins (4) added a little spice occasionally. See Picture 1 on P.3.
- In 1949, in the temporary absence of Alfa Romeo, the rules which applied 1947 – 1951 allowed 1.5 litre PC cars (V12 Ferrari and IL4 Maserati) to compete with 4.5 litre NA (IL6 Lago-Talbot). The 6 races which would now be recognised as classics were shared:- Ferrari 3; Talbot 2; Maserati 1. No lack of interest there.
- By 1950 - 1951, with the Alfa 158/159 back, the 1.5 PC versus 4.5 litre NA battle was well-and-truly joined, the NA car being a V12 Ferrari which was gradually enlarged up to the full 4.5 litres and then further developed. The breakthrough win by the Ferrari came in July 1951 at Silverstone when Gonzalez beat Fangio's 159. Alfa were defeated twice more in succession but they fought back and won the final race and the Drivers' Championship for Fangio. Had there been a Constructors' Championship in 1951, Ferrari would have won it. This had been another internecine struggle, in Italy this time, between Lombardy (Milan) and Emilia (Maranello). See Picture 2 on P.3.
- In 1953 the 2 litre NA cars of Ferrari (IL4) and Maserati (IL6) fought a "local Derby" – Maranello versus Modena – which the simpler engine won easily.
- A "*might-have-been*" rather than a definite duel was the Lancia D50 versus the Mercedes-Benz W196 over late 1954 to mid-1955. Under the 2.5 litre NA Formula the former was a V8, the latter an IL8. In the 4 classic races which they both entered the Lancia took Pole twice (1954 Spanish, 1955 Belgian) and had an equal time to the W196 Pole at a 3rd (Monaco). However, the best Lancia finish was 2nd. On the occasion when Ascari in the D50 was unknowingly within ½ lap of overtaking a broken-down W196 for the lead at Monaco at 82% distance, he crashed into the harbour. Four days later he died in a Ferrari sports car at Monza. This was the last straw in convincing the Lancia family to withdraw from Grand Prix racing (save allowing the relative-rookie Eugenio Castellotti to take one car to Spa, where he took Pole but DNF). After the D50s were given to Ferrari, with a FIAT subsidy, the cars were to have raced unchanged against the W196s in the 1955 Italian GP but the tyres were unsafe on the banked Monza track and the entries were withdrawn. By the time they raced again in 1956 the Mercedes were gone.
- The powerful-but-fragile Vanwall IL4 2.5 litre engine in a beautifully-smooth Frank Costin-bodied Colin Chapman-influenced chassis beat a V6 Ferrari to the 1958 Constructors' Championship with 6 wins to 2. If Stirling Moss had not sportingly supported Michael Hawthorn at the stewards after an incident in the Portuguese GP the Vanwall would also have powered the Drivers' Champion.

- Over 1959 – 1960 under the 2.5 litre NA rules a simple IL4 engine from Coventry Climax thrashed a more powerful V6 Ferrari, 11 wins to 3, because it was mounted in the middle of a stable Cooper chassis. That concept changed Grand Prix technology for ever and shortly afterwards, via Lotus, it revolutionised the US open-wheel racing scene as well. See Picture 3 on P.4.
- In 1977 Renault picked up the rules challenge of 1.5 litre PC being allowed to compete with 3 litre NA, the major successful exponents of which were Cosworth DFV-engined cars or else V12/F12 Ferraris. Renault applied the, novel-to-GP-racing, technology of TurboCharging (TC). The fascination was then the development of their V6 for higher power plus reliability up to their first win in 1979. After Ferrari produced their own TC V6 they took Constructors' Championships in 1982 and 1983 but it was Piquet in a Brabham powered by an IL4 BMW which gained the first TC Drivers' Championship in 1983. See Picture 4 on P.4.
- In 1994 the first 3 places in the Drivers' Championship were taken in cars powered in order by V8, V10 and V12 engines, the inverse of what might have been expected theoretically. The early death of Senna, who led the V10 cars, and the rise of the other super-driver Schumacher, driving the V8, had something to do with that, of course.

The FIA drive to standardise engines

In 2001 the FIA began a serious drive to standardise Formula 1 engines – a contradiction of the spirit of Grand Prix, so that it can be considered dead. The initial move was to make V10 engines compulsory. Pro tem designers *were* still allowed to choose their Vee angle! But the 3L V10 rule was replaced for 2006 by a 2.4L 90^0 V8 rule, with many other restrictions on parameters and materials. After 2006 engine specs. had to be frozen. Standard ECUs came in 2008.

An attempt was made in 2008 to move to a 1-make engine for 2010 and Cosworth were announced as the chosen supplier. The teams would not accept that. Nevertheless, the drive to standardisation via specification rules continued.

All this was in the name of cost reduction – teams were no longer allowed to decide for themselves how much they were willing to spend to win.

Where we are today

Competitive Grand Prix engine development is now over, probably forever.

In 2014 and onwards all who wish to continue racing in Formula 1 will have to use what is virtually a standard engine, although with some scope for originality in energy recovery systems.

Chassis development

Of course, despite many and various rules, ingenious and competitive chassis development did not halt - and probably used up the money saved by not doing engine development! The consequences of that, over 2010 -2012, were 2 pairs of cars, each pair using the same engine, which produced vastly different results:-

Red Bull-Renault (28 wins) and works Renault/Lotus (1 win);
McLaren-Mercedes (18 wins) and works Mercedes-Benz (1 win).

In 2013 the Red Bull-Renault extended that disparity with 13 wins to Lotus' 1. The McLaren team suffered a drought while works Mercedes cut their deficit by 3 but are still a long way in total behind their customers.

The 3rd Pressure-Charged Era

What the 3rd PC Era will bring is anybody's guess. Maybe competition in power-train "*electrickery*" will produce duels as interesting as past engine technologies – although that may only be seen as icons on a TV screen! Let us hope that it *will* produce "green" advances which one day can be applied cost-efficiently to ordinary mass-produced cars.

Derek S. Taulbut.
25 January 2014.

Pictures 1 &2 on P.3, 3 & 4 on P.4.

A P.S. has been added after P.4 to describe events of the 2014 season.

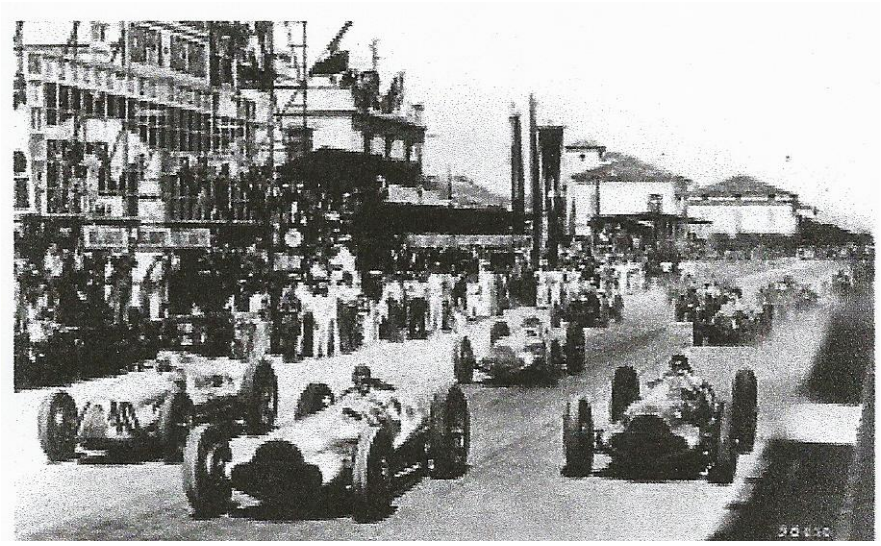
Picture 1

3 litres Pressure-Charged (Mechanically-Supercharged) mid-engined versus 3 litres Supercharged front-engined.

Let battle commence!

Start of the 1938 Coppa Acerbo at Pescara.

Tazio Nuvolari (No. 40, Auto Union D-type) on Pole at left;
Manfred Brauchitsch in centre (Mercedes-Benz W154);
Hermann Lang on right (W154).
Rudi Caracciola (W154), in centre at back, was the winner.



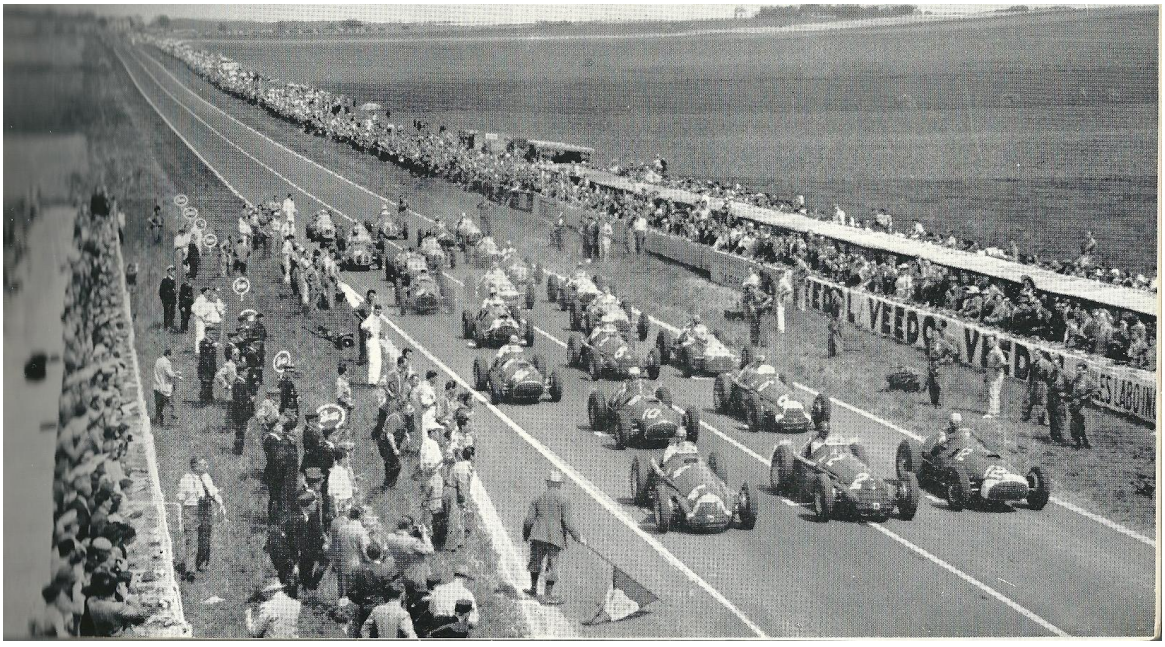
Credit G*rands Prix 1934-1939*; R. Fellowes & R. Walkerley

Picture 2

1.5 litres Pressure-Charged (Mechanically-Supercharged) versus 4.5 litres Naturally-Aspirated.

The start of the 1951 Grand Prix de l'ACF at Rheims.

Juan Fangio (Alfa Romeo 159) on Pole on the left; Guiseppe Farina (Alfa Romeo 159) in 2nd place;
Alberto Ascari (Ferrari 375) in 3rd place on the right.
Fangio, sharing with Luigi Fagioli (Alfa Romeo 159) after his car broke down, won.
Ascari was 2nd, sharing with Froilan Gonzalez (Ferrari 375), after *his* car broke down.
Two weeks later the make finishing order would be reversed, Gonzalez beating Fangio!

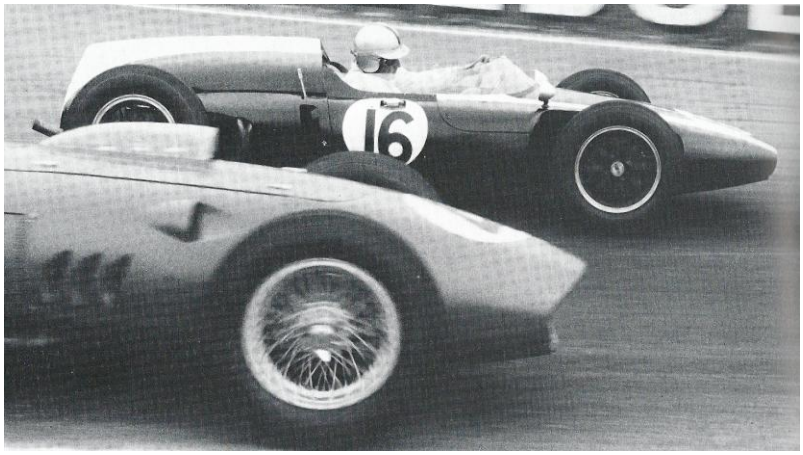


Credit *Motor Sport Racing Car Review 1952;* D Jenkinson

Picture 3

2.5 litres Naturally-Aspirated front-engined versus 2.5 litres Naturally-Aspirated mid-engined.

1960. Phil Hill (Ferrari 246) being overtaken by Jack Brabham (Cooper-Climax T53)
in the GP de l'ACF at Rheims.
Brabham won, Hill DNF.

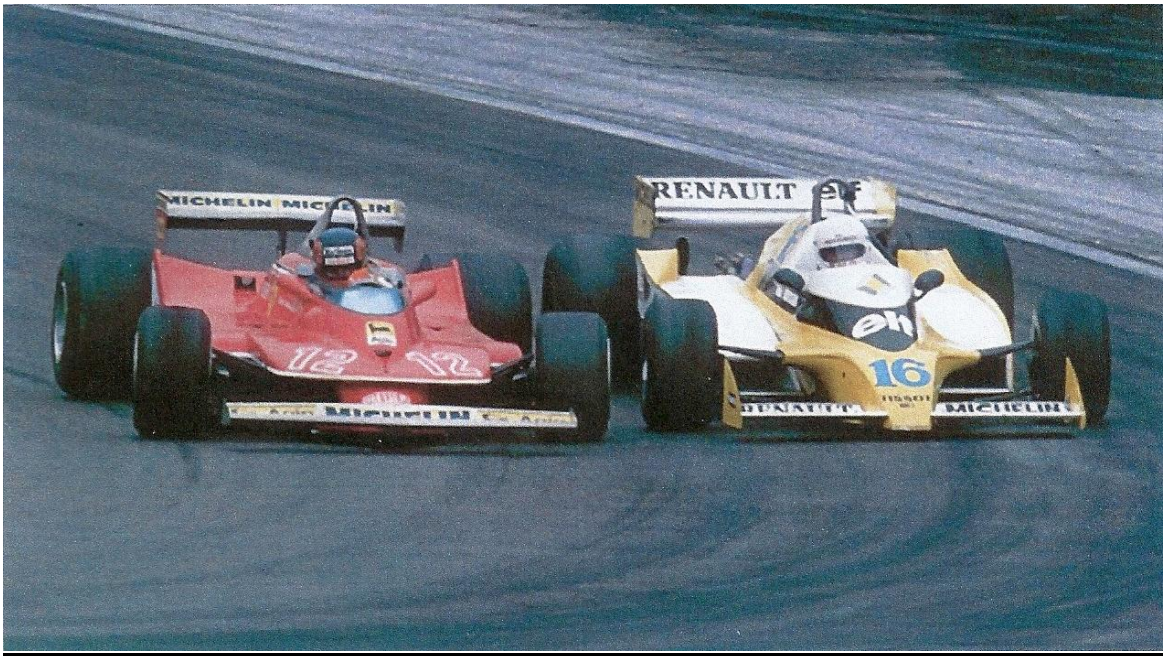


DASO 938

Picture 4

3 litres Naturally-Aspirated versus 1.5 litres Pressure-Charged (TurboCharged).

1979 GP de l'ACF at Dijon. With Jean-Pierre Jabouille (Renault 1.5L RS10 TC) in the lead and about to win the 1st GP by a TC car, Gilles Villeneuve (Ferrari 3L 312B) fights René Arnoux (1.5L RE10 TC) for 2nd place and wins it by ¼ second!



Credit article by Matt Youson

P.S. on next page

Mercedes AMG superiority

Readers are entitled to ask "*How do the 2014 results compare with the remarks made in the note of 25 January 2014?*".

In 2014 the Mercedes AMG W05 with its PU106A Hybrid power unit – both chassis and engine British-built, in Brackley and Brixworth, respectively – substantially out-performed its competitors. This contradicted the expectation that no large differences would emerge in the 3rd Pressure-Charged Era because of the highly-prescriptive FIA rules *unless* the "electrickery" provided it. That reservation may still be the answer. As the FIA had decreed that teams' engine specifications had to be frozen by the 28 February 2014, Mercedes' rivals could do nothing about their dominance by developments in that area.

The lap speed differences where Q3 results were not influenced by rain have been as follows, comparing the fastest Red Bull RB10/Renault F1-2014 (as the team which won the previous 4 Championships) with the fastest Mercedes:-

Circuit	W05 speed MPH (kph)	RB10 slower than W05 - %	
Bahrein	129.9 (209.1)	0.92	
Barcelona	122.2 (196.6)	1.22	
Monaco	98.3 (158.2)	0.52	
Montreal	130.3 (209.7)	0.89	
Austria	140.4 (225.9)	0.76	[Williams FW36/Mercedes PU106A actually 0.27% faster than W05]
Hockenheim	133.7 (215.1)	0.96	[Williams at -0.28% from W05]
Hungaroring	118.5 (190.7)	0.59	
Monza	154.0 (247.9)	1.55	[Williams at -0.67% from W05]
Singapore	107.2 (172.5)	0.16	
Suzuka	140.4 (226.0)	1.67	
Sochi	132.9 (213.9)	1.13	
Austin	128.4 (206.6)	1.21	
S. Paolo	137.6 (221.5)	1.29	
A. Dhabi	123.7 (199.0)	0.78	
Average		0.975	**Call it 1%**

This Mercedes speed advantage was turned into 16 wins out of 19 races (84.2%).
It compares with the record winning ratio by the McLaren MP4-4/Honda RA168E in 1988 of 15/16 = 93.7%.

The only *observable* difference in the W05 was that the PU106A Hybrid had its TurboCharger elements separated, the Turbine at the rear of the V6 and the Compressor at the front, shaft-driven through the Vee, the Dynamotor of the MGU-H being in between. This should provide cooler air to the intercooler, which was also reported as air-to-water unlike air-to-air in other cars (which latter system was also the common choice of all the Championship-winning engines of the 1982 – 1988 era).

If the exchange rate of "+4% of power increases lap speed by 1%" applied (see Note 104) then the W05 had 4% more power than the RB10. If the RB10 had a chassis advantage over the Mercedes, as some reported and which was certainly true in 2013, then the power advantage of the Mercedes was greater than 4%.

However achieved, Mercedes AMG succeeded in breaking out of the straight-jacket imposed by the FIA which was intended to produce near-standard cars. Probably the team's decision to allow their two drivers to fight each other was an attempt to keep up spectator interest and avoid a ban on their special trick, whatever it was, but this only involved 2 cars out of 22. Not what the FIA had in mind

Revised rules

In FIA theory the frozen engine specs. would stay as they were for 2015 but, of course, Renault and Ferrari wanted this to be eased. Naturally, Mercedes did not. In early January 2015 the FIA found some way to permit a limited amount of engine development for the new season, to apply to *all* the 3 current suppliers but *not* to Honda who are to re-enter F1 as engine suppliers to McLaren in March. The argument ran that Honda should be able to produce engines to rival Mercedes because they had an extra year to do so. Honda objected to this exclusion and, amazingly enough, the FIA gave way and included them in the permitted development!.

Time will tell if Honda have been able to equal Mercedes performance and whether Renault and Ferrari can catch up during 2015. This pre-supposes that the dominant Mercedes situation in 2014 *was* due to better engines.

The alternative approach to 2014 rules by the AC de L'Ouest

In sharp contrast to the prescriptive FIA F1 rules the AC de L'Ouest, which governs the Le Mans rules and, by extension, the World Endurance Championship rules, decided for 2014 on a different approach. They also mandated a 30% reduction in fuel consumption and Hybrid engines for the premier LMP1 class but they gave designers great freedom in how to achieve that result.

The principal LMP1 contenders then chose quite different solutions:-

Audi (winners of 12 previous Le Mans races) selected for their R18 e-tron Quattro a Diesel Turbocharged (TC) 4L 120^0 V6 with Kinetic Energy Recovery System (KERS) by Williams Hybrid Power flywheel ;
Toyota's TS040 choice was a petrol Naturally-Aspirated (NA) 3.7L 90^0 V8 with KERS recovery to a super-capacitor;
Porsche, (winners of 16 Le Mans races), returning to Le Mans and being a member of the same Volkswagen Group as Audi, chose for their new type 919 a petrol-direct-injection TC 2L 90^0 V 4 with KERS, + an exhaust energy recovery system, to a lithium-ion battery .

The 2014 results were:-

Eight race Manufacturers Championship;
1st Toyota 289 points (they won 5 x 6 hour races);
2nd Audi 244 points (they won at Le Mans, which counted double points + a 6 hour race);
3rd Porsche 193 points (they won the last 6 hour race).

Toyota TS040

Racecar Engineering
April 2014

One can only regret that the FIA had not had the same courage as the AC de l'Ouest to allow the same scope for innovative solutions to the demand for reduced fuel consumption. It could have restored the true spirit of Grand Prix racing.

Derek S. Taulbut
January 2015