A Short Glossary of abbreviations is attached at P.5 as an aid to following the text.
A full Glossary is given as a Key to Appendix 1.

From 1906 to 2000 "GP Car-of-the-Year" (CoY) Peak Power (PP) rose from 90HP to a peak for a single Qualification lap of 1200HP in 1986 with TC. Thereafter rule revisions detailed in Table 1 dropped power substantially, but then further development especially to higher RPM raised power to almost 800HP by the end of this review. The CoY powers across the years are illustrated on Fig. O1, showing the design eras, and the associated engine Basic Dry Weights (W) and Power/Weight ratios (PP/W) are given on Figs. O2 and O3 (details in Appendix 1).

The year 2000 PP/W was an all-time high in the review period for NA at 7.5 HP/kg (5.6 kW/kg), having been multiplied about 29 times since 1906 (see also Note 7 referring back to an 1889 ratio of 0.025 HP/kg, the date when Daimler built his first specific automobile engine). The improvement of NA 3.5 Litre and 3 Litre engines since 1989 is particularly remarkable – this was a consequence of the greater development funds available, as mentioned in the Introduction (also see Note 113).

The way in which engine development has progressed under the most popular rule, of specified Swept Volume (V), is shown as PP/V ratio on Fig. O4. The advantages under that rule of MSC and especially TC are very clear (although the latter examples do not include the weight of the intercooler(s) necessary to enable those engines to run on petrol).

Addition of BMW 2005 P85

The 2005 BMW prototype engine P85 has been added to the Figures (with firm official data, see Note 112 from (1095*)), although not raced, because it was the last Grand Prix engine to be built before the FIA greatly extended their drive to remove the competitive element from engine technology by ever-more-detailed limits in the rules. It reached an all-time-high for PP/W at 11.4 HP/Kg (8.5 kW/kg). BMW did not carry on with the P85 because of a sudden FIA demand that engine life should be doubled, which could not be met. It therefore represents the end of Grand Prix philosophy as it had been understood since 1906.

The effect of the FIA approach to technology since 2000 is shown by the BMW estimate that an engine to the 2006 V8 2.4L Formula could have been built at a weight of 69 kg where the FIA had imposed a minimum weight of 95 kg, i.e. 38% heavier (1095). A rule for 2006 specifying 4 poppet valves per cylinder had already killed a major and successful Ilmor programme which was developing the Bishop rotary valve (see "How many valves per cylinder" at P.2).

* DASO1095. *Ten Years of BMW F1 Engines*. Paper by Prof. Dr-Ing. Mario Theissen et al. 2010.

Addition of Cosworth 2006 CA6

The 2006 Formula required a 90V8 2.4L engine with maximum Bore of 98 mm, as well as the 95 kg minimum weight mentioned above and other restrictive details. Details are available for the non-CoY 2006 Cosworth CA6 (see Note 108 and Appendix 1 at SO25) and it has been added to the Figures.

Specifications were frozen at the start of 2007 and a "Red Line" limit of 19,000 RPM was imposed. Only limited development was allowed for the rest of the Formula. In 2009 the "Red line" limit was brought down to 18,000 RPM, which helped achieve a new required life equivalent to 2,000 km (from an equivalent 1,600 km imposed in 2005). Details are available for the non-CoY 2009 Toyota RVX-09H (see Note 111 and Appendix 1 at SO26), which produced 761 HP @ 17,350 RPM, shown on Fig. 01 (only). This was a good engine result, although the car as a whole was not successful.

Addition of Mercedes Power Units for 2014-on Formula

The FIA 2014 Formula took a further step towards their ambition of a common engine (leaving aside auxiliary systems) by carrying prescribed details down to the diameter of the valve stems.

The 2014-on Formula, set at 90V6** 1.6L with a maximum Bore of 80 mm, was aimed towards "greening the planet" by requiring a large increase in Thermal Efficiency. This was to be achieved by TurboCharging (TC) and use of a Kinetic Energy Recovery System (re-named Motor Generator Unit (MGU)-K). Fuel (94.25% petrol + 5.75% bio) flow rate was limited to a maximum of 100 Kg/Hour at 10,500 RPM with a race ration of 100 Kg. With another MGU, labelled -H, in the drive from the turbine to the compressor to feed any excess exhaust power to the battery and then re-accelerate the TC from low RPM, the MGUs plus battery and control system, added to the Internal Combustion Engine (ICE) was termed the Power Unit (PU) and was to be a minimum of 145 Kg. Power draw-down from the battery was limited to a maximum of 120 kw (161 HP) for 33 seconds.

Once again, from the initial engine specification declared, very little development was permitted. This had the result that the first PU to have a superior performance was not likely to be overhauled. That was the Mercedes PU106A of 2014, which basic design, with the controlled changes permitted, has now taken all 5 double Championships to the time of writing.

Some details of the Mercedes PUs for 2014 and 2018 have been given on the internet, and are included in Note 129 (also in Extra 2 and 3 in Appendix 1). They are included on the Figures.

_____

**In December 2010 the FIA published the formula to take effect in 2013 as IL4 1.6L TC. Ferrari objected to this and in June 2011 the FIA changed to a 90V6 configuration, allowing an extra year to produce this.

Figures O1 to O4

The following key applies to all Figures in this **Overview UPDATE** and also to the Figures in the **Analysis of Overview UPDATE** and **Analysis Part 2 UPDATE**:-

Grand Prix "Car-of-the-Year" (CoY)

Era	Dates	Symbol	Description
1NA	1906 – 1923	♦	Naturally-Aspirated (NA) with "Tortuous Inlets & Simple Exhausts" [code = **T**]. See Note 12;
1PC(MSC)	1924 – 1951	■	Pressure-Charged (PC) by means of Mechanically-driven Supercharger (MSC). All **T**;
2NA	1952 – 1982	●	Naturally-Aspirated (NA) with "Individual & Tuned Inlets & Exhausts" [code = **I**]. See Note 12;
2PC(TC)	1983 – 1988	▲	Pressure-Charged (PC) by means of TurboCharger (TC). All **I;**
3NA	1989 – 2013	●	Naturally-Aspirated (NA) with "Individual & Tuned Inlets & Exhausts" All **I**;
3PC(TC)	2014 on	■	Pressure-Charged (PC) by means of TurboCharger (TC), and with MGU-K. Both **I**; **CoY**;

Addition of 1992 Honda RA122E/B and 2005 BMW P85 (both NA and **I**). See Appendix 1 at SO20 and SO27; **Non-CoY**; ○ ;

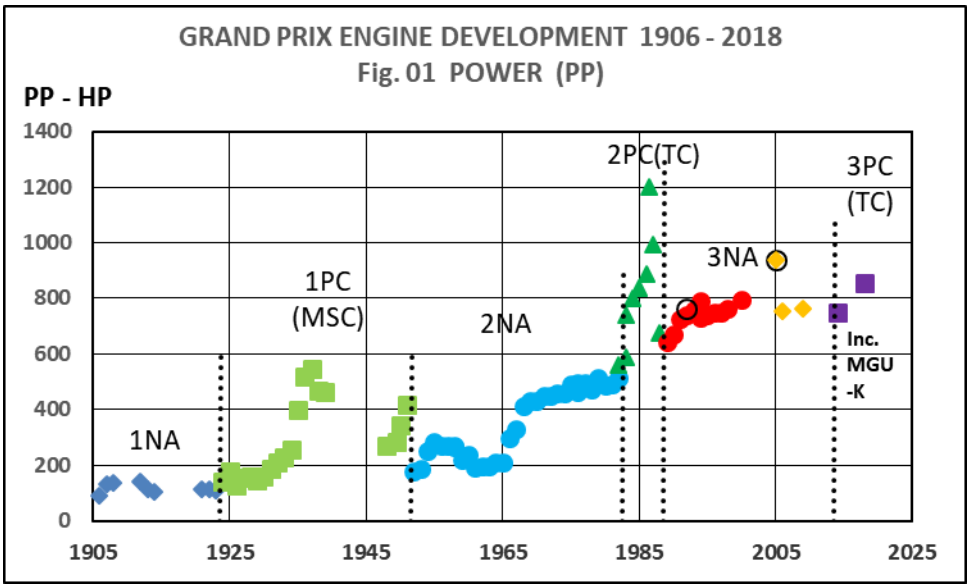
Addition of 2005 Honda RA005, 2006 Cosworth CA6 and 2009 Toyota RVX-09H (latter Fig. 01 only) (all NA and **I**). See Appendix 1 at SO29, SO25 and SO26; **Non-CoY**.

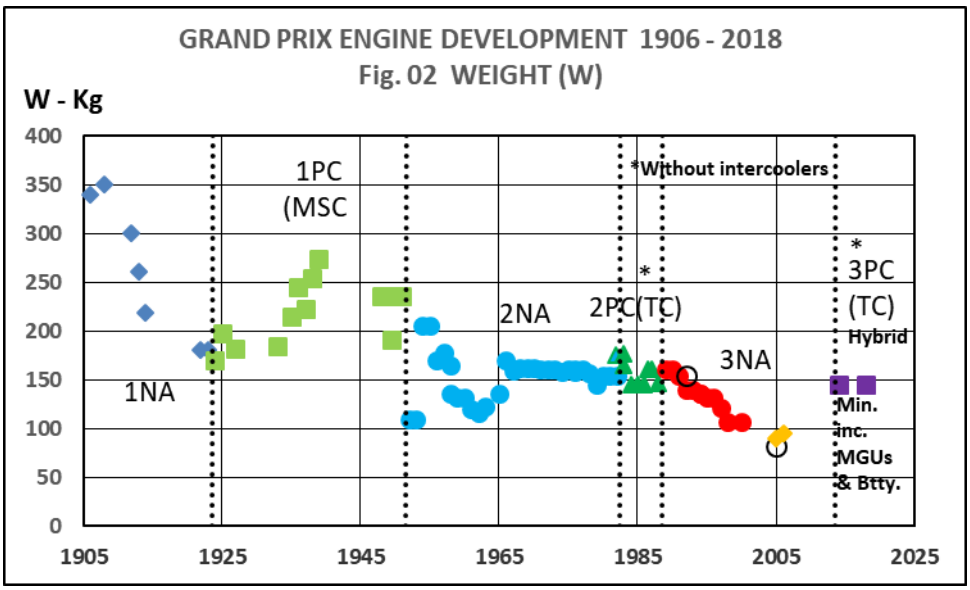
♦.

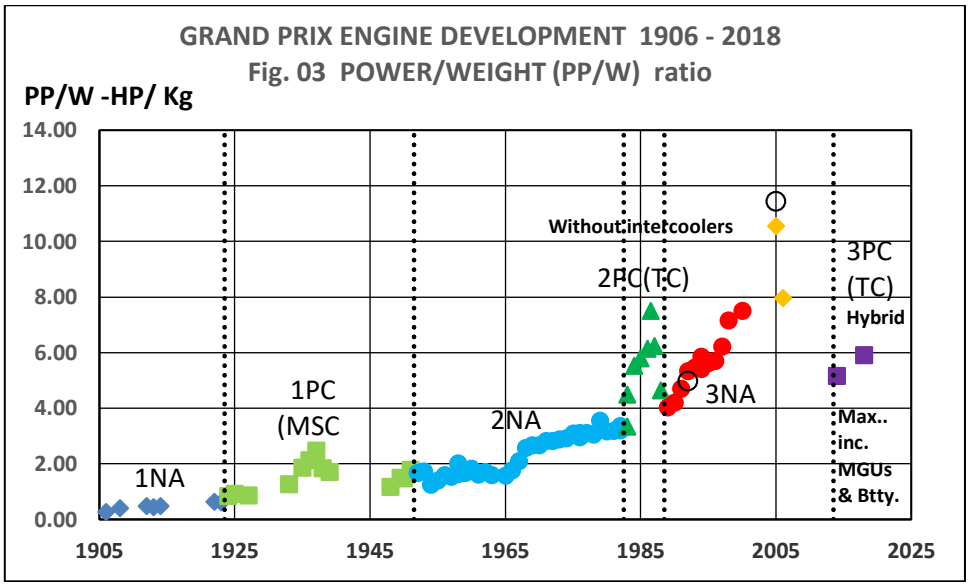
Engine Locations:- Front-Mounted until end 1958 (except 1936, Mid-Mounted); Mid-Mounted in 1959 and onward.

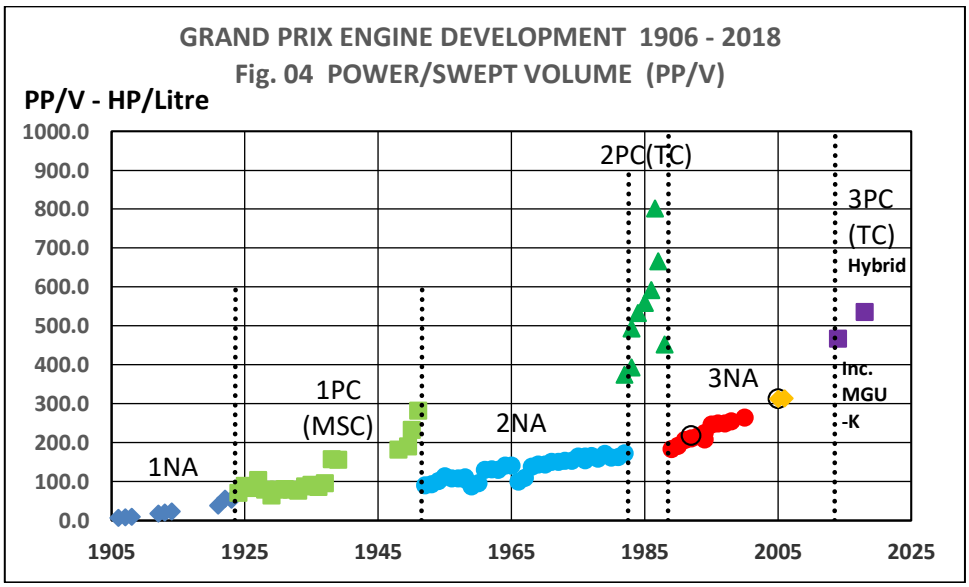
Chassis:- Aerodynamic downforce in 1968 and onward.

Details of the Formulae applying to each year are given in Table 1 of The Sporting Limits.









The **Overview of Performance UPDATE**, **Analysis of Overview of Performance UPDATE** and the **Analysis UPDATE, Parts 1 & 2** are a coherent suite of sections and should be read consecutively.

SHORT GLOSSARY of Abbreviations

This is given here as an aid to following the text. A full Glossary is given in Appendix 1 Key

Appendix 1 Line No.

B = Bore **mm**; S = Stroke **mm**; V = Total Swept Volume **cc** (or **L**). 18,19,57.
VIA = Included Angle between Valve stems if OHV (see below) **Degrees**. 23
R = Compression Ratio (volumetric). 17
PA = Total Piston Area **sq. cm**. 55
IVD = Inlet Valve Head Diameter **mm**. 24
IVA = Total Inlet Valve-Head Area **sq. cm**. 58
CRL = Connecting-Rod Length between centres **mm**. 37

OHV = Overhead Valves (PR = Push-Rod actuated).
OHC = Overhead Camshaft (per bank if Vee or Flat configuration);
S = Single; D = Double.

NA = Normally Aspirated.
PC = Pressure Charged; MSC = Mechanically Supercharged;
TC = TurboCharged.
IVP = Inlet Charge Pressure at inlet valve **ATA** (Atmospheres Absolute) 44
(1 ATA = 14.696 psi).
MDR = Manifold Density Ratio, relative to ambient density at 45
Standard Temperature and Pressure (15^0C & 14.696 psi).

PP = Peak Power* **HP** (BHP wherever this is certain, dividing known CV or PS by 1.01387). 49
NP = Crank rotational speed @ PP **RPM**. 50
* May unknowingly be a Rated Power @ Rated RPM below NP.
Where known shown as PR @ NR.

TP = Peak Torque **lb ft** 51
NT = Crank rotational speed @ TP **RPM**. 52

BMPP = Brake Mean Effective Pressure (BMEP) at PP **Bar** 74
(1 Bar = 10^5 Newtons/sq, cm
= 14.503 psi)
BMPA = BMPP Adjusted to R = 12 by Air Standard Efficiency ratio 79
and to Petrol if fuel is largely Alcohol by dividing by 1.12 for NA only (when MSC alcohol adjustment is within MDR calculation). **Bar**
BMTP = BMEP at NT **Bar** 76
BMTA = BMTP adjusted as for BMPP to BMPA **Bar**. 82

MPSP = Mean Piston Speed @ NP **metres/sec** = (2 x S x NP)/60,000 73
(m/s x 196.85 = ft/min).

BNP = Bore Speed @ NP **m/s** = (B x NP)/60,000 96

MVSP = Mean Valve Speed @ NP **m/s** = (IVL x NP)/(IOD x 83.333) 97
IVL = Inlet Valve Maximum Lift **mm**
IOD = Inlet Valve Open Duration
off/on seat **Crank Degrees**.

MGVP = Mean Gas Velocity @ NP **m/s** = (PA/IVA) x MPSP 94

MPDP = Maximum Piston Deceleration @ NP **g**. 99

W = Weight (Basic Dry, excluding exhaust system; also excludes intercoolers for TC)
(other definitions vary) **kg.** 124

To return to home page: Home Page