A DECADE'S PROGRESS

A design comparison by Leonard Setright of the 1958 Vanwall and the 1967 Lotus 49

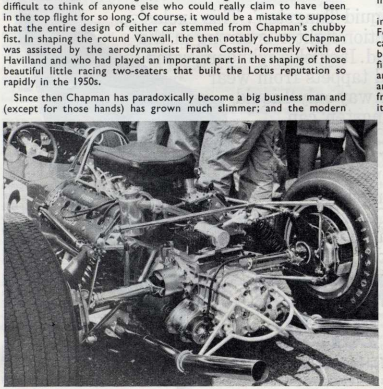
'Who overcomes by force hath overcome but half his foe'—Milton

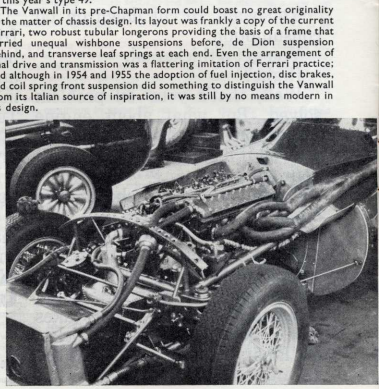
IN July, 1957, the British Grand Prix was won by a Vanwall driven by Tony Brooks and Stirling Moss. In July, 1967, the British Grand Prix was won by a Lotus driven by Jim Clark, in the presence of Brooks, Moss and a Vanwall (albeit the 1958 version), all there to take part in a perfectly splendid parade of classic racing cars driven by *Anciens Pilotes*. Another interested party on both occasions was Colin Chapman, who had a big hand in the design of both of the cars.

The two prompt an interesting study in comparison, for they show the progess made in ten years by a man who has remained in the top flight of racing car constructors for an unusually long time. Ferrari has of course been at it longer, and so had Bugatti in his time; but it is difficult to think of anyone else who could really claim to have been in the top flight for so long. Of course, it would be a mistake to suppose that the entire design of either car stemmed from Chapman's chubby fist. In shaping the rotund Vanwall, the then notably chubby Chapman was assisted by the aerodynamicist Frank Costin, formerly with de Havilland and who had played an important part in the shaping of those beautiful little racing two-seaters that built the Lotus reputation so rapidly in the 1950s.

Since then Chapman has paradoxically become a big business man and (except for those hands) has grown much slimmer; and the modern pencil-slim Grand Prix Lotus has come from more than one drawing board. Nevertheless, it was Chapman who was the chief architect of both cars, creating in the Vanwall not only his first Formula 1 car, but also the last front-engined Grand Prix machine to be an unquestionable success, the definitive form of the classical monoposto racer. After two more front-engined ventures—he was engaged as a consultant by BRM to revise the 2½ litre car, then went on to build his own beautiful yet abysmally unsuccessful type 16 Lotus—he then set about the business of becoming a revolutionary in the wake of the Coopers, and in the process produced a succession of Formula 1 Lotus cars in which must be recognised the definitive form of the modern rear-engined monoposto racer, culminating in this year's type 49.

The Vanwall in its pre-Chapman form could boast no great originality in the matter of chassis design. Its layout was frankly a copy of the current Ferrari, two robust tubular longerons providing the basis of a frame that carried unequal wishbone suspensions before, de Dion suspension behind, and transverse leaf springs at each end. Even the arrangement of final drive and transmission was a flattering imitation of Ferrari practice; and although in 1954 and 1955 the adoption of fuel injection, disc brakes, and coil spring front suspension did something to distinguish the Vanwall from its Italian source of inspiration, it was still by no means modern in its design.





For 1956 great things were schemed for it, that being the first year that the Vanwall engine (formed in effect from Norton heads on Rolls-Royce shoulders) was brought up to a full 2½ litres swept volume. But if the engine was simply modified for 1956, the remainder of the car enjoyed a complete metamorphosis. Chapman, known at the time as probably the most far-sighted and original chassis designer on the evidence of his success with ultra-lightweight and very scientifically designed sports-racing cars, was consulted by Vandervell and undertook the design of an entirely new chassis to replace the existing inadequate one.

The structure that he evolved was typical of his then current work, a space frame fabricated from small-diameter tubes properly disposed by triangulation so that all loads were distributed through the frame members either in tension or compression, and so that elimination of bending stresses allowed tubing of lighter gauge to be employed. He also attended to the rear suspension, trimming the unsprung weight by lightening the de Dion axle beam, and providing at once for precise control of its movement and for accurate location of the rear roll centre by using a Watt linkage for lateral location. The Vanwall gearbox/final-drive complex was rather too substantial to be ditched—which was perhaps a pity, for its arrangement made it difficult to alter gear ratios. However, Chapman managed to reorganise its accommodation so as to provide synchromesh for the four gears and an extra unsynchronised ratio below, so as to allow effective starting-line sprints without depriving the car of the high overall ratios needed on the faster circuits. Then he looked at the front suspension, threw in an anti-roll bar, and called it a day.

The following year he had more to do. He got rid of the leaf spring at the rear, substituting tall inclined helical springs with telescopic dampers inside. He set the rear roll centre high and the front one low, gave the rear wheels three degrees negative camber, and by such means produced a car with consistent understeering stability.

The finished chassis would have given any convention-bound racing car designer of the time apoplexy. The driver sat high in the air, the tall engine was placed far forward, and all the apparatus of rear suspension extended well out towards the rear wheels. How on earth could the Vanwall be competitive, when its shape compelled it to present such a large frontal area? This was where, back in '56, Costin came in. He knew as well as any that a square foot of frontal area was worth yards of streamlining; but he also knew that a frontal area 20% greater than that of some rivals, as the Vanwall's must be, could be compensated for by a coefficient of penetration 15% lower.

The result was perhaps the most surprising and memorable of racing car shapes to have been seen since the 1934 Auto Union erupted from the fertile brain of Dr Porsche. The Vanwall body was a remarkably tall, broad and bulbous shape, and yet beautifully smooth and curvilinear. There were no ugly lumps, no clumsy bulges on the bonnet, no vortex-generating aero screens nor inept pitot intakes for the carburettors. At the extreme nose the air intake for the radiator was a neat lenticular hole of the smallest possible size, and all other bodily apertures were arranged to take in necessary draughts of combustion or cooling air at points of high pressure, and to exhaust waste air in regions of low pressure. Even the exhaust system was built flush with the body, while the high-sided cockpit left only the top of the driver's head emergent from the comprehensively faired structure. The whole thing was commonplace by the standards of aircraft engineers, but astonishingly advanced for motor cars. The barter of frontal area for improved airflow was justified: the Vanwall had a higher maximum speed than any other Formula 1 car of its time.

We must not lose sight of the fact that the Vanwall engine was in any case more powerful than its contemporaries. But the difference was not more than 10 bhp, or rather less than 4%, in comparison with the V8 Ferrari, and this discrepancy could not account for the Vanwall being 10 to 15 mph faster than the Italian car on the Masta straight at Spa, for instance. As we all know, in 1957 the Vanwall became the fastest car in Formula 1 racing; and in 1958, after a winter of frenzied development work on adapting the engine to new fuel regulations that stipulated petrol rather than the nitro/alcohol brew of 1957, not to mention some revision of the suspension to improve the handling, the Vanwall also became the most successful car of the year, winning six of the nine Grandes Epreuves and the Manufacturers' Championship. During the British Grand Prix of that year, held at Silverstone, the best placed Vanwall only finished fourth, in the hands of Stuart Lewis-Evans, but in

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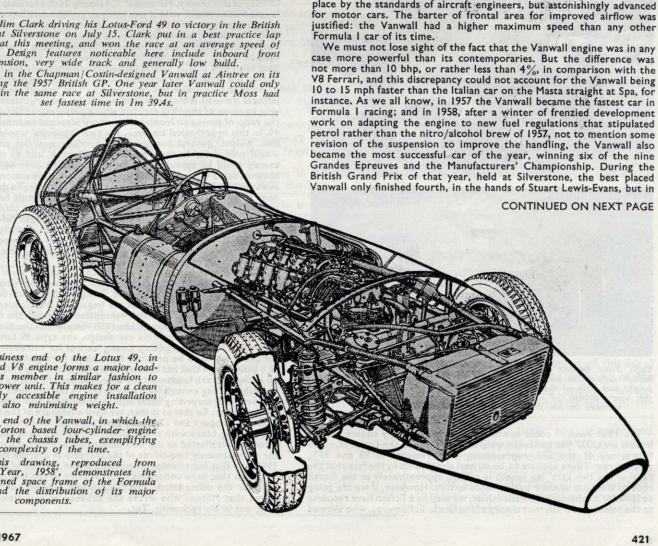
Above, left: *Jim Clark driving his Lotus-Ford 49 to victory in the British Grand Prix at Silverstone on July 15. Clark put in a best practice lap of 1m 25.3s at this meeting, and won the race at an average speed of 117.64 mph. Design features noticeable here include inboard front suspension, very wide track and generally low build.*

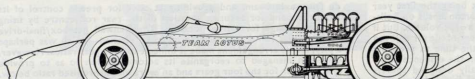
Above: *Moss in the Chapman/Costin-designed Vanwall at Aintree on its way to winning the 1957 British GP. One year later Vanwall could only finish fourth in the same race at Silverstone, but in practice Moss had set fastest time in 1m 39.4s.*



Far left: *Business end of the Lotus 49, in which the Ford V8 engine forms a major load-bearing chassis member in similar fashion to BRM's H16 power unit. This makes for a clean and reasonably accessible engine installation while also minimising weight.*

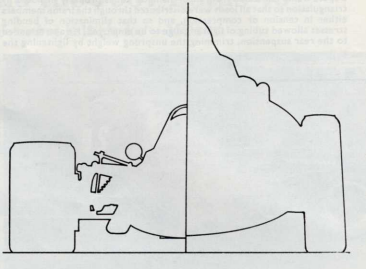
Left: *Business end of the Vanwall, in which the Rolls-Royce/Norton based four-cylinder engine nestles among the chassis tubes, exemplifying the complexity of the time.*

Cutaway: *This drawing, reproduced from 'Automobile Year, 1958', demonstrates the Chapman-designed space frame of the Formula 1 Vanwall, and the distribution of its major components.*



Left: *Side elevation of the Lotus-Ford 49 (reproduced by courtesy of our sister magazine,* Miniature Auto) *shows the monocoque centre section, and generally 'conventional' modern shape.*

Below: *A simple, but telling, comparison in frontal area between the Lotus 49 and the Vanwall.*

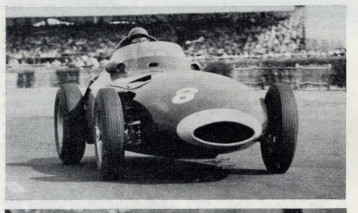


A decade's progress—CONTINUED

practice it had lapped the circuit in 1m 39.4s at an average speed of 106 mph.

At Silverstone in 1967 the Lotus 49 that won the race was driven round the circuit during practice at a speed of 123 mph when Clark lapped in 1m 25.3s. It is not necessary to examine in detail the specifications of this car, for it has become remarkably well known in its short and not entirely successful life so far; but all the features characteristic of Chapman's design philosophy since 1962 are evident therein. The driver is almost supine in a stressed skin hull, ahead of a commercially-acquired engine, the weight and frontal area are minimised to the greatest possible extent; while the highly developed suspension, tyres and brakes combine to make possible not only the approach to and departure from a corner at the maximum possible rates of deceleration and acceleration, but also the negotiation of that corner at a level of lateral acceleration twice as high as the Vanwall could sustain—which involves the negotiation of a given corner at a speed rather more than 40% higher than that of the earlier car!

Not all the improvements made in the intervening years have been of such great measure. The difference between the Vanwall's practice lap in 1958 and that of the Lotus in 1967 is a difference of 16½%; but to see to what extent the change in the basic design of the racing car has been responsible for this difference, we must consider and compare the basic performance factors of the two cars.



Top: *Tony Brooks is almost buried in his Vanwall during the 1958 British GP at Silverstone. Note the generally 'slippery' shape and the height and bulk of the whole car.* **Above:** *Clark in the Lotus 49 during this year's British GP at Silverstone. Comparison with the Vanwall tells volumes on ten years' progress in Grand Prix car design.*

The 1958 Vanwall could summon 20.8 bhp for every square foot of frontal area, 327 per ton laden weight. In the case of the Lotus 49, these figures are 41 and 573, representing improvements of 95 and 77% respectively. There appears to be no real significance in the fact that the ratio of the two cars' lap speeds is related approximately as the fourth root to the ratio of their performance factors. However, if we are going to look for mathematical relationships, we may by a fiction have recourse to the celebrated sixth root theory of the late L. E. Pomeroy, who showed that for similar cars lap speeds were proportional to the sixth root of the ratio of engine power to frontal area. Pomeroy himself was amazed at the validity of this theory. He wrote: 'Obviously such a formula is empiric . . . It could not remain valid if increases in power were not matched with improvements in braking and road holding; improvements in chassis design can in themselves lead to gains in speed with no increase in engine output; and the formula is necessarily limited to the type and size of car used in Grand Prix racing'. So much have racing cars changed over the past ten years that it proves impossible to reconcile their performance factors and realised performances in terms of the sixth root theory.

In order to equalise the cars, suppose that instead we imagine a conjectural Vanwall whose size, shape, weight and engineering style were akin to those of the 1958 car, but whose performance factors—especially the ratio of power to frontal area—were identical to those of the Lotus 49. In this hypothetical instance, the two 'Vanwalls' would be similar in size, weight, general conformation, handling qualities and so on, but would only differ in their performance factors, and so the sixth root theory could be applied. Pursuing these calculations, we find that this notional super-Vanwall could be expected to lap Silverstone in 1m 28.5s, at a speed 11.22% higher than that of its real ancestor. To do this it would need an engine developing about 515 bhp, which would have to be supported by vast quantities of fuel, and which would in turn probably set the relatively puny tyres of the previous decade alight before it reached its first corner. Even with all this excess of power, and supposing that a 1m 28.5s lap were possible, the car could still not have been better placed than on the fourth row of this year's starting grid, with 11 cars that had lapped faster in practice ahead of it.

The difference between 11.2 and 15.5% may not seem considerable, but it is the measure of the improvement that has been wrought in racing car design over the years since 1958. The great revolution to rear-engined all-independent cars was of course begun by the Coopers; but it was Chapman who refined this new conception and made this modern racing car the thing that it is today. If the 1958 Vanwall was the pinnacle of classical front-engined Grand Prix car design, the type 49 Lotus may prove to enjoy a similar ascendancy among cars of its succeeding generations for there seems to be precious little scope for significant improvement of a basic design that has become so crystallised in the past few years that all racing cars are fundamentally alike, and each in effect a Lotus. Perhaps ten years is long enough for a man to stay in the top flight; perhaps there are new and surprising ideas still to come from this man Chapman, or from another. Be that as it may, we have a measure of the improvements that the Coopers and Chapman have together made : for in comparing the existing Lotus with the notional Vanwall we have found that brute strength, manifested as the two performance factors discussed, accounts for approximately two-thirds of the increase in average lap speeds since 1958, and that fair science—manifested as the revision of all the elements of design that have undergone improvement in the interval—is responsible for the other third. This the scholars may find disturbing, for it shows that Milton, who wrote the subhead to this article, was nearly 17% out in his reckoning. Tut.