

COOPER WISHBONE SUSPENSION & ITS SWING-AXLE CHALLENGERS

One time Lotus engineer and Cooper 500 owner Tony Caldersmith looks at the 1951-2 struggle for 500cc supremacy

In the early post war period, when 500 racing was getting underway, there were numerous limitations imposed on designers, not the least being the poor availability of good racing tyres. Another factor was the limited development of suspension systems, particularly for light cars, which in England tended to use non-independent systems (i.e. MG TC beam axles) and very basic chassis designs, usually simple channel-section structures.

So designing a very light car for the new 500 racing scene set some interesting challenges for their usually amateur designers. There was initially a follow-on from the British hillclimb specials, such as *Dorcas* and *Freikaiserwagen*, but this was quickly left behind by some of the more innovative builders such as Cooper, Bicknell (Revis), Keift, Arnott and

Bottoms (JBS).

John and Charles Cooper recognised from the start that they needed independent suspension on both the front and rear wheels and made the inspired choice of using the front suspension from Fiat's 500 Topolino. This comprised a top transverse leaf-spring and lower wishbones, which Cooper used on both the front and rear of the car.

This system initially proved adequate for location, steering and braking loads for these relatively light vehicles as follows;

- The top leaf provided the springing medium, as well as the upper lateral and longitudinal location for the hub upright.
- The lower wishbone provided the lateral and longitudinal location for the hub as well as a pickup point for the tubular shock absorber/damper.

The near central mounting of the spring, which formed the upper suspension link, was a lot closer to the centre of the vehicle compared to the lower wishbone pivots and this resulted in geometry where the outer loaded wheels had increasing undesirable positive camber in a cornering situation. The effective length of the early Cooper top lateral link is probably about 60% greater than the lower link. While the effective length of a leaf-spring acting as a suspension member in flex is less than a solid arm, the change in these applications is probably less than 3% in effective length and would not compensate for the difference between the top and bottom suspension links.

The front and rear geometry was essentially the same and therefore both the front and rear wheels would have similar



Demonstrating a touch of oversteer, the great Ken Wharton expertly power-slides his new Cooper twin out of Shelsley Walsh's 'Top Ess' in June 1950. Photo www.stilltime.com

positive camber under cornering loads. The car's relatively low centre of gravity limited the amount of roll and therefore kept the positive camber of the loaded wheels to a usable amount for most drivers in the early days.

The competitiveness of 500 racing influenced Coopers to make the chassis change from ladder to multi tube in the 1952 Mk6. The change was clearly designed to improve the rigidity of the chassis and therefore improve the predictability of the handling, which had come under some criticism. It was tough enough dealing with the positive camber change and a locked rear axle aggravating handling changes in power on/off situations, but a flexible chassis had made the early cars a handful. They improved that further in the 1954 Mk8, by moving to Cooper's 'curved tube' chassis design which they continued to use on their sports and racing cars up to their 1959 F1 cars.

There were virtually no geometry changes in the Cooper 500 suspension until the 1954 Mk8 when declining competitiveness induced Cooper to upgrade their suspension by revising the front spring pickups. The original central bolted spring location was eliminated and replaced with a 'curly leaf' which provided the lateral location but allowed the main spring to flex around the load point in such a way that it also gave some roll resistance (acted like a roll bar). By widening the front spring mounting/pivot points from 305mm to 393mm and using the curly leaf, Cooper effectively reduced the length of the spring when it was acting as the top link under cornering loads and reduced, if not eliminated, the positive camber problem.

The curly leaf/improved roll resistance concept was also incorporated in the rear suspension of the 1955 Mk9 still further improving its cornering capability. The top spring had limited for and aft locating capability and was eventually replaced by a tubular wishbone in the later F2 and F1 cars, where the top spring would have been unable to cope with the greater braking loads. Cooper's final designs lowered the centre of gravity which minimised any roll-camber changes and resulted in the dominant 500 car by the end of the 500 era.

Most Cooper 500s used a solid rear axle

These roll diagrams by Tony Caldersmith show the slightly reduced negative camber of the Cooper Mk8 compared with the earlier versions. The principal benefit though was in roll stiffness, a new concept for Coopers. The Keift shows some geometry faults which Moss and Parker, in their special versions, were doubtless able to offset by adjustment and driving skill.

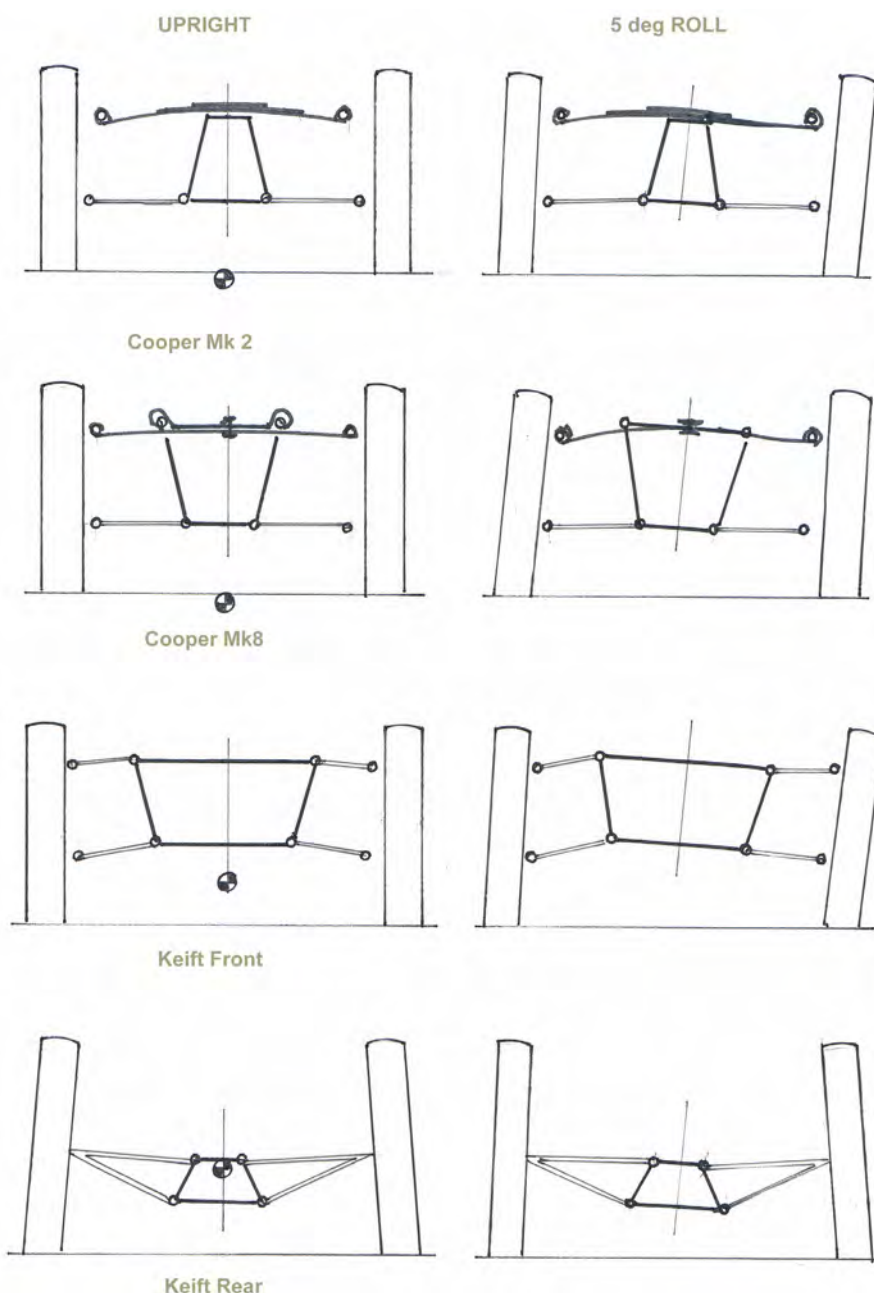
to deliver the power to the rear wheels, although a limited-slip differential was available as an extra. A solid axle tends to need a steady flow of power so as not to upset the handling and that, coupled with Cooper's positive-camber rear suspension geometry, meant that to get the best out of the car, the driver needed to develop smooth cornering techniques. Stirling Moss' smooth style meant he was able to get the best out of his Cooper when in competition with drivers whose previous experience had been on cars that were not so sensitive to abrupt power or steering movements.

The Cooper V-twin cars used basically the same suspension as the 500s, with a change in the number of spring leaves to cope with the greater weight of the bigger

engine being the only variation,

These bigger-engined Coopers had an increase in wheelbase to accommodate the larger engines, which would have made little difference to their handling. The major difference was the extra power. Effectively doubling the power available meant that the driver had the capability to control the cornering by the application of throttle. The V-twin Cooper was probably the first Cooper model that could be drifted, as opposed to steady-on-line cornering, which was designed to minimise power loss and speed in a 500.

While Coopers tended to dominate the 500 (Formula 3) grids, there were some one-off and limited production cars that displayed interesting design ideas, some successful and some not.



In the very early days of the new formula 3, builders came up with a wide range of concepts, including engines, but once the Cooper appeared, it almost dominated the designs competitors used and Fiat suspensions were everywhere. Almost as quickly the engine scene resolved into two options; JAP or Norton, with Norton eventually becoming the dominant engine.

There were a number of innovative designers who sought competitive advantage, if not in engine selection, then in chassis design. A couple of notable examples were as follows:

- **JBS:** had twin wishbone suspension front and rear, but unlike Cooper the top wishbones were shorter than the lower wishbone, resulting in the wheels retaining an upright attitude under cornering loads. These cars were very competitive and if it was not for the fatality of Alf Bottoms in 1951 they may well have become the leading 500 design.

- **Keift:** used a similar geometry on the front suspension to JBS, but reverted to swing half axles at the rear. The second generation Keift designed and built by Dean Delamont, John Cooper (not the Cooper of the Cooper Car Co) and Ray Martin and driven by Stirling Moss also included adjustable suspension, resulting in Moss being able to set the car up to suit his driving style. This combined with a substantial weight advantage made this prototype car successful, a situation that did not seem to translate into the later production versions.

A few of the one-off 500 builders used swing axles at the rear, for simplicity, cost, low weight and the ability to get negative camber on cornering, the latter by setting the car up with substantial negative camber at rest. Fortunately, the racing tyres of the period (usually Dunlop R1) had a more rounded tread than the later racing tyre developments that were focused on maximising tread footprint by keeping the tyre upright during cornering and that meant they were still able to provide reasonable adhesion under camber change.

The post-war 500 formula and the larger 1172 formula were the catalysts for the racing revolution that began the English domination of grand prix racing that started in the 'sixties. The need to compete in formulas where the power available was much the same for all competitors created a focus on handling and chassis design. Success came from both innovation and evolution, both successful characteristics of the Coopers' approach to making 500s.

with 2 wins (including the scratch race for the fastest cars) and no retirements, having raced hard with Tom Sulman's Maserati 4C all day. By contrast, Dick Cobden's Cooper JAP 1100 was unplaced, with several retirements. At the next Mt Druitt meeting on March 22, Brabham repeated the dose with 4 wins and a second out of 5, again including the scratch race. There was more Cooper opposition this time, with Marshall (Mk4), Cobden and Hirst (Mk5s), all with 1100 JAPs. This performance prompted the *Australian Motor Sports* scribe to wax lyrical: "One of the most amazing sights seen in New South Wales for a long time

occurred at this Mt Druitt meeting, when four Coopers all got going at once to put on some fine close racing during the day. Keeping up with the bad reputation of these cars for reliability, three of them performed somewhat erratically as the day wore on, but that of Jack Brabham kept running on like a chaff cutter and scored four wins and a second from five starts. Brabham's preparation of his HRD Vincent engined car was a personal tour de force for repeating last months efforts. His perseverance with this car, which has heart-breakingly played up and broken things for over 6 months, has been well rewarded."



FROM ALLAN FREEMAN

Dear Garry,

It was good to receive *Loose Fillings* 43 via Ian Garmey, and as usual I enjoyed reading it even though my '500' days were 60 years ago!

This note is just to add to David McKinney's 'Big Twin' article. I'm always amazed how well he does with his long range research as it is hard enough to dig up details when you're 'on the spot' let alone when you're resident in the UK.

At the first Ardmore GP there was also another driver with an 1100 JAP - Syd Jensen in one of Ron Frost's JBS' in which he had installed it. He too was a retirement but I think it was in the latter stage of the GP and I don't know what his problem was. As far as know he only used Nortons in all his Cooper 500s.

In my case the engine in my Cooper was an 8/80 JAP ex Tom Sulman which he had used in England pre-war in a Skirrow midget on the speedway. After the war he brought it back to Sydney along with the Sulman Singer but never got around to using it again.

To put the record 'straight' I did make fastest NZ driver twice in practice but the incorrect grid position didn't make any difference as a con-rod 'let go' on lap 11 and that was the end of my race - and of the 8/80 too! Bill Lee had brought out two new 500 JAPS with his Mk5 Cooper and kindly sold me one which I used from then on.

Allan Freeman,
New Zealand

BITS & PIECES

- Not a lot of racing has been done over the winter period, however Brian Simpson ran at the long-track Winton meeting, August 10-11, in the Derry Greeneklee Cooper Mk9 and had a win in a 7 lap event. At the short-track Winton meeting in late May three air-cooled cars ran, Derry in his Mk5 Cooper 1100 JAP, Brian Simpson in the afore-mentioned Mk9 and, making a return to racing after a 13 year sabbatical, Alan Morton in the Alba Triumph 650.

- Garry Simkin ran his Cooper Vincent Mk4 at Morgan Park in Queensland in July, a great circuit which is well suited to aircooled cars. The next event for these is Wakefield Park, Goulburn NSW on September 27-29 for the HSRCA meeting and it's possible that up to four Coopers will be running.

Loose Fillings is published digitally and in print about 3 times year. Please send a book of 60c Australian stamps to receive printed issues by post in Australia only or supply your email address. Recent issues can be found in pdf format at www.hsrca.com.

EDITOR Terry Wright, 02 9418 2974, tsrwright@gmail.com

PUBLISHER Garry Simkin, 28 McClelland Street, Willoughby, NSW 2068, Australia, 02 9958 3935, gjsimkin@iprimus.com.au

FOUNDING EDITOR Graham Howard