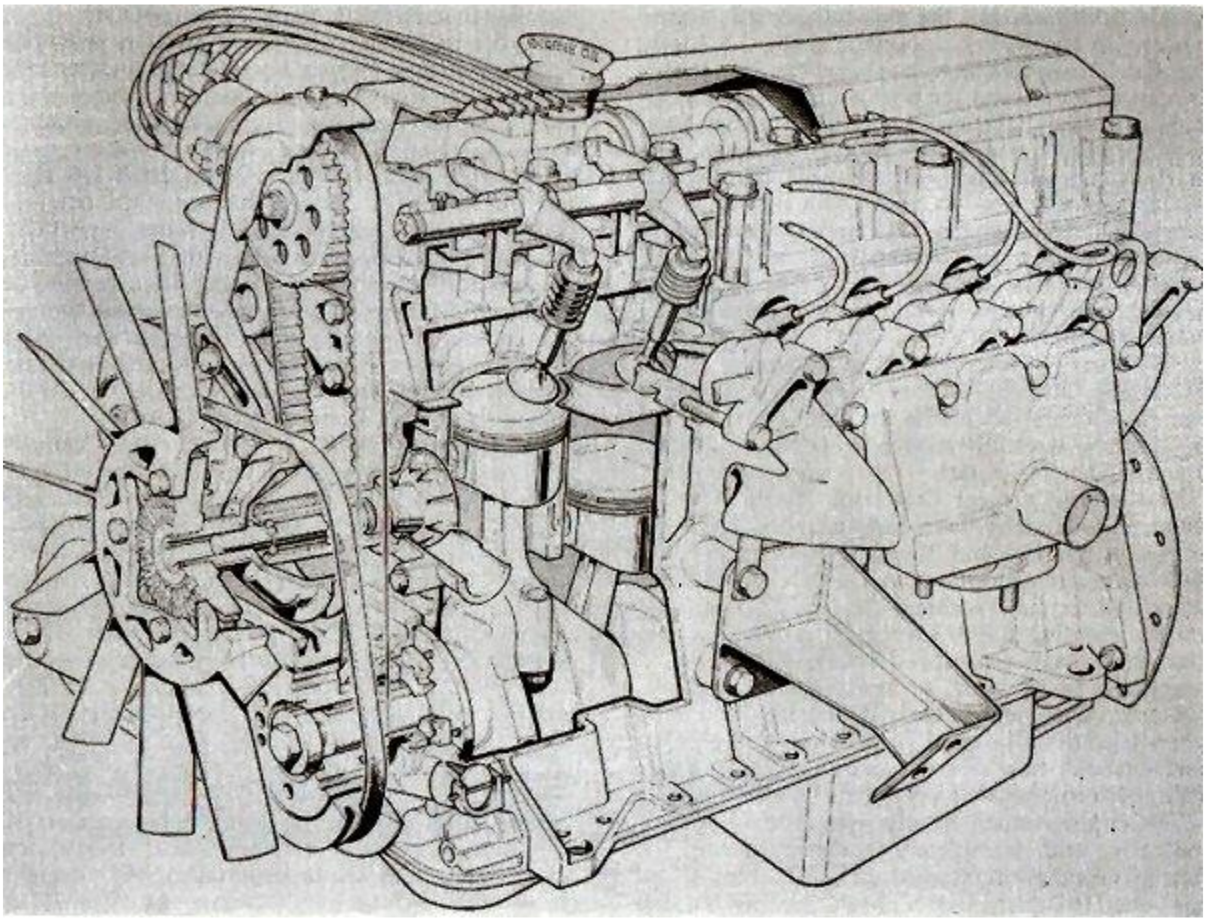
Engines : Rover SD1 Six

Although it has received a bit rap in the trade thanks to its well-documented problems, the SD1 Six is a very capable engine. However, it could have been so much more had it been given the start it so richly deserved.

On its 30th birthday, Robert Leitch casts an analytical eye over this oft-maligned engine and separates fact from fiction…

Leyland’s first, Triumph’s last



In my beginning is my end. In succession
Houses rise and fall, crumble, are extended.
T S Eliot, Four Quartets – East Coker

THE merger agreed on January 17th 1968 which briefly created the world’s fourth largest car manufacturer was a new beginning, yet it was inevitable that some of the ‘houses’ from which this rambling megastructure was constituted would eventually fall. The engine which powered the mid-range Rover SD1 cars represented both a beginning, as the first all-new engine from the merged company, and an end, as the last power unit to be designed by the engineering department of the Triumph motor company, With the rich benefit of hindsight, it should have been clear that the utmost priority should have been given to developing a new range of engines to replace the bewildering and overlapping range of power units inherited by the merged business, many of which originated in the two middle decades of the twentieth century. It is indicative of the paralysis and petty tribalism which prevailed in the first decade of British Leyland's existence that the first new 'Leyland' engine did not appear until October 1977, nearly ten years after the company's creation.

Given the project number RT1 in February 1971, the new large car to replace the Rover P6 and large Triumph saloons, was the first joint Rover-Triumph project. The designation lasted but two months, changed to SD1 to reflect Leyland's newly constituted 'Specialist Division'. The division of labours should have been an indication that the two marques were not yet ready to merge seamlessly into one. Rover's engineers under Spen King, and the Solihull styling department under David Bache took responsibility for the body and chassis of the car, building on the work begun on the P10 project to replace the P6 2200/3500. Triumph's designers had been given the chance to produce their own ideas for a big car replacement codenamed 'Puma' in an internal competition. Rover's proposal won the day, but Triumph's consolation was that three of the new car's major components, the six cylinder engine, the LT77 gearbox, and the rear axle would be designed at Canley.

Observers at the time would have considered the choice of design office to be well-judged. Triumph's engineering star seemed to be at its zenith, with the OHC Slant Four "Saab" engine being followed by a V8 derivative which appeared far more in tune with modern European practice than Rover's Buick-derived V8. The icing on the cake was the award-winning PE114 Dolomite Sprint engine, the world's first mass-produced four valve per cylinder engine. As the years passed, history has viewed that era's Triumph engines less kindly, and regrettably their heritage of cylinder head and gasket problems was to manifest itself again in the SD1 engine.

Inception

In 1970, working under Jim Parkinson, Triumph engineer Mike Loasby, a recent recruit from Aston Martin, was put in charge of the development of an engine project codenamed PE166 intended to power the 'Innsbruck' Triumph 2000 and 2.5PI and its proposed Puma and Bobcat replacement projects. It was demonstrative of the lack of integration of the merged company two years after its constitution that there was no group-wide engine programme and individual companies appear to have had near total autonomy to develop major powertrain components without reference to the needs of the overall organisation.

The earliest proposal was for a low-cost overhead camshaft conversion of the existing Triumph six bottom-end, almost certainly never built as a prototype. The simple in-line valve layout, combined with the base engine's 74.7mm bore could only have brought limited benefits – there would have been no opportunity to increase the valve area significantly, and the gain in more accurate valve operation at high engine speeds would be unnoticed on a long-stroke engine delivering its power low in the rev range. Furthermore, the Triumph bottom-end was already stretched to the absolute limits of its capacity, having evolved from 803cc four cylinder engine of the 1953 Standard Eight.

All was to change with the decision to produce only one car to replace the Rover P6 and large Triumph saloons, with the design responsibilities divided between Solihull and Canley. It was clear that a far more radical approach was required to create a power unit for a car intended to compete directly world-wide with the products of Mercedes-Benz, BMW and Volvo, all of whom already had larger and more advanced sixes in their armouries, and were not marking time in furthering their development.

Closer to home, the Ford Essex V6, freed from the shackles of the gross Zephyr / Zodiac Mk.IV, was gaining friends among the British specialist manufacturers, traditionally Triumph and BMC customers. In Ford's own range the compact unit first demonstrated its potential in the Capri – once installed in the 1972 Consul/Granada, both chassis and engine presented both Rover and Triumph's engineers with significant benchmarks.

Development

By the start of 1972 the design team's brief had been expanded to permit a more ambitious and appropriate cylinder head design, and an increase in cylinder centres to accommodate a larger bore, and "squarer" proportions. The intent at this stage was to produce an engine in one capacity of around 2300cc.

The designers may have been freed from the confines of the old Triumph block, but the dead hands of 'cost engineering' and component sharing were constantly on their shoulders. In late 1972 it was decided that the connecting rods from the Dolomite Sprint should also be used in the new engine, necessitating a reduction in the height of the block. Despite this constraint, the means was found to increase the stroke to 84mm creating a hitherto unanticipated larger capacity version of 2597cc. The bore had previously been set at 81mm for the two engine sizes, allowing the great majority of components to be common to both.

Two significant constraints were to remain in place until 1973, a late stage of the engine's design, just prior to the ordering of production tooling.

The first was the retention of elements of the original Triumph block to allow continued use of existing casting and machining equipment. The second was the expectation that the new engine would be used in the "Innsbruck" Triumph 2000 / 2500, which until 1973 was expected to be sold in parallel with the Rover SD1. This seems astonishing, given that the 1969 facelift would be seven years old by the earliest expected production date for the new engine, but its implication was that a significant finite limit on the length of the engine was imposed by the confines of the big Triumph's engine bay.

In early 1973 it was decided that production of the big Triumphs would cease with the introduction of the six cylinder engined SD1. Far less constrained by the limits of the SD1's spacious engine bay, the engine design team were able to consider alternative proportions including an 86mm bore variation which provided a capacity of 2928cc. With a commitment to production looming, the design team took the best advantage they could of their late emancipation from the final constraints of the old Triumph block and bodyshell. The block was lengthened by 20mm, the bore and stroke dimensions of 81mm and 76mm/84mm were retained, and water passages were introduced between the cylinders. Those familiar with the engine's stablemates will note that non-conjoined bores were a luxury enjoyed but rarely in the British Leyland power unit armoury. While the incorporation of coolant passages between cylinders is without doubt sound engineering practice, the additional space also allowed the opportunity of a substantial future increase in bore size if and when circumstances permitted.

A widely reported challenge faced by the design team indicates that one of the hurdles they faced was the inability of the local production infrastructure to accommodate the engineering practice of the time. Beans Industries, the Leyland subsidiary who were to cast the new block, requested that the water jacket should be reduced in height to facilitate casting of the deep-sided block. This was accepted at first and the resultant difficulty of high piston temperatures was addressed by an oil-cooling solution whereby an oilway ran through the conrod and sprayed lubricant on the underside of the piston. In the background the design team continued to work on a method of achieving a full height water-jacket, and this was incorporated into the production engine. As a result of the introduction of the oil-cooling passage in the conrods, the only significant strand of commonality with an existing Leyland engine was lost.

If the design of the lower half of the engine was in a constant state of flux until it was committed to production, the development path of the top end was far more linear, drawing on Lewis Dawtrey's acclaimed work on the Dolomite Sprint's 16 valve cylinder head. Although the six cylinder engine had only two valves per cylinder, the valve gear was operationally identical to the four cylinder engine, with inlet valve operated directly through inverted bucket tappets, while the same cam operated the exhaust valve through a rocker arm. While the use of a single cam to operate both valves is clearly efficient in terms of parts count, it has the disadvantage of imposing the same opening period on each valve. In practice this was of no real significance, as symmetrical valve timing was used in almost all engines produced at the time.

Again drawing on the Dolomite Sprint engine experience, a pent-roof combustion chamber was used partly formed in the head and partly in the pistons. Considerable work was done on optimising valve sizes during the development stage, with some experimentation into using a very large inlet valve and an exhaust valve relatively smaller than was the accepted norm. The disparity was found to hinder rather than help breathing, and in final form an inlet valve head diameter of 42mm was achieved, the equivalent diameter for the exhaust valve was 35.6mm. The choice of an opposed valve layout with a sizeable 40 degree included angle of was wholly appropriate given the engine's relatively small bore dimension in comparison with its main competitors.

The benefits of this design rigour were demonstrated when the first prototypes developed over 150bhp, uncomfortably close to the V8s output. It is evident that some measures were taken thereafter to tailor the engines' output to their place in the SD1 range, under the guise of optimisation of fuel efficiency.

Realisation

The basic architecture of the engine has been outlined in the 'development' section, but a number of its features, innovative rather than radical, deserve further comment.

The new engine would not have caused any unease at Jaguar or Alfa Romeo were there ever any prizes offered for aesthetically pleasing engines. Physically unprepossessing, with its featureless black 'coffin-lid' cam cover and HT leads and intake trunking draped over looking like an afterthought, it nevertheless was impressive in the way it filled the SD1's sizeable engine bay.

Far more important was the engineering within and around the bland exterior.

The engine's bottom-end was made massively strong at the insistence of Spen King, in his role as Director of Engineering and Product Planning, but the choice of four, rather than seven, main bearings appeared to go against the accepted convention of the time – a decade previously, BMC had expended considerable cost and effort in engineering three extra bearings into the C-series bottom end for its new MGC and Austin 3 litre applications. However the idea of improving efficiency by reducing bottom end friction seems to have been a priority with British Leyland's all-company Engine Development Group in the first half of the 1970s. The implementation of the resulting design decision was above criticism, with a massively strong forged EN16 steel crank (rather than a lower cost but weaker nodular iron casting) running in four sizeable bearings. If further vindication of the four bearing decision was required, the same number featured on Mercedes-Benz's 1975 M123 engine.

A number of other notable features deserve comment:

· The engine was Leyland's first to feature a toothed belt camshaft drive.
· The distributor was driven off the nose of the camshaft and was set horizontally to minimise the engine's overall height.
· A number of sintered components, a technology relatively new in automotive applications, featured including the combined timing pulley and torsional damper, and the water pump impeller.
· The top end design was based on a stack system with a die-cast aluminium alloy camshaft carrier, This gave considerable production engineering advantages over the discrete bearing caps used in the Dolomite Sprint engine, and also anticipated the construction used for the K-Series engine by many years.
· Controlled tightening of the cylinder head bolts featured on the production line, applying a system first used on the Cofton Hackett E-Series line. The elimination of manual tightening was all but essential for accurate fixing of the complex alloy castings of the SD1 and had the additional advantage of eliminating the requirement to re-tighten cylinder head bolts at the first service.
· The Design Council award winning thermostatic inlet air temperature control device, which first appeared on other Leyland engines a few years previously, featured on the SD1 six.

LJK Setright's thorough and incisive analysis of the engine in *CAR* November 1997 observes the extent to which the engine was de-tuned relative to its power potential: 'There is plenty scope for tuning it for high performance: for production ease, the bore of the inlet manifold is appreciably less than the mating bore in the cylinder head, and the same step-up can be seen on the other face where the exhaust ports lead into the inlet manifold. Cleaning up these passages and blending their junctions would be an easy first step on the road to more power, which could be followed by more conventional tricks such as a better ignition system (an electronic one would be far more welcome than the cheap Kettering distributor that is fitted as standard.) and a more adventurous camshaft than the present one which only gives valve openings of 238 degrees.

'The fact that the Rover's performance figures are pro rata less impressive (Compared with the Porsche 928 V8) has nothing to do with its head design, but is due entirely to the obvious and deliberate de-tuning of the engine to modest levels, consistent with a desire to set running economies above other aspects of performance. We have only to see how sharply the BMEP falls off above 5000rpm in the 2600 and above 4000 in the 2600 to see how restrictive the timing and carburation must be.'

As they were developed as one engine, the 2300 and 2600 versions differed only in the crankshaft throws and piston type – even the connecting rods were the same. The 2600 engine used high-duty solid skirted Mahle pistons, while Hepworth and Grandage supplied their W-slot pistons for the 2350cc engine, with an appropriate height set above the gudgeon pin to allow the same 9.2:1 compression ratio as the larger capacity engine.

While the commonality of components between the two versions of the engine was remarkable, there was no evidence of any sharing of major parts with any other Leyland group engine, either existing or projected.

Comparisons

Manufacturer	Rover	Mercedes-Benz	Renault PRV	Ford	BMW
Date	1978	1975	1975	1977	1976
Designation		M123	Douvrin V6	Cologne V6	M30 B25
Application	2600	W123 250	Renault 30TS	Granada 2.8	525
Configuration	6 in line	6 in line	90 degree V6	60 degree V6	6 in line
Bore x stroke (mm)	81.0 x 84.0	86.0 x 72.5	88.0 x 73.0	93.0 x 68.5	86.0 x 71.6
Cubic Capacity	2597cc	2525cc	2664cc	2792cc	2495cc
Head/block material	Alloy/iron	Alloy/iron	Alloy/alloy	Iron/iron	Alloy/iron
Valve gear	SOHC 12v	SOHC 12v	SOHC 12v	Pushrod 12v	SOHC 12v
Main bearings	4	4	4	4	7

Compression ratio	9.25:1	8.70:1	8.65:1	9.20:1	9.00:1
Carburettor	2 SU	1 Solex	1 Solex	1 Weber	1 Solex
Power bhp (DIN) @ rpm	136 @ 5000	127 @5500	131@5500	135@5200	148@5800
Torque lb ft @ rpm	152@3750	145@3500	150@2500	159@3000	153@4000

By the mid-1970s, the new engine under development faced some stern competition. The table below outlines the characteristics of the most significant rivals.

The figures indicate that in late 1977, when production began, the new Leyland six matched the capabilities of its main competitors on paper, but certainly did not set any new standards within the class.

Some brief observations are worthwhile in relation to the four engines listed.

Mercedes Benz M123.
Something of an oddity in Mercedes' six-cylinder pantheon, the M123 was developed to power the W123 250 models produced from 1976 to 1985, and never appeared in any other Mercedes Benz car. It was effectively a cut-down version of the twin-cam 2.8 litre M110, produced from 1972 to 1985, a "pinnacle" product which was Stuttgart's robust and meticulously engineered response to the BMW M30. The smaller single overhead cam engine bears closer comparison with the SD1 six not only for its short production life and limited application, but also for its four main bearing crankshaft, a design decision which flew in the face of accepted practice at the time, but was not without its benefits.

PRV Douvrin V6
At the inception of the SD1's development, it is highly unlikely that the design team anticipated the seriousness of the competition the burgeoning French motor industry would present by the time of their car's launch. The Renault 30TS and Peugeot 604's success had its foundation in the all-new 2.7 litre all-alloy V6, the product of a joint venture amongst Peugeot, Renault and Volvo.

Despite having almost exactly three-quarters of its capacity, the French unit delivered performance close to that of the Rover V8, and smoothness which belied its "wrong" 90 degree V angle. Equally notable was the compact and light engine's supreme adaptability – in a bewildering array of vehicles it was employed in front engine rear wheel drive, transverse and longitudinal front wheel drive, mid-engined and even, in the DeLorean DMC12 and various Alpines, rear-engined configurations.

Produced until 1998, the V6 was accompanied by closely related in-line four-cylinder petrol and diesel units widely used across the Peugeot, Citroën, and Renault ranges. Of all the rivals listed, this is without doubt the one that Leyland, had they been blessed with broader vision and deeper capital reserves, would have done best to emulate.

Ford Cologne V6
In 1977, a rationalisation of Ford's European production facilities sent the British-built Essex V6 into exile in South Africa, its place in the second generation Granada being taken by the older, smaller and lighter German Cologne V6. Dating from 1964 it shared the British engine's 60 degree V angle and general configuration, but had no major parts in common.

The German engine's cast iron heads and pushrod valve operation betray a lack of sophistication in the company of its straight-six compatriots, but outputs were well up to the class benchmark, and improved on those of the bulkier British V6. In the second iteration of the Granada it was a more than acceptable substitute for the Essex unit, the carburetted 2.8 providing comparable power and torque outputs to its predecessor, despite giving away 200cc. The 160bhp fuel-injected version trumped the 155bhp of the carburetted SD1, although the character of the delivery was markedly different.

BMW M30
A six cylinder extension of Alexander Von Falkenhausen's masterpiece, the 1961 M10 in line slant-four, the single overhead cam crossflow M30 was first produced for the 1968 2500-2800 cars. The pair were widely regarded as the outstanding conventional engines of the1960s and 1970s, and still set class standards when they were replaced during the 1980s by the more cost-effective and in many ways inferior M40, M50 and M60 units.

The 'cooking' carburettor 2.5 chosen for comparison leads the group for power, while the relatively high revolutions at which maximum torque is developed indicates the sporting character appropriate to the manufacturer's carefully nurtured brand identity.

Reception

The six-cylinder Rover SD1s made their public debut at the Earls Court Motorfair in October 1977. Supplies of the 2600 were built up slowly and it was not until May 1978 that the first 2300s were delivered to customers. Their arrival was less momentous than the V8 engined SD1's launch a year previously, but the engines were reviewed with keen interest not only for indications of the future direction of Leyland's power unit design, but also for their effect on the performance of the SD1, still wildly regarded with some awe and now to be available to a far wider group of customers.

By 1977 even the weekly British motoring press were far from deferential to Leyland and their products, as was evidenced by the lukewarm reception given to the Marina and Allegro. The company could therefore take comfort from the measured enthusiasm which greeted the new engine. Motor summed the 2600 up their 22 October 1977 road test as follows: 'Though nearly a litre smaller than the V8, Leyland's new single ohc six cylinder engine gives the Rover a very similar – and excellent – performance. It is smooth and flexible, but noisy when accelerating at high revs and lacks good low speed torque.'

In the same issue, Roger Bell's impressions of the 2300 scarcely mention the engine but concentrate on the omission of power steering and the fifth gear from the smallest-engined version. Perhaps he was making a tactfully oblique reference to the small engine's power and torque deficiency when he stated: 'Much as I like long-legged gearing, the 2300's 123bhp is scarcely enough to pull such a heavy car along in an overdrive giving 25mph / 1000rpm. You invariably have to slot down two ratios to get going again after slowing down. Fourth (20.8 mph / 1000rpm seems just about right so why spend extra on a largely redundant fifth?'

In the November 1977 issue of CAR, the new Rover engine found an unequivocal champion in LJK Setright. Particular praise was given to the rigidity of the block, with deep ribbed skirts extending well below the crankshaft centreline, and the bold decision to use four rather than seven bearings.

Setright speculates that Harry Mundy may have been instrumental in that decision – around 1971 he was advocating reduction of bottom-end friction as the most fruitful path to improving power and efficiency. The idea is an enduring Setright theme. In a later article on the Bristol six-cylinder engine (CAR July 1981), he memorably comments that: 'These proportions … allowed the short crankshaft to spin freely in four main bearings instead of labouring in seven.'

Of the upper half of the engine, Setright is no less effusive, he notes that while the inlet valve area of the contemporary Porsche 928 engine was less than 19 per cent of the piston area, the equivalent figure for the Leyland engine was 27 per cent. He expounds further with the following: '….you only have to look at the high-duty solid-skirted pistons (with steel constrictor bands, as in the Sprint) provided by Mahle for the 2600, or look at the elegance and obvious efficiency of the camshaft and tappet gear in their separate aluminium alloy diecasting above the head, and at the smooth profiling and generous section of the 12 ports, to see that there is plenty of scope here for making an engine of quite brilliant performance should our motoring way of life take a turn for the better some time during the next ten years.'

Setright's impressions of the early 2600 were characteristically iconoclastic – he was at pains to challenge the accepted orthodoxy that the smaller engines diminish the SD1's appeal, and suggests that the six cylinder units imbued a different but welcome character to the car: 'It (the 2600) is a gentleman's car in a way that the V8 cannot aspire to emulate. The engine is a smooth hummer, quick to answer the throttle pedal, strong enough to qualify the car as a fast one, but always impeccable in its manners.'

As the years passed, opinions polarised somewhat. In the December 1980 issue of the same publication the trenchantly perceptive Ian Fraser summed up the engine of the 2600S (a new designation denoting trim changes and improved equipment, although the engines remained unchanged) he had just driven to the Paris Salon as follows: 'Apart from being a finicky cold-starter (the manual choke requires frequent and prolonged use) the engine's other hurdle is its lack of refinement. There's nothing you could put your finger on and quantify, like a transient vibration period, but there's a nagging rawness about the way it does things. Never smooth, never truly harsh, just a limbo-land engine floating in a greyness that's curiously behind the times. Conversely this does bring character to the car: the engine, and the whole car around it, has a hearty, full bodied feel to it that you can grow to like very much.'

Earlier in Fraser's article is a single sentence which turned out to be extraordinarily prescient: 'It remains the sort of power unit that history will record as merely a means of moving a Rover, rather than as a work of art in its own right'.

The manual choke to which Ian Fraser referred was banished to history along with, its elegant but fragile console mounted operating lever, when the Cowley-built series II cars appeared, including the new automatic-choke SU carburettors among a wide range of refinements. It was however notable that beyond the new carburettors, no substantive changes were reported to the six-cylinder engines.

CAR's assessment of the updated cars in January 1982 seemed prematurely elegaic. What SD1 admirer would not have felt a chill on reading these words?

'When, at the turn of the century, the last Rover SD1 is compressed into a cube of waste steel, it will be the 1982 versions that historians will implore us to remember'.

Returning to the six-cylinder engined cars, a process of ongoing refinement had delivered some benefits. Later in the same article the un-named writer makes these telling observations: 'More convincing, more driveable and more refined, the 2600S has now moved from the prototype stage into the fully developed model it has always strived (sic) to be… Rover have developed a greater understanding of exhaust noise problems and have been able to do something about it in the 2600S, the taming of the pipes has transformed the car into a silky performer not far removed from the smoothness of the V8s.'

Down the boulevard of broken dreams

The collected road test comments suggest that, for an all new engine, the SD1 six in 2.6 litre form was, at best, adequate for its job. The smaller capacity version of the engine was considerably worse, its low speed torque deficiency making it appear considerably less powerful than a 13bhp difference would suggest. There was no compensation in running costs either – low gearing and an unfavourable power to weight ratio made the 2300 less economical than the V8 in both manual and automatic forms.

There is evidence that the new engine was burdened by high unit costs. The immensely strong bottom end, high quality materials, and built-in expansion capacity suggest a design which defied the company's bean counters. The protracted development period, lack of commonality with any other engines, and largely new production equipment also took their toll in costs. The problem would have been exacerbated by relatively small production numbers. The SD1 engine's highest annual production was just over 30,000, dwindling to 10-15,000 in later years. The Austin-Morris O-series annual production, by comparison, peaked at around 100,000 engines per annum.

The consumer was to pay the price in the currency of ruthless reductions in equipment levels in the early six cylinder models. In order to achieve the 2600's £5800 price tag, £1000 less than the 3500, power steering and electric windows were omitted from the specification. The sacrifices paid by early 2300 owners were far greater: Self-levelling rear suspension, fifth gear, halogen headlights and even the boot carpets were omitted, and drivers had a constant reminder of their parsimony in the form of a cut-down tachometer-less instrument module which would have disgraced a van.

Competitive pressures ensured that equipment levels were quickly upgraded, the effect on unit profitability no doubt being shouldered as grudgingly as ever by Leyland's ultimate proprietors, the British taxpayer.

Any engine's lack of distinction in performance, refinement, or fuel efficiency could be forgiven readily if it demonstrated bulletproof reliability and longevity in service. With its immensely strong bottom end, relatively simple valvegear design, and unstressed state of tune, the SD1 six appeared at least to have the potential to provide durability and dependability.

Regrettably this was not to be the case, and the trade and consumers soon became aware of a variety of top end problems leading to costly and often catastrophic failures.

The most widely known point of failure was the abnormally high incidence of camshaft and valve gear failure, resulting from blockages to the oil feed passage to the camshaft and valve rockers. The system was designed to provide an intermittent oil feed to limit the amount of oil in the top end and thereby reduce oil consumption – standard engineering practice, but in this application sludge build up could block the oil supply completely with disastrous results. It might also be speculated that the Dolomite Sprint inspired valve gear had a particularly hard job – each cam had twice the normal amount of work to do, and in the six cylinder engines also had to cope with far larger valves and consequently stronger springs than the 16 valve four. What is certain was that the situation was not helped by the lengthening of oil change intervals from 6000 to 12,000 miles with the 1982 facelift.

In the 1970s and 1980s top end problems were widespread among the new breed of OHC engines. As well as the Triumph engines mentioned previously, Ford's Pinto and CVH engines and their GM competitors suffered a variety of wear, lubrication, sealing and gasket frailties. Nevertheless, Leyland's failure to make the changes necessary to address their new engine's Achilles Heel as soon as the first failures became evident seems like an act of serious commercial negligence, given that the engine was a showpiece for the company's engineering capabilities, and that a sustained reputation for poor build quality and unreliability across the entire product range was setting sales of most of their products on a downward spiral.

Production of the SD1 six ended in May 1986. Despite an existence lived out in the permanent shadow of the charismatic V8, the six cylinder engines powered almost exactly half the 303,345 SD1s produced. The 2600 was unquestionably the more popular six, accounting for 35.6 per cent of overall SD1 production. For comparison, the equivalent percentages for the 2300 and all V8s are 14.2 per cent and 37.6 per cent respectively.

Before the Series 2 SD1 range appeared, the plans for its XX successor, and indeed its principal technical details, were widely known. Rover's future passenger car engineering direction was to be Honda-led and exclusively front wheel drive, and held no place for the SD1 straight six, nor indeed the V8 which had cast a shadow over its entire relatively short existence.

Premature though it may have been, the Rover six's demise simply reflected changing realities in the world of automotive engineering. The widespread adoption of front wheel drive even in very large cars, and the pressure of crumple zones, pedestrian impact protection, and ancillaries on engine bay space were to ensure that by the early 1980s the V6 was the near-universally favoured large engine solution for the world's carmakers. Today, other than for BMW, for whom the configuration has become nothing less than a corporate leitmotif, and Volvo, with their ingeniously applied modular engine, the straight six has been consigned to the history books.

Footnotes

To paraphrase Winston Churchill's rather unfair description of Clement Attlee, the SD1 six was "a modest engine with much to be modest about". It is intriguing to speculate firstly on what might have been had the undoubted potential of the unit been realised, and secondly, whether the one and only purpose the engine served, powering the middle-range Rover SD1s could have been more effectively achieved by using different "building blocks" from the corporation's range of engines.

Onwards and upwards

Technical analyses of the new Rover engine which appeared at the time of its launch naturally speculated on the directions its future development would take. A capacity increase was the most obvious. The reduced block height set in 1973 probably ended the possibility of any substantive stroke increase beyond the 2600's 84mm, but Setright mentions 'there is enough meat in the bores to permit opening them out by 3mm or so' (CAR November 1977). This size increase presumably would still retain the water passages between cylinders – maintaining commonality of components between the two versions would give useful capacities of 2.5 and 2.8 litres. Beyond this, the Robson/Langworth Triumph history mentions a capacity of 2928cc being achieved with an 86mm bore, before the engine dimensions were finalised for production.

It should be noted that the water passages between cylinders were a late addition, and if sacrificed, as was the case in the majority of existing Leyland engines, a full three litres would surely be attainable. Given that its valvegear design was derived from a four-valve per cylinder unit, it was speculated that the Rover unit would eventually follow the same path. The power figures achieved easily from the Dolomite Sprint engine clearly demonstrate that had a 24-valve, 3 litre, fuel injected engine been developed, it could have provided a class leading 200+ bhp within the lifetime of the SD1.

Several factors militated against such development. The first was the economic and political turmoil resulting from oil supply uncertainty, which triggered rampant inflation and was to bedevil economies worldwide and hit the UK particularly hard from 1973 the early 1980s. Conspicuous consumption fell from favour, to be replaced by a spirit of belt-tightening and a quest for ever greater efficiency.

The other was the undoubted influence of Jaguar on any upward development of the Rover range. Commercial logic would have suggested building on the SD1's favourable reception by moving the six cylinder engines into the sector occupied by the original 155bhp V8, and developing its V8 versions to provide the far greater power and larger capacity it was only to deliver late in its life. It was surely no coincidence that the fuel-injected Vitesse and Vanden Plas V8s appeared as late as October 1982 when the countdown had already begun to the August 1984 Jaguar flotation.

Playing by the European rules

Another commercial opportunity missed was the adaptation of the six cylinder engines to fit the fiscal strictures imposed by most European governments on large-engined cars. These took the form of increased sales tax, road tax and, in Italy, even driving licence restrictions. These varied widely from country to country, but particularly penalised capacities of 2.8 litres and above. The German manufacturers manifestly recognised and exploited this with their engines, which were invariably just below the 2.8 litre limit. The competing 3.5 litre V8 SD1 was left in the invidious position of attracting a disproportionately high tax burden in much of Europe while giving no more power than its smaller capacity rivals. A de-restricted 2.6, with the cam timing and manifolding alterations necessary to provide 150-160bhp would have provided an acceptable substitute with a far lower consumer tax burden, and could have been developed at minimal cost.

For the most fiscally punitive territories, Italy and Greece being the prime examples, a short-stroke 2.0 litre six would have widened the cars' market considerably. Again de-restriction would easily have lifted the power output to 2300 levels. Such an engine would have been an ideal candidate for turbocharging, curiously ignored by Italian legislators when setting their limits.

With the benefit of hindsight, tailoring the six cylinder engines to European tax categories would have made sound business sense and, at far less cost and risk, could have delivered many more sales than the SD1's inglorious North American adventure.

Missing the Diesel boat

Another potential development route, also mentioned in Robson and Langworth's book was a diesel version. The engine's immensely strong bottom end looks to have been designed with this possibility in mind, and a high-efficiency high-performance turbo-diesel with would have fitted the Zeitgeist of the SD1's era perfectly.

The diesel deficiency was partly addressed from April 1982 by the bought-in VM turbo-diesel engine in the 2400SD, which briefly made it the fastest diesel car sold in the UK. The Italian engine was costly, lag-prone, and over-complicated as a result of its modular design.

A home grown six cylinder turbo-diesel engine would not only have filled an important gap in the SD1 range – it could, in time, have changed the course of the entire company's history. The other Leyland product in desperate need of a high quality diesel engine was the Range Rover. Had Austin-Rover used the SD1 six as the basis of their second Perkins joint venture, rather than the "Iceberg" V8, would they have needed to open their door to BMW in their search for an engine good enough for the 1995 P38A Range Rover?

A pointless exercise?

E6 – an engine for nothing?

For a few thousand SD1s built by Leyland South Africa from 1977 to 1983, this option became reality. As a result of the 1976 closure of Leyland Australia, the tooling for the P76's 2622cc E-Series six was transferred to Blackheath, in Western Cape province, for use in the locally built SD1. The engine was in a very soft state of tune, giving only 110bhp, but was reported to be smooth, torquey and surprisingly economical. Intriguingly, it is reported that some examples were delivered to the UK for evaluation purposes. Since this can be assumed to have happened once the SD1 six was in production, it seems possible that Leyland management may have seen an opportunity for a particularly ruthless piece of rationalisation and cost-cutting!

With its archaically undersquare dimensions and simple in-line ohc valve configuration, the E-Series six resembled the inchoate PE166 proposal which never developed beyond the drawing board. It was in no sense a better engine than the SD1 six in its final form, but given the 95bhp output of the Maxi HL, effectively two-thirds of the same engine, it can be seen that the highest power outputs ever required of the Triumph designed engine were well within the capability of its similarly-sized BMC designed stablemate.

The real attraction of the E-series option is that it would have cost virtually nothing to develop and would have provided additional utilisation for the chronically under-employed Cofton Hackett plant. Giving consideration to the group's wider needs, if a ready-designed engine had been used in the SD1 the talents of these Triumph engineers could have been better employed on the truly modern small engine which was so desperately needed to meet the challenges of the Peugeot XA and Volkswagen EA111.

Six-Cylinder O-Series

The other new Leyland engine, the four cylinder 1.7 and 2.0 litre O-Series became available with the launch of the Princess 2 in July 1978, only nine months after the Rover engine. Less ambitious in its engineering than its six-cylinder near-contemporary, and far more constrained by manufacturing costs and its early applications, it nevertheless proved extraordinarily adaptable and enduring.

A six cylinder O-Series would never have fitted under the Triumph Innsbruck bonnet, but the convoluted path the SD1 six followed to production led to it being almost the same size per cylinder module as its Austin-Morris counterpart. The putative O-6 would almost certainly have been shorter than the production SD1 six. As with the E-Series, although with far greater development potential, the attraction of this option would be the opportunity of sharing production facilities and the development process with a high-volume mass market engine – exactly the strategy which served Volkswagen and Audi so well with the EA827 series.

V6 Options.

It has been observed that there were at least three in-house routes already in place to provide a V6 of the right size for the SD1. A cut down Rover V8 is the most obvious – such an engine was produced in tiny quantities from 1984 with DOHC four-valve heads for the Metro 6R4 and XJ220. The most persuasive reason for this option not being pursued was that the V8 production facility was operating at full capacity for most of the SD1's life. Similar arguments could be used against the feasibility of a six-cylinder derivative of the Stag V8 – the disruption to the shared production tooling meant that the time taken to produce one V8 was the same as was required to make three slant-fours.

There is a further, intriguing, if improbable, option involving halving a Jaguar V12 to produce a 2.7 litre V6. Close in size to the Douvrin V6, but with the "correct" 60 degree V angle, it could have been put into production at very little cost in capital or development time. Whether the chronically under-utilised Jaguar V12 production line could have provided the 600 engines a week required at the peak of SD1 six production is questionable. A more viable version of this strategy would have been to utilise the research and development which had gone into the Jaguar V12 as the basis of a range of in-line fours and V6s, including diesels, designed for high volume production. If this plan could have emulated the success of the French PRV engines, Leyland's investment would have been rewarded with an engine range which remained competitive well into the final decade of the 20th century.

Instead, by developing an engine from their past rather than creating an engine for their future, the company found themselves with a major component line incapable of serving them any further purpose after fewer than nine years of operation and just over 150,000 units produced.

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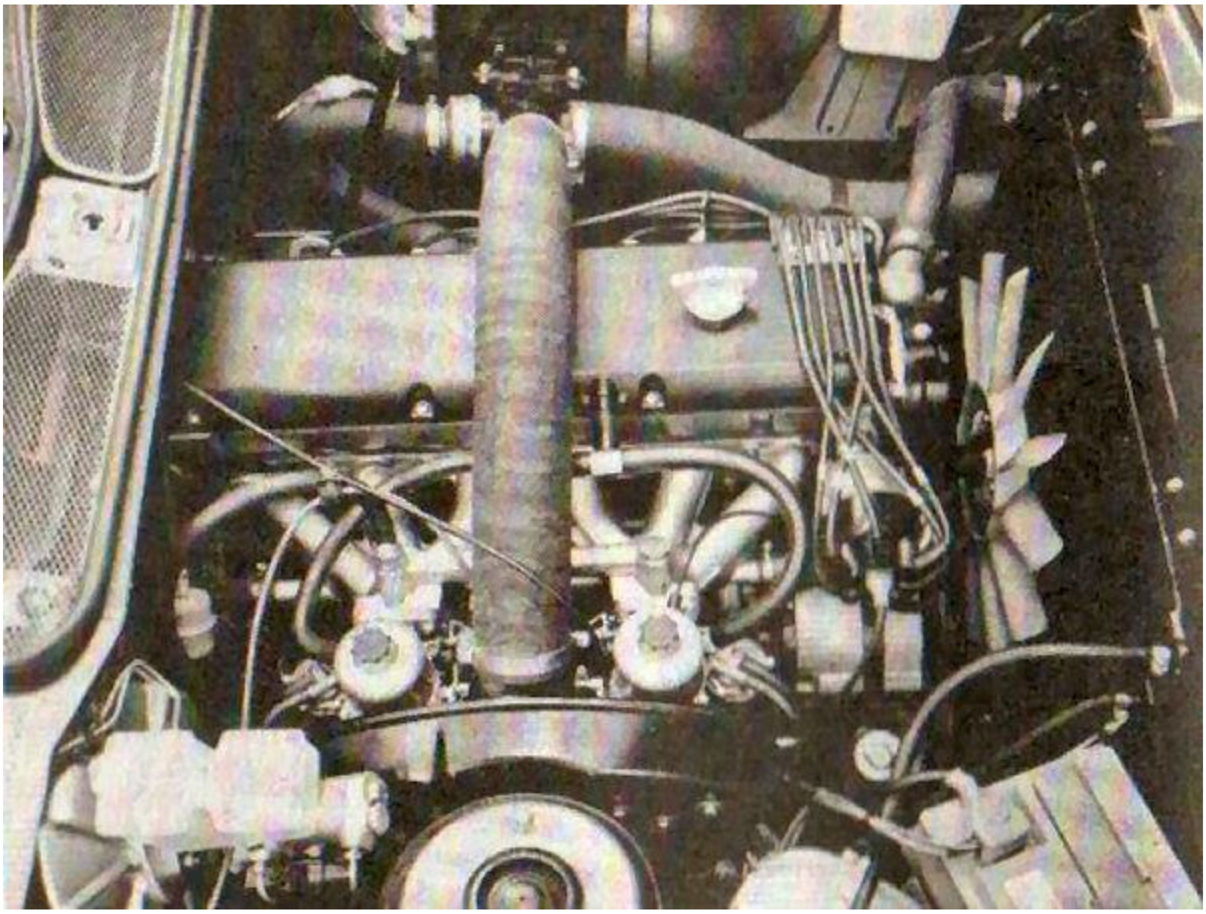
Gallery



The 2600 unit, installed in an early Rover SD1.

Posted in: Engines, SD1

About the Author: Keith Adams

AROnlineholic between 2001 and 2014 - editor of Classic Car Weekly, and all round car nut...

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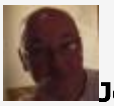
1. **Jonathan Carling** says:

27 August 2011 at 7:17 am

That need to develop a new engine from the basics of an old one was driven by cost considerations – and was a common feature of BL engine design at the time. The R and S series were developed from the E series, and the O series from the B series (and the later M16 and T series were based on the O). The extent to which this policy was successful is debatable, with the T being an outstanding engine, but the others having flaws – especially the O which was rough and gutless. Did they actually save any money over the cost of developing a new engine? It seems that the changes required were so great, and new challenges emerged during development which pushed up costs, that the savings over the development of a new unit were probably limited.

The shining exception to this practice was the K-series, an engine ahead of its time which eventually replaced all predecessor engines – although when expanded to 1.8 cooling became problematic and resulted in the well-known head gasket problems.

Reply

2. **Richard Moss** says:

27 August 2011 at 10:46 am

The sharing of parts between the two capacities reminds me of the AJ6/AJ16 used in the XJ40 and X300. All versions of that engine used the same block (2.9, 3.2, 3.6 and 4.0) and varied the capacity by changing the stroke whilst still using the same connecting rods, pistons and cylinder head (except the 2.9 which used one V12 head).

This makes life easier for the DIY mechanic as my 4L Sovereign is now quite happily using a head from a 3.2

Reply

3. **Hilton Davis** says:

27 August 2011 at 1:27 pm

A very comprehensive article on the 2600/6 engine. I always thought the vast majority of SD1's were V8 powered. I guess the 2.6 litre was a good size bridge between the economy 2300 and the 3500.

I guess the 2000 SD1 would have been underpowered given the body size and weight.

Reply

4. **Jemma** says:

27 August 2011 at 2:26 pm

I've had direct comparison between a SD1 2300 SE and a Renault 25 2.2i GTX and its like chalk and cheese, and there was only 5 years difference, sadly with the SD as the cheese. I don't know what they did to the Rover engine to make it so damn slow but even in perfect tune it was horrible compared to the long stroke Douvrin 4. I suppose you could say it sounded nicer, but that's subjective.
What I don't understand is I know for a fact that the Rover nee Buick V8 could put out much more power than the 143/200 tune in the SD1, so why cripple the S6? Why didn't they leave the S6 in its prototype (decent) configuration, and do the work on the V8 instead?

Reply

5. **Darren** says:

27 August 2011 at 4:32 pm

For a brief period my Grandfather owned an early mk2 Sd1 with the 2-litre 'O' series engine. Marketed as the new 'Rover 2000' this car performed better than it deserved to, but the engine looked puny in the large Sd1 engine bay!

Reply

6. **David 3500** says:

27 August 2011 at 5:05 pm

Jonathan Carling – The O Series "rough and gutless"? Have you never driven an MG Maestro EFi/2.0i? Admittedly the engine is not the most refined unit around, but gutless it most certainly isn't.

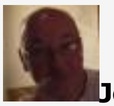
Reply

7. **Dennis** says:

27 August 2011 at 7:04 pm

Isn't the Maestro the R-Series? Then replaced by the S-Series.

Reply

8. **Jonathan Carling** says:

27 August 2011 at 7:58 pm

David 3500 – you're right, I was thinking of the original fitted to the Marina and Princess in 77/78

Reply

9. **Richard Moss** says:

27 August 2011 at 8:12 pm

Dennis – the 1.6L Maestego was the R/S series but 2L cars had the O series. Assuming that the 1.7 was not used (because of tax breaks) I would have thought that a shorter stroke O series would have been a more logical unit to use than the R & S series.

Reply

10. **owen lewis** says:

11 June 2014 at 12:15 am

I've had examples of all the different petrol variants of sd1. The 2300 lacks sufficient torque to pull the gearing, running out of breath once in fifth gear. it sounds a lot sweeter and free revving than the 2600 but is no better on fuel.
The 2600 is a decent compromise. in manual form it's not far behind the v8 in performance with 30 mpg a realistic possibility.
Both of my sixes had religious 3000 mile oil changes and were still going strong well into six figure mileages.
The 2.0 O series SD1 had lower final drive gearing and in this application was in a higher state of tune (twin carbs and 101bhp) than a standard O. not exactly fast but not a slow car either, not the disaster you would expect.

Reply

11. **Pete** says:

24 January 2015 at 2:37 pm

I started my working career as mechanic at a small bl dealer in the Netherlands.
Having worked there from 1979 till 1990, i remember this engine very well.
We once had an 2600 in the shop with 40000 km on it and making a very strange hammering noise We stood around it listening and suddenly the engine seased up!
It turned out to be a repair liner(we delivered the car brandnew) had come loose and once it went down far enough into the block the piston rings jumped over it causing the sudden stop.

Reply