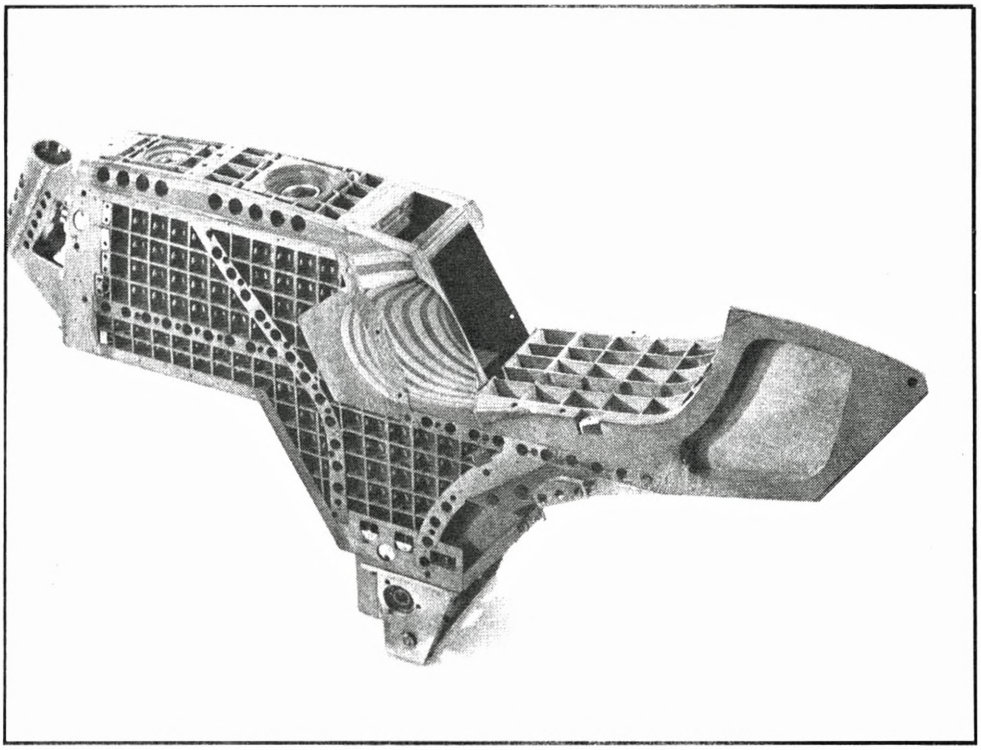
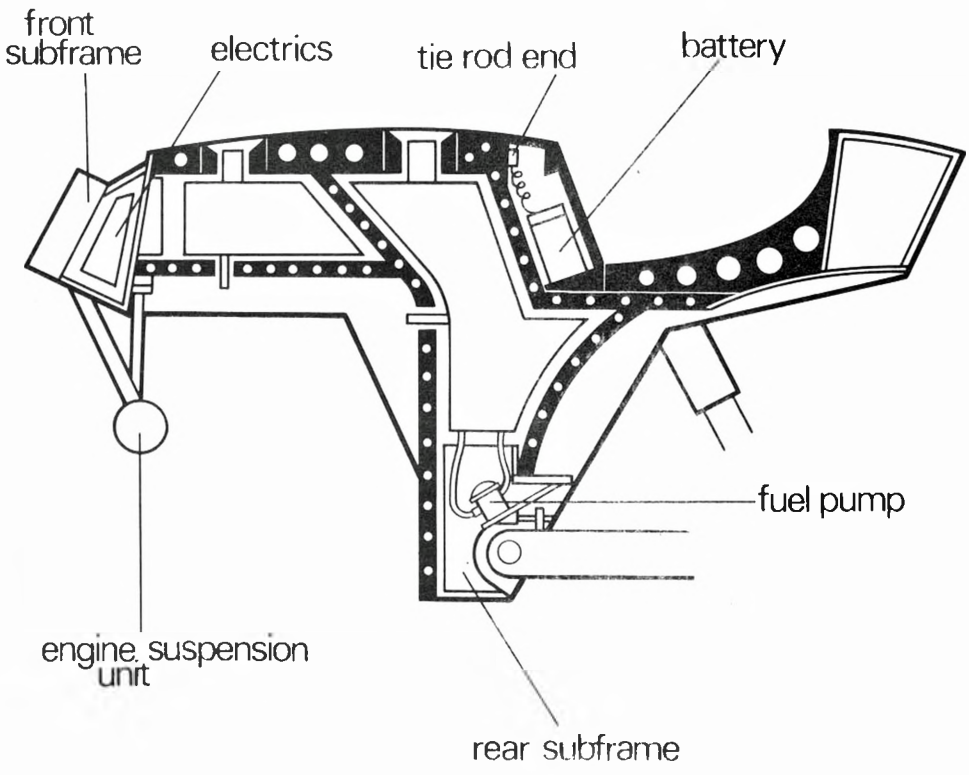
Stirred, But Not Shaken



Above: the plywood monocoque chassis with its dural subframes is a real work of art. It is immensely strong, yet very light, housing dural oil and fuel tanks surrounded by foam.

Below: a schematic diagram of the chassis reveals the way in which it is split into various compartments which naturally help to promote stiffness and strength.



'IF I was going to do anything new now what I'd like to do is make a bike out of four pieces of wood and two castings, but that's another story.' Don Woodford was obviously enjoying himself immensely. Having warped my brain with some of the ideas that had gone into his incredible Red Shift custom machine, he was half-jokingly expanding my horizons once more. I didn't fall over laughing at his suggestion, slap him on the back or ask if there was a doctor in the house. After a guy's built a bike with a wooden monocoque chassis that also cures a Triumph Twin's vibes, anything seems possible.

It all began with a 750 Triumph powered Dresda twin that he bought in 1972. Because the frame was so much lighter than the standard Triumph trellis, the bike vibrated like a road drill. And being a fully qualified mechanical engineer, Mr W decided to do something about it.

'This problem of vibration's been going on since the middle thirties, right. If they'd got a reasonably competent engineer from industry — and I mean *real* industry, not the motorcycle industry — that problem wouldn't have lasted six months. It would just have gone away. It's not a great engineering problem. It's a trivial problem to be quite honest . . .'

He rapidly demonstrated one of the ways of isolating the rider from the vibration produced by a 360deg parallel twin. With the engine pivoted at the rear, the front hung from a link containing a modified rubber engine mount from an MGB and the engine's balance factor drastically altered so that the total mass of the pistons was unbalanced and all the out-of-balance forces were made to act in a vertical direction, the system proved very effective. Very little vibration reached the rider. MZ utilise a similar system on their 250 single.

As Don Woodford explained, 'It only works provided the engine doesn't thrash about an unduly large amount, so you've got to have the weight of the pistons at about one hundredth of the weight of the engine. And then the movement of the engine is one hundredth of the stroke, roughly speaking. So for a three inch stroke you get a 30 thou movement which you can just about tolerate.'

The engine is pivoted at the rear because if it was flexibly mounted here as well chain tension would pull it back until it clobbered the frame. All chain tension goes directly through the pivot mounts and the engine is free to oscillate up and down, controlled by rubber in compression. For Red Shift he went even further and provided lateral rigidity on the front mounting by using a Panhard rod — a device normally encountered on a car with a live rear axle where it provides extra location to the body or frame.

Now although this system is a very simple way of countering engine-induced vibration, there are problems. In many bikes the engine contributes a great deal towards the strength of the chassis, particularly torsional stiffness between the steering head and swinging arm pivot. So when the engine is freely suspended in a lightweight duplex frame like the Dresda's you lose this brace and the penalty you pay for eliminating vibration is a deterioration in handling. The only answer, reasoned Don Woodford, is a monocoque chassis combin-

ing light weight, smoothness and good handling.

I suppose that I should point out at this stage that Mr Woodford hardly considers this course of action — or Red Shift — as anything like radical enough. 'In a way,' he admits with a smile, 'I see this as something that's very old-fashioned . . . it's sort of old/new . . . it's like one of those spaceships in *Star Wars*. There's this fantastic spaceship, all automatic, but when they're being attacked the guy goes to the back and sits there with a gun.

'What you want is a water-cooled engine, totally enclosed in a stressed-skin chassis . . . that's what I should like to make. In the meantime you're left with this hotch potch . . .'

So why stick to this outmoded British engine? For one thing he owned it, and for another he decided that he'd like a well-balanced Triumph twin because apart from its inability to hold its liquor he values the lightness and inimitable power characteristics. Okay, I suppose, but why build a *wooden* chassis?

The argument runs like this. If you compare plywood to steel the former actually comes off better as chassis material especially if you wish to enclose within a monocoque structure all the items such as fuel and oil tanks, electrics and so on which are usually and often untidily tacked on to the outside of a tubular frame.

Take a steel tube of 3in diameter and consider how its weight would increase if its diameter were increased. If the ratio of the wall thickness to tube diameter remained constant, the weight of the tube would increase as the square of its diameter; thus a tube four times the diameter would be sixteen times as heavy. Plywood is about sixteen times less dense than steel, so if this larger, 12in diameter tube was made of wood instead of steel, it would have the same weight as the original steel tube. Now the stiffness of a tube of given material increases as the fourth power of its diameter and its strength increases as the cube of its diameter. So if the properties of wood and steel were the same then the wooden tube would be 256 times stiffer and 64 times stronger than the original steel tube. Taking account of the different properties of the two materials, the wooden tube turns out to be slightly stiffer and stronger in torsion and about ten times stiffer and stronger in bending. It can therefore form the basis of a chassis that is rather stiffer and stronger than a steel unit of the same weight.

So, plywood it was and Don Woodford set to work with 4mm and ⅛in marine ply which is flexible and easy to shape if you know how. He decided to adopt the familiar double-skin structure used widely in the aircraft industry, with the laminations separated by a kind of honeycomb matrix of ply rather like an egg-box. The double skin of Red Shift is stiff and strong, the thickness giving strength to joints that might otherwise require bracing, and tie bolts and metal load-spreading members are easily concealed between the skins.

The side panels were made first and the first skin laid over a curved mould. Using this thickness of ply Don Woodford could only produce single curvature surfaces, achieving the double curvature on the knee cut-outs by building up layers of ply and cutting it back. All the criss-cross ribs that look like an egg-box were individually shaped and glued into place. Once they were in position the panel held its shape and could be taken off the mould and skinned over.

As you can see from the diagram of the chassis, internal panels provide both stiffness for the overall structure and sub-divide the frame into compartments for oil tank, battery compartment and so on. It is this whole assembly of wooden panels and the two dural subframes that form the core of the machine.

The two subframes weigh about 10lb each and the red bit you can see about 25lb. The complete rolling chassis minus engine tips the scales at 160lb. Total weight is 310lb. The subframes play a very important role in the structure and were turned, filed, welded and milled by hand. They relieve the wooden components of stress by providing an alternative path for the transmission of forces and spread residual forces over a large cross section of wooden panels. The rear subframe bears both the engine and rear fork pivots and so provides a path between the engine and rear fork — a specially constructed Dresda box-section unit which moves on tapered roller bearings — for the transmission of the reaction to the chain tension. The steering head subframe, through a tubular support, transfers more than half the engine's weight directly to the Metal Profiles front forks.

If this all sounds delightfully unsound, let me tell you that the front subframe is spigotted to the chassis and located by no less than 14 bolts — with captive nuts behind the wooden panels — as well as two quarter-inch diameter stainless steel tie rods that run right back into the battery compartment directly in front of the seat. 'So if you brake,' laughs Don, 'and the front bolts start coming out like poppers, you've still got those two . . .' And naturally as all the electrical components are housed on a single plate within the front subframe, the tie rods are used to pass power through from the battery. The only wires running anywhere here are the ones to the contact breaker and alternator.

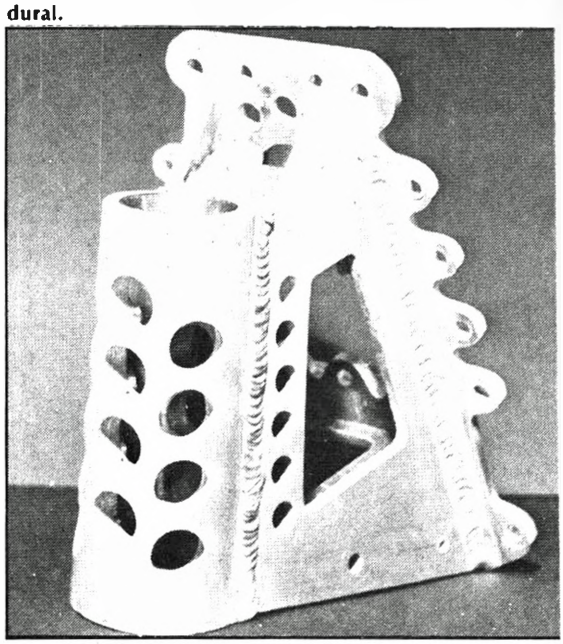
Behind the front subframe and immediately above the engine is a five pint oil tank, constructed like the 1½ gallon fuel tank behind it in 22 gauge dural. Both are surrounded by the chemical-mix expanding foam popular with boat-builders, so the lubrication system must include a finned alloy tube cooler behind the matt black GRP fairing as the foam is such a good insulator. A VW fuel pump sits within the rear subframe, operated by the movement of the swinging arm.

'I think the mechanical pump will be replaced by an electric pump later because you feel a right nerk bouncing up and down on the seat just to keep the engine going,' says Don. The small fuel tank is in turn explained by Don's desire to produce a slim machine and the engine, now with 650cc barrels and a single Amal Concentric Mkl carb, is so high geared that 65mpg is quite possible.

Other details catch your eye apart from the CMA cast wheels, the S&W air shox, the perforated cast iron discs from Pagehiln and the superb rear-set controls. Those 'open' pipes for instance are deceitfully quiet. In fact they're in two sections blanked off internally from one another and interconnected in two loops via a baffled silencer box under the gearbox. They're made of stainless steel and were incredibly difficult to have made, but Don Woodford likes the look of open pipes and dislikes heavy silencers waving around at the rear. Inside the rear-set footpegs are torsion bars to hold the gear lever in the correct attitude and act as a brake pedal

Above: Red Shift is supremely slim. Note the Warp Factor electronic speedo calibration and the beautiful 'three fingers and a thumb' caps for oil and fuel tanks. They're wooden, of course . . .

Below: the front subframe is made from dural.



Photography John Wallace

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preload spring. Everything's inside, out of sight, concealed.

Working in the electricity industry, Mr Woodford is scathing about the crude instrumentation on today's machines. 'When you think of the micro-circuits available now, and what d'you get? You get tachos driven by twisting cables!' He reckons that it's quite possible to have just a single instrument which, with a series of buttons to switch functions, could monitor the whole of a bike's condition from battery state to fuel level and still act as a speedometer. His homemade electronic speedo is calibrated simply 2-4-6-8-10. 'Oh yes, that's Warp Factor 2 and so on.' And the name, Red Shift? 'Oh, yeah. When a star moves away from you at a speed approaching the speed of light there's a shift in the spectrum down to the red end. As the thing moves away from you it gets redder and redder. It's really a white bike, but it's moving so bloody fast it *appears* red . . .'

Despite the three years it has taken him to get it all together, Don Woodford remains detached from his creation. He doesn't claim supersonic top speeds (about 112mph he reckons), but the acceleration should be gratifying from such a light machine. And he thinks that he's gone about the whole project the hard way.

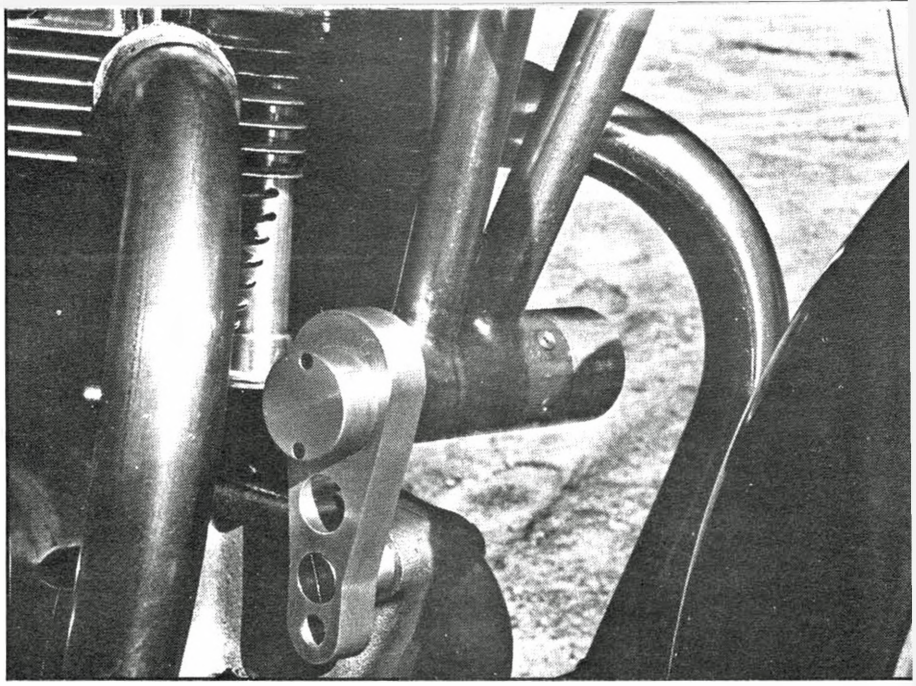
'The first thing to do is to tell someone that this is *not* the way to do it. It takes too long . . . you could build a bike using straightforward ¼in panels as long as you didn't want curved surfaces.' With plenty of bracing at the corners you could knock one up in three weekends. And there are far simpler and quicker ways to produce a double-skin monocoque. You could foam-fill the interior completely or separate the skins with bits of balsa or dowelling, even a paper honeycomb.

'That's it!' he suddenly cried. 'A paper bike; that's what you want. A few copies of the *Mirror* and some Araldite and you could have one of those . . .'

What really struck me while we were talking was how right, how logical his approach to the basic design problems of motorcycles was. He loathes telescopic forks, is in favour of complete engine enclosure but not a silent running machine, and sees little hope of the oversize bicycle with an engine tacked on to it that we are still served up with and which we still demand, disappearing.

'What you want is to make a sudden switch in people's values by bringing out something completely different. Market research won't do that. Market research will only give you more of the same,' he argues.

And of course he's right. I came away from the stockbroker-infested corner of Surrey Don Woodford inhabits having accepted the wooden monocoque chassis as a good thing. Having accepted total engine enclosure as a logical if unlikely development in motorcycle design. I mean, just think about all those superbly seductive shapes you could have, and no engine to wash down before the winter salt scarred its cases for ever. The ideas are highly attractive and the reality might be even more so. But there's a problem. On our current record it's about as likely as Don Woodford's neighbours deciding that just because he owns a few motorcycles he shouldn't really be treated like a social outcast after all.



Above: the engine suspension unit which contains rubber in compression. Lateral location is secured via a Panhard rod while the whole thing is quite beautifully crafted. Exhaust pipes are stainless.

Below: front view of Red Shift reveals the clay-moulded glass fibre nose fairing in the centre of which is the finned alloy tube oil cooler. I wonder what E. Turner would have made of it?