# Steering arms

***by David Cochrane***

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Towards the end of 2002 1 became aware that the topic of replacement steering arms was cropping up fairly frequently in magazines and on the internet. As is often the case, there was quite a lot of chat but very little action! Talking to various people made me realise that the problem was rather more serious than first thought; none of the usual suppliers were selling these arms, and the stockists of used spares were finding it very difficult to get hold of any that weren't cracked. Wayne Rushin (Midshire Sevens) and Tony Betts (County Sevens) were most helpful, and examined

Cracked and broken steering arm (Bruce White)

several batches of steering arms which came through their hands. They managed to crack test a total of about 60 arms, and found that the average failure rate (i.e. cracks present) was around 70-80%.

For those of you familiar with failure analysis, the traditional "bathtub curve" illustrates how some kinds of failure occur early in life, then the failure rate drops; whereas other kinds become more and more frequent as the vehicles get older, i.e. the failure-rate graph rises up again. Fatigue failures belong in the latter category, so we might expect a lot more of these failures as time (and mileage) goes on.

Several people told me that they had had them fail; Nigel Coulter of the 750 Brooklands Centre wrote: "On a fine warm spring day I had been out for a lunchtime pint with a friend and we were returning home. Coming into Liphook we started to turn right at a tight roundabout. This needed a fair wrench on the steering wheel and just as we started to turn, the wheel suddenly became free and we carried straight on into a flower bed on the far side of the roundabout. Fortunately there was no other traffic near the roundabout at the time. Being an Austin 7 it took but a moment's effort to remove it and park it safely by the roadside. Half an hour later having got a lift back home I fitted a replacement arm and we were on our way. Immediately before the steering arm finally, broke there may have been some early warning in the form of an increased springiness in the steering. Otherwise there was no reason to believe there was anything amiss. The arm must have been cracked for some time but it was the hard pull at slow speed (thank goodness) that caused the eventual failure."

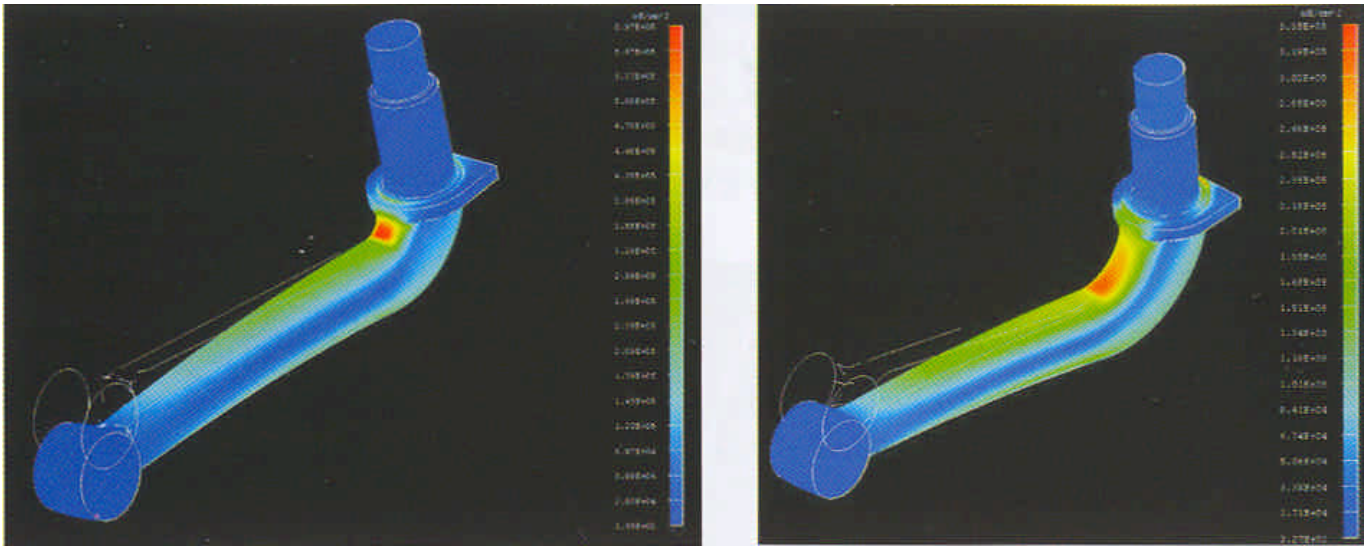
Other accounts usually ended with something along the lines of "Thank heavens there was nothing coming the other way". Obviously it would be a very useful service to get some replacement parts made.

A metallurgical analysis was carried out a few years ago, and Steve Jones kindly supplied me with the results. This suggested that the material used conforms to EN 1 6B.

Looking at the various arms produced by Austin over the years showed that there had not been any significant redesign until the Big Seven came along. This arm is much heavier and the radius of the bend is not so severe, but there are several other differences: it has no flat on the flange, there is a keyway on the shaft, and the arm does not curve back as far as the earlier type. However, to my knowledge, none of this type has ever been known to fail, so it was decided to use this arm as the basis for the new ones. It seemed justifiable, in this case, to break from usual practice and make these parts to a later design.

Assuming that techniques in mechanical engineering and production have moved on somewhat in the last 80 years, I thought that improvements should be possible in both design and manufacture. Given the safety-critical nature of this component, it was decided that a professional quality regime should be observed at every stage of the project. A conversation with Geraint Owen in the pub after the VSCC Derbyshire trial was extremely useful, and he put me in touch with Hartham Technology, an engineering & technology consultancy near Bath. They undertook to analyse the existing design and use computer modelling and analysis techniques to improve the life of the arm. Part of their brief was to retain the aesthetic appearance of the arm as far as possible. Dave Williams of the Austineers kindly allowed them to inspect and photograph a rolling chassis so that they were able to understand the way the arm was fitted and used on the car.

They produced a very comprehensive report, which included finite element model generation, analysis, results and life estimates. They also provided drawings, manufacturing recommendations and advice on material selection for the re-designed steering arm. The stress distribution in the bend for the original and redesigned arms is shown, from which it can be seen that the maximum stress is much lower than before, as well as being far less concentrated (the peak stress denoted by the red in the right picture is about half the value of the peak stress denoted by the red in the picture).



The overall improvement in life of the re-designed arm is significant. From the stress results calculated by finite element analysis, it can be shown that the life has increased from several

thousand to several million cycles (assuming an indicative loading for comparison purposes - this does not give the actual life). For instance, looking only at the stress in the bend, under the assumed loading conditions the original arm would fail in this region after approximately 6 thousand cycles. With the re-designed arm there is a reduction in stress of 48% and this effectively takes the stress below the recommended endurance limit for EN 1613 steel. Hence the life is likely to be greater than 10 million cycles (at the indicative loading). Whatever the actual loads, this represents a large increase in the life of the steering arm at this location.

Hartham Technology also looked at the choice of manufacturing techniques: casting, machining from solid or forging. Each has benefits and drawbacks, but in terms of the steering arm the biggest considerations had to be strength and fatigue resistance. Casting would require complex heat treatment to restore the material structure and properties and was therefore discounted. Machining would only weaken the material slightly (due to cutting through the structure), but to create the steering arm would take a significant amount of time on a CNC mill as well as produce a large amount of material wastage; hence this too was discounted. Forging is the most suitable simply because this will maintain or even enhance the strength and fatigue resistance of the part.

Once the forged part has been produced, only simple machining processes are required to finish the steering arm. They recommended that EN 16 steel should be used, as it gave the best match for strength and fatigue resistance 1 was fortunate in finding Mills Forgings, a local company in Coventry, who were ISO 9001 approved and willing to produce a small batch at an affordable price. They liaised closely with Hartham Technology to ensure that the re-designed arm could benefit from up-to-date forging techniques. All the arms are heat-treated and 100% crack-detected. I obtained quotes from several local machining companies, and selected C.K.S. Precision in Nuncaton, who were recommended for their good work on some vintage Delage parts and were also ISO 9001 approved. Both companies met the prices and delivery times given in their quotations.

These new steering arms are intended for use with any standard Austin Seven, and the improvements in design, materials, manufacturing processes and quality should go a long way towards increasing the fatigue life of this component. They will be supplied painted and with a new nut and lock washer; comprehensive fitting instructions will also be included. Please contact me (A7C@ingineur.co.uk or see under Pram Hood Register on the back page) for price and delivery details.

I would like to acknowledge the encouragement, help and advice of many people in the Austin Seven movement, in particular Rupert de Salis, Steve Jones, Nigel Coulter, Dave Williams, Wayne Rushin, Tony Betts and members of the PWA7C Midshires Group. The advice and assistance of the three companies used in this project have been to the highest professional standards.

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