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Finite Element Analysis
Solving a mesh model.

Having solved the model, we now need to examine the results to see if they are meaningful and realistic, let's see what Lewis has to say on the subject.

So here we have the model already solved and the first thing that we do is check the displaced shape for both sort of direction and magnitude to check it actually makes sense. So if we take a look at this animation it should tell you a little bit about the way the component has been loaded, which evidently it does, you just need to wait a second while it gets going. And you can see from the plot, if we leave it in the right view that it's essentially doing the right things in that the flange is bending locally where the loads are being applied. The axle is stretching generally due to the pre-load and also the bearings are displacing and becoming out of round on the axle which is obviously indicative of high radial loads. And effectively because the magnitudes are all within reason, as you can see the highest one we have here, well it's round about a millimetre so that's believable. If it was twenty millimetres you would probably question yourself and have to start again so that's the first place to start, is just to check the displaced shape and magnitudes are looking reasonable.

So here we have the stress part of the results, and as you can see based on the displaced shape the higher stresses are in the areas that you probably guessed based on the displacements we see. Basically where there's any reasonable amount of bending there's often an associated high stress in the nearby radius. So for example the rather main obvious ones really are the ones near the flange, on both the wheel and nut side. So the wheel and bearing side if you like and they're areas of concern for us which we'll base our calculations for the life of the component on and you can also see high stress gradients near the route of the thread of the nut again because this is where the minimum section is. And some of these stresses we will either disregard or try and use some basic sort of engineering common sense if you like really, to make sure that we don't always use all of the stresses because the peak model stress is very, very high but that actually is adjacent to the constraint that we've used to stop the model from disappearing into space. So we'd ordinarily ignore some areas of the model completely because of that.

And having seen the results in general you can obviously see there is some fairly high gradients going on in these radii so there has to be some decisions made as to whether you'd re-mesh the model, which you often try and come to a decision on that based on the element stresses and as you can see there's not really many high gradients within that radius. Perhaps if we'd had a little more time to do more modelling we may re-mesh this and have it on a longer run time with more elements around the radii, but in this case we'll disregard that because we feel we have a good enough read on the peak stress and the radius which is the one that defines the life of the component.

Red Bull has developed a life tracing policy for components such as the hub, replacing them at appropriate intervals before fatigue failure becomes an issue. The life is related to the number of cycles, the mean stress levels and amplitude of stress variations - all predicted from the FEA results.

Note also that there is a significant stress gradient in the region of the wheel nut, which happens also to be a region of minimum section size. So whilst the wheel nut thread was neglected it was a good idea to take account of the wheel nut load and reaction back on the hub.

Lewis mentions a significant point too regarding the somewhat artificial flange restraint. The imposition of this restraint on a single node generates a high stress gradient surrounding it. This makes sense in terms of the model itself, indeed it should be expected - but it can be safely ignored in relation to the real thing as it was bit of a dodge to anchor the component and prevent rigid body motion.