Finite Element Analysis

Treat your results sceptically.

It is important to consider the results of a finite element analysis with as much rigour as went into the modelling stage. The basic result is the deflection of the structure, stored as displacements Ux, Uy and Uz at all the nodes. This is what the solver produces. Other data are computed directly from these displacements. The displacements are differentiated to produce strains and then stresses are found using the material properties.

Reaction forces at restraints are computed from the displacements and structural stiffness. Then we have to apply our engineering judgements on these predicted results. We would check for factors of safety in material yield using perhaps the Von Mises equivalent effective stress plots. For potential fatigue life predictions we may be more interested in principal tensile stress plots. Remember that Red Bull had their own criteria for lifing the components which would be logged and the components replaced on a regular basis.

The National Agency for Finite Element Methods and Standards - or NAFEMS - says that it is a common mistake in computer analysis to assume that the output, or results, of a processing job are as valid as the processing accuracy of the computer. Instead NAFEMS recommends that it is safest to consider a set of results to be wrong until you are sure that they are at least of the expected orders of magnitude. And for example computed reaction forces agree closely with hand calculated values and so on. Remember, the computer won't tell you that you've modelled the restraints properly, or that the material properties are correct.
And don't forget - in real life the Engineers are responsible for making sure that variations in manufacturing, handling and transport, fitting on assembly and use and abuse in service have all reasonably been covered in the worst case analysis.

In Red Bull's formula 1 team they have built up experience and expertise in the practical performance of the hub and the chassis tub and relating these to the simulation models. Remember then the key messages:Solving complex real life engineering problems involves many explicit and implicit assumptions, requiring experienced judgement from the engineer or designer; The finite element method is very useful and powerful but can only ever give an approximate numerical solution to an already idealised problem;
The results are only as good as the many assumptions and modelling steps involved throughout the process.

In the wrong hands modern finite element packages can be dangerous! In the right hands they are extremely powerful and useful aids to engineering design - an essential part of a winning formula!