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Land Rover, Chassis Integration

The Third Generation Range Rover

Computer Aided Engineering (CAE) is central to the design and development of Land Rover products. The use of CAE techniques, in this instance, allows Land Rover to model and analyse refinement and comfort concurrently with the development of the mechanical design. This provides significant competitive advantage over the historical methodology of developing refinement and comfort on rigs and systems post mechanical design.

With each new product there is an increasing drive towards virtual validation. This drive dictated that it was necessary to develop new techniques for refinement and comfort modelling. To achieve cutting edge analysis for the new Range Rover the latest thinking in modelling techniques needed to be included in the Range Rover SIMPACK ride model.

Once the simulation models have been brought up to the latest standards the effect of any future modifications may then be easily assessed and the integration optimised.

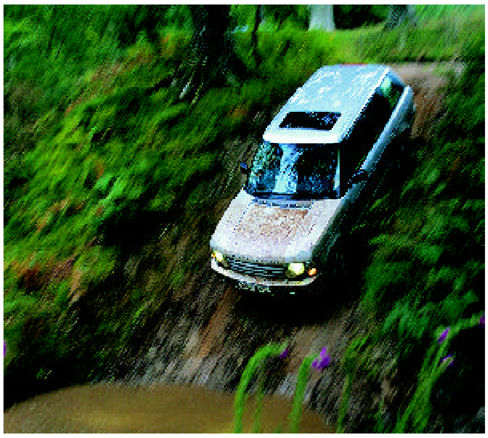
Land Rover has been using SIMPACK for the last seven years and has just recently increased their number of licences. SIMPACK is currently being used by Land Rover for analysis work in the following areas:

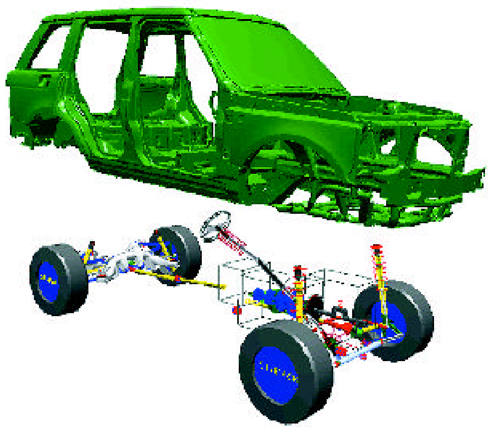
- Ride; where test rigs and varying road obstacles are simulated.
- Driveability, the response of the vehicle to transient engine torques.
- Shimmy (nibble), rotational vibration of the steering wheel, caused by suspension inputs.
- Tramp (power hop)
- Load generation for durability analysis.

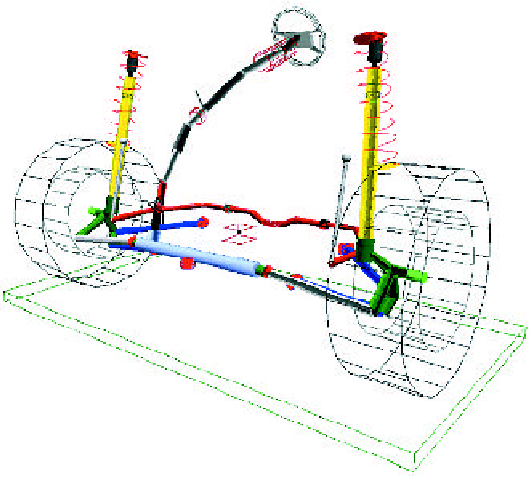
The award winning third generation Range Rover is a luxury permanent four wheel drive sport-utility vehicle. The vehicle offers occupants superior ride comfort and handling on the road as well as off the road on very extreme terrains. SIMPACK has proven to be especially useful for analysis work which includes large non-linearities and sudden changes of states which are necessary for simulating off-road adventure vehicles. Because of internal time limitations INTEC was contracted to carry out work on updating the SIMPACK vehicle model to the latest standards.

Parameterised Substructures

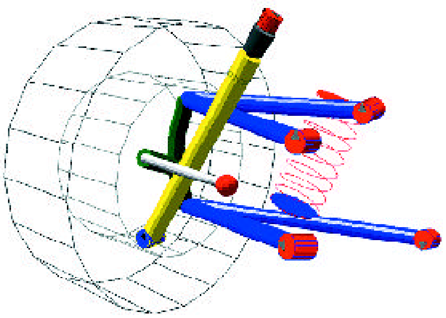
The entire model has been built up using several fully parameterised substructures which not only aid in general model maintenance and updates but also enables easy analysis of individual components and assemblies, e.g. compliance curves of front and rear suspensions. Future simulation models may also be readily generated by simply switching the substitution variable files. Both the



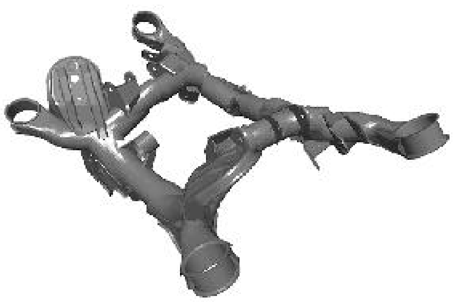




Front Suspension with Steering Assembly



Rear Suspension Unit



Exaggerated Bending Mode of Rear Subframe

front and rear subframes as well as the chassis were modelled as flexible bodies. The complete drivetrain with hydraulic bushings and differential gearboxes was also included as well as the entire detailed steering mechanism.

For each substructure a fully parameterised file exists which not only includes the hard point locations, spring stiffnesses and damping coefficients etc, but also includes all values for describing the 3D graphics with which default inertias are also calculated. The parameter files, which all use a standardised nomenclature, enable a user to easily review, and modify, if necessary, all parameters used in defining the model. Input functions have also been implemented to describe characteristics of the bushings and bump stops. Due to the normalized topology and nomenclature of the substructures entire suspension units can be easily switched regardless of the number of chassis connection points.

Flexible Bodies

Extremely detailed FEM models of the front and rear subframes and body were created using NASTRAN. The chassis FE body consisted of over 400 000 nodes with six times as many degrees of freedom. The models were dynamically reduced within NASTRAN and then integrated into SIMPACK using the FEMBS interface. CAD files (wave front) were also generated from the NASTRAN models using the FEMBS interface. Several SIMPACK input files containing different eigenmodes and frequency response modes of the component could be easily produced. Superfluous modes which lengthen integration times could then be identified and excluded.

Correlation of the model to measured data is advisable to obtain confidence in the predictions. This ensures that the data and techniques used are adequate to describe the situation being modelled.

For example, installing a new power unit in a current production vehicle. The first step would be to model and measure the current vehicle with its standard power unit. An initial correlation exercise would then be undertaken to ensure that the modelling technique correctly predicted the vehicle response. With the initial model correlated the changes to the power unit could be included with a level of confidence.

More detailed vibration comfort work can be carried out with the updated simulation model, thereby allowing Range Rover to stay at the top of its competitive set.

Now that active control of vehicle dynamics is a reality, it is a necessity to include control systems in vehicle models. SIMPACK, along with its interfaces to SIMULINK, will allow these next steps in the development of the virtual refinement and comfort model to progress.