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**Title: *Vehicle Dynamics Project Portfolio***

**This document is part of my resume, showcasing some of the vehicle dynamics project’s executed during my tenure at *JLR, Daimler, Altair and Hinode*** *in the area of* ***CAE – Multi-body Dynamics (Vehicle Dynamics, Vehicle chassis control system and Powertrain Dynamics)***

* ***Design and Optimization of Double Wishbone Suspension and Multi-Link Suspension***

The aim of this project to design and optimize the suspension hardpoints, design, performance, durability and correlate with testing. This involved K & C testing, to determine the optimum response - bump steer, roll steer, brake steer, ride rate, kinematic roll center, roll stiffness, anti-dive & squat angles, Vehicle CoG height, caster, camber, toe angles evaluation, longitudinal and lateral compliance, Aligning torque and understand the effects of mount stiffness, friction/hysteresis.

* ***Directional stability control using Torque Vectoring Differential***

This project is the evaluation of vehicle directional control for various steering responses and maneuvers which involved a powertrain model with torque vectoring differential. This activity was done using co-simulation MATLAB Simulink (driveline controls, wheel slip controls). This helped us evaluate the driver response and vehicle response with and without Torque vectoring.

* ***Wheel slip control strategies for a slippery surface***

Developed a plant model (using Simulink) which work before TCS due to network delay, this model cut-off of engine torque independent of driver input till the wheel gains traction on a high slippery surface such as icy roads. The plant model is active till TCS takes over, helps to stop wheel slip – driver panic and propel the vehicle safely.

* ***Evaluation of Park lock engagement speed – high-speed ratcheting and low-speed engagement***

Correlate the engagement speed for the given gear tooth profile at the system level using contact methodology and then evaluate in the full vehicle model. DOE study was carried to optimize the engagement speed as per homologation requirement by modifying various parameters such as gear tooth profile, park pawl, and cone design. The methodology was published as a standard for the evaluation of park lock engagement speed.

* ***Improve the Vehicle Handling Characteristic with Active Control System***

This project involved working with the vehicle control team and calibration team. This aim is to improve the directional stability response of vehicles with vehicle active safety systems (ABS, TCS and Torque vectoring) using co-simulation with MATLAB/Simulink. The control’s error and transfer function were optimized in the MBS simulation environment and later these changes were introduced in controls and calibrated to get optimum handling performance of the vehicle.

* ***Development of high fidelity CAE MBS model of Engine – Engine balancing & Torsional Vibration***

Evaluated 3 cylinders Inline Engine and correlated with the test for engine torsional vibration (Idle/WOT, part load), mount loads, and vibration. This model was later parameterized for V type and several cylinders and this parametric engine model is heart to evaluate, optimize the torsional vibration across JLR vehicle platform – Torque convertor selection, Boom noise reduction, etc.

* ***Development of Application for Driveline Angle Calculation for the Design Team***

Developed an application integrating excel and SIMPACK – MBS parametric model to evaluate the maximum operating angles, mount deformation for quasi-static condition and maximum loading such as maximum forward/reverse torque and maximum suspension travel of various powertrain/driveline configurations (RWD, FWD, AWD & 4WD) which helps the powertrain/driveline design engineer to choose the appropriate joints, shafts and mounts to meets the vehicle specification. The main aim of the project is so that the component Engineer - various attributes (powertrain/driveline/suspension/chassis) who have no prior experience in MBS software, can use already familiarized Excel to feed up the required data and evaluate and optimize the performance and met design requirements. MBS software works in the background for calculation and the results and recommendations are shown to the design excel in excel sheets using numerical, statistical, and plots. This application has been standardized and currently in use across the JLR platform.

* ***Mitigating the Failure of Torsional Vibration Damper (TVD) in Hybrid Powertrain***

Developed a plant model using the first principle to mitigate the shock load (max travel) – of engine TVD connected to BISG. Start-Stop, recuperation, and Mode change for power requirement has a drastic load on TVD. The plant model (using Simulink) measures the angular acceleration of the electric motor and cuts off the torque if the acceleration is above the limit. The vehicle performance was the key parameter to be met as well as solve the TVD failure.

* ***Developing Three-Point Mounting System for Rear Drive Unit (RDU)***

This project was started as a research activity to evaluate a three-point mounting system for RDU with a primary focus on cost reduction which can be used in a modular platform. The main aim is to get considerable performance equivalent to the traditional four-point mounting strategy. This project involved defines the three hardpoints and stiffness curves for mounting based roll, yaw, and pitch of RDU, vibration transfer to chassis, and driveline operating joint angles.

* ***Sloshing Dynamics – Tanker Vehicle***

This research activity was done to improve simulation capabilities in Daimler. Primarily focus on the influence of fluid sloshing (partial filled) on rollover stability, directional stability (yaw instability), and straight-line braking performance. Initially started with a simple pendulum model (combined longitudinal and lateral) to capture the fluid dynamics using test data and then moved to co-simulation with CFD software.

* ***Shock loads prediction on vehicle suspension, powertrain components, and mountings, evaluate the influence of load mitigation with vehicle control systems – TCS and ABS.***

This involves a full powertrain model with a Full vehicle with and without vehicle controls systems. The dynamics were predicted for various rough road and abuse conditions such as Humpback Bridge – airborne condition. The main objective is to predict the shock load transfer to the chassis/suspension from the wheel. The difference in wheel rotation velocity and vehicle linear velocity and Inertia results in the shock loads. And also evaluate interaction network delays in TCS, ABS. This was carried out co-simulation with MATLAB/Simulink.

* ***Solving Steering Kickback phenomena***

Mitigating the steering kickback by optimizing the suspension design and hardpoints such as kingpin inclination angle. There was a considerate reduction of 70% in steering kickback response felt by the driver.

* ***Optimize the Pressure - Force Distribution of Wiper Blade on the Vehicle Windshield***

The aim is to map the pressure distribution across the wiper blade. This involved using contact and discrete wiper blade (beam elements) to analyze the pressure-force distribution of wiper blades on the windshield and calculate the optimum performance by modifying the blade profile and flexibility.

* ***Prediction and Mitigate the Driveline Boom***

This was the first project executed at JLR which remains the starting point for NVH capabilities. Built a full discrete torsional powertrain and integrated it in the full vehicle to evaluate the driveline-induced vibration in the cabin. This involved powertrain testing, MBS model correlation with test results, torque convertor FMU integration and finally publishing the standard procedure for all future NVH domain activities.

* ***Predict the Directional Stability of the Semi-Trailer Truck (Articulated Vehicle)***

Modelled a tractor/semi-truck with trailer (with full suspension subsystems) connected using the fifth wheel. The project aim is to understand the directional stability of the vehicle under various conditions such as weight distribution, wet roads, emergency braking, and lane change scenarios also harsh conditions such as jackknifing. This evaluation includes an open loop and closed driver models. Validated the model and process by correlating with test and later this validated process used across other capacity vehicles.

* ***Correlation of vehicle dynamic simulation results with the test for ISO Lane Change analysis (LCV/HCV)***

Developed virtual prototype of Light-duty Commercial Vehicle/Heavy-duty Commercial Vehicle variants and simulated ISO Lane Change handling simulations and correlated the simulation results with physical test data and developed process for correlation of vehicle dynamics simulations

* ***Comparison of Physical Test and MBD results for Brake Steer analysis (LCV/HCV)***

Developed virtual prototype of LCV/HCV variants and simulated Brake Steer simulations and compared the results with physical test data and also carried out design iterations to optimize - reduce the brake steer of vehicle.

* ***Determination of Stability of LCV/HCV – Tipper based on IRTE guidelines***

Developed a virtual prototype of the tipper vehicle and simulated it to determine the vehicle stability in ramp and banking conditions based on IRTE guidelines.

* ***Extract Steering Forces of Single and Twin steer LCV/HCV models***

Developed virtual prototype of LCV/HCV variants to extract steering forces of single and twin steer vehicles for durability analysis of steering components. Later developed a customized program that interacts with Motion View to build a virtual prototype of steering systems of LCV/HCV variants, simulates and extracts steering forces for durability analysis of steering components.

* ***Comparison of Pacejka and Fiala Tire models and correlation with test***

Carried out vehicle handling response simulations such as ISO Lane Change and Steady-State Constant Radius simulation to compare Pacejka and Fiala Tire models with testing results. This work presented at the HTC conference held in 2011 and has secured first place in the MBD stream.

* ***MBD- FEA Analysis of Backhoe Excavator (Kinematics Motion & Dynamics loading evaluation)***

Developed a virtual prototype of backhoe excavator and carried out Kinematics analysis (envelope study, tear force and breakout force analysis), Dynamics analysis (backhoe lift capacity and front loader lift capacity) based on SAE Standards and also Dynamic loading conditions such as vehicle steering on inclined plane, backhoe bucket impact on the ground, backhoe digging, steering with front loader fully loaded, vehicle on uneven road, front loader sudden stop, rock chipping, trenching, swing backhoe, side rock movement and also carried out FEA Analysis of components (boom and dipper) for above mentioned extreme dynamic loading condition in MSC ADAMS Environment.

* ***MBD –FEA Analysis of Two-Stage Reciprocating Compressor (Piston – Crankshaft Assembly)***

Built a Two-Stage Reciprocating Compressor and carried out MBD simulation of piston-crank assembly in ADAMS environment and FEA analysis to get stress distribution component-wise in ADAMS environment.

* ***MBD Analysis FAV (Fast Attack Vehicle) - Full vehicle durability (critical load conditions) simulations.***

Developed a virtual prototype of Fast Attack Vehicle and carried out MBD simulation – Four poster analysis for Chassis durability load conditions (3G bump, lateral/forward kerb strike, cornering, pave, rough road, and various conditions) to determine the acceleration on the body with load flowing and with load flowing and also extracted dynamics loads for FEA Analysis for chassis weight optimization.

* ***Conceptual Product Design and Development of Hospital Bed – (ICU Beds)***

Designed a new conceptual hospital bed - mechanical system (no electric motor – all hand-driven), the conceptual design consists of vertical actuation, knee break, headrest, and Trendelenburg using toggle jack, Bevel gears, and Screw mechanism. And analytically evaluated conceptual hospital bed product design is safe.