4 Recommendations to Reduce LX-3000 Vehicle Active Braking Vibration by 30% using Validated Linear and Nonlinear Models

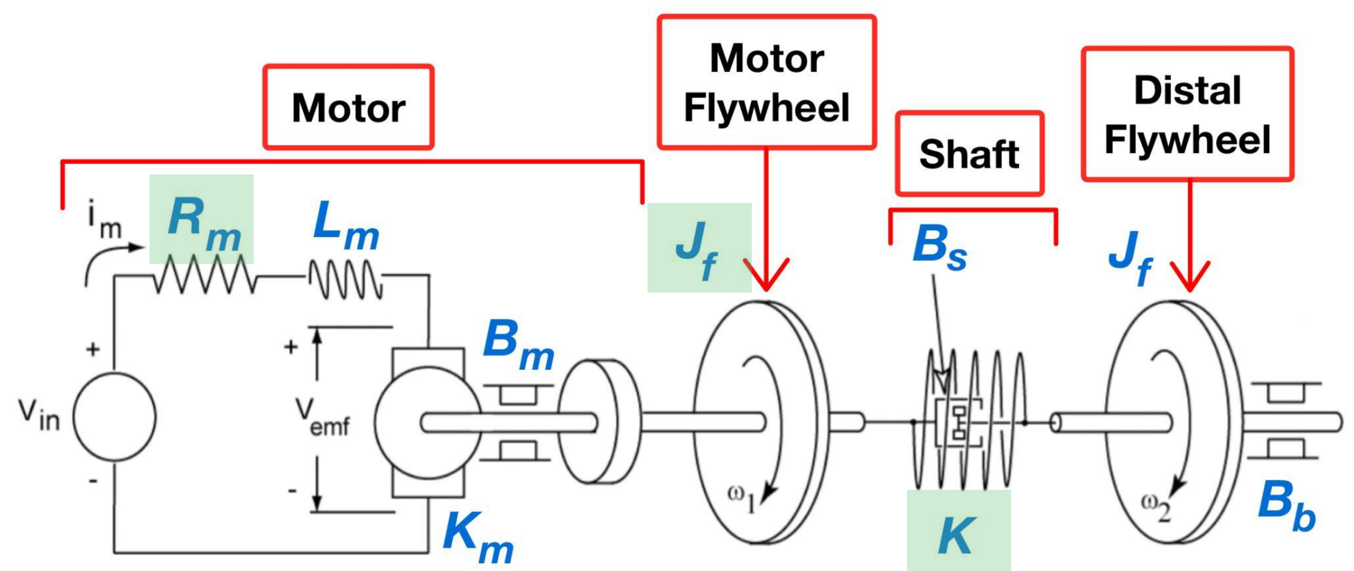
Don Draper | Joan Harris | Salvatore Romano | Trudy Campbell

EKA Inc.

Problematic Vibrations Must Be Reduced

- improve passenger experience by reducing LX-3000 hybrid vehicle resonance amplitude by ≥ 30% (-3.1 dB)
- identify cause of vibrations
- propose 4 design modifications

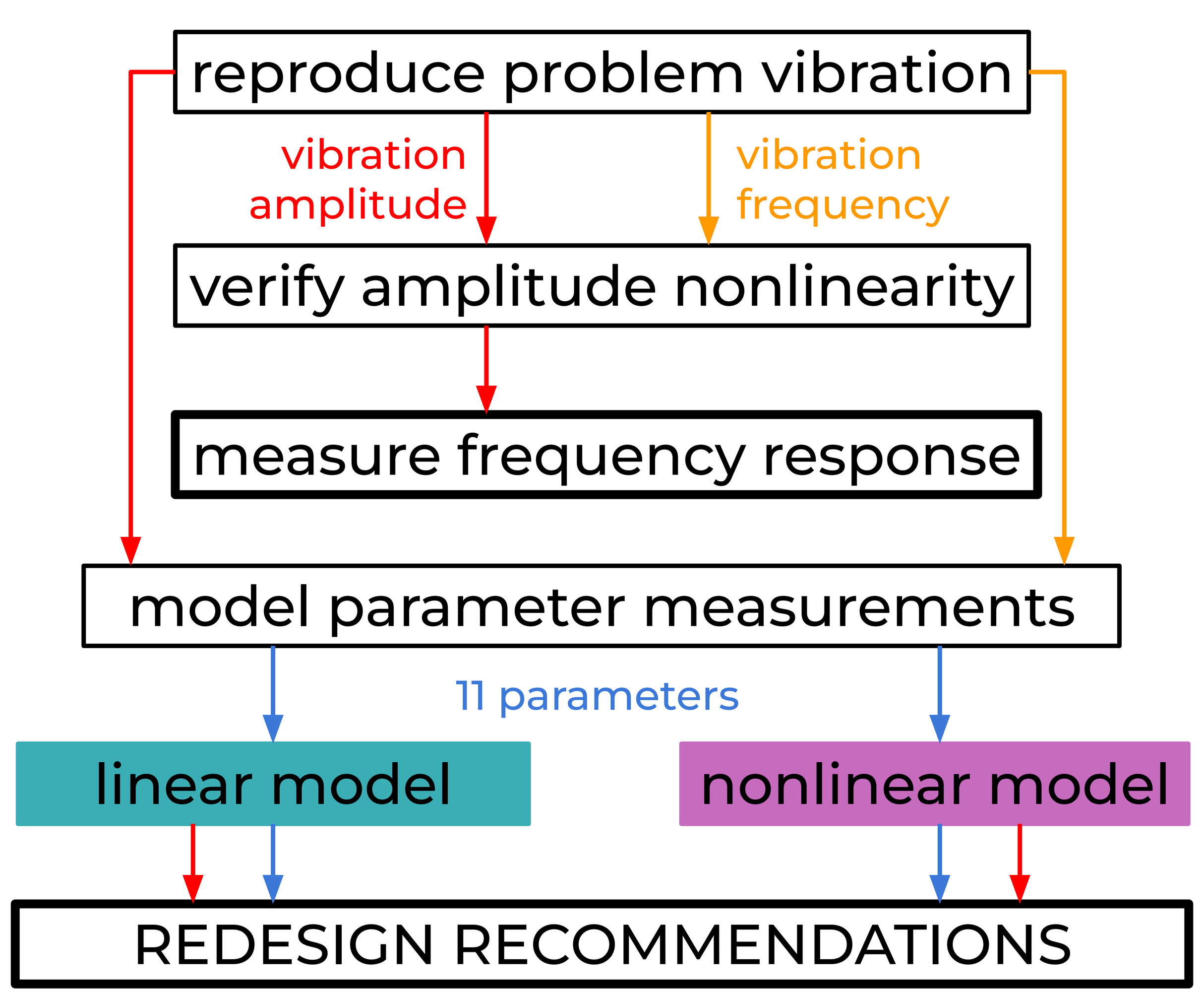
Linear and Nonlinear Models Represent the Real System



Model Assumptions:

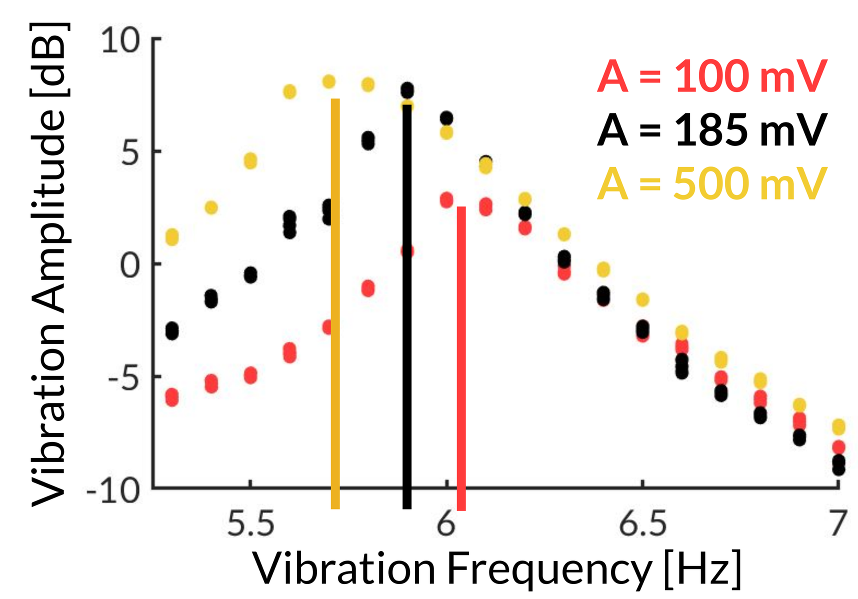
- motor and bearing damping (B_m and B_b) = viscous
- shaft = linear spring with negligible damping (B_s = 0)
- negligible motor inductance (L_m = 0)
- negligible coupler inertia

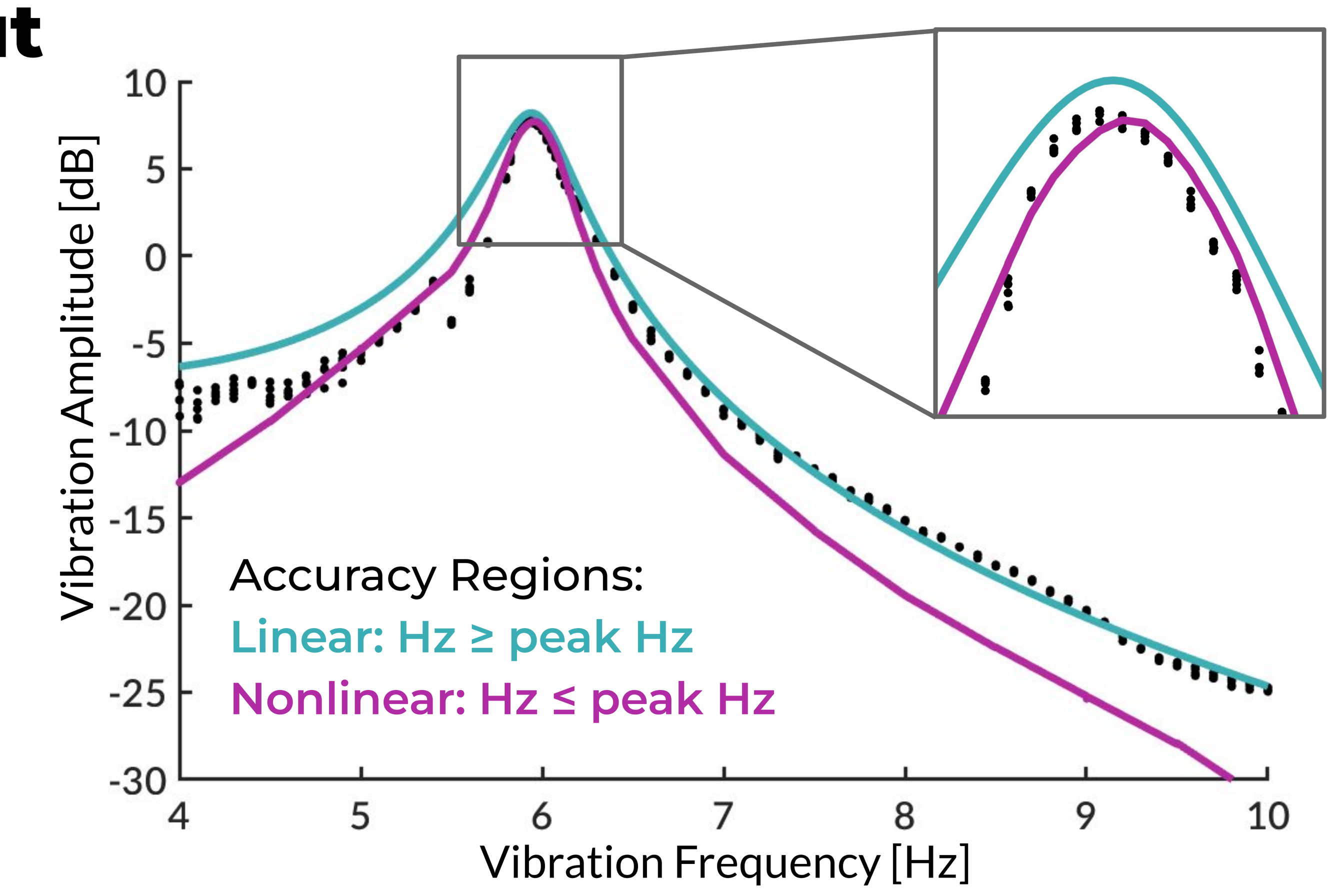
Methods Result in Empirically-Informed Models



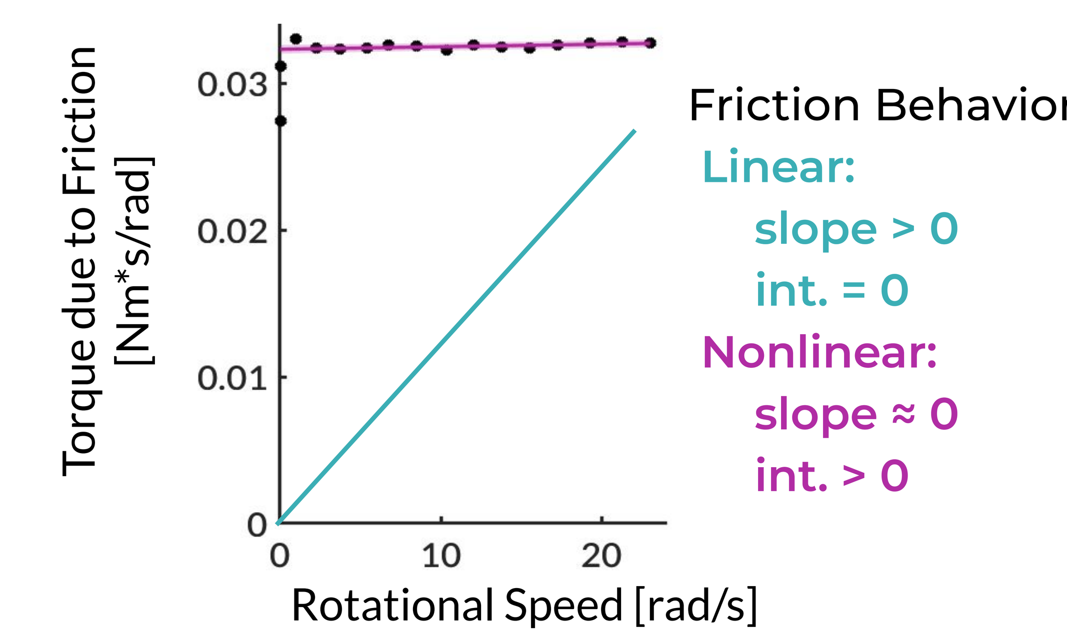
Linear and Nonlinear Models Accurately Predict Frequency Behavior Under Problematic System Input

Input Amplitude Nonlinearity Shifts and Expands Peak



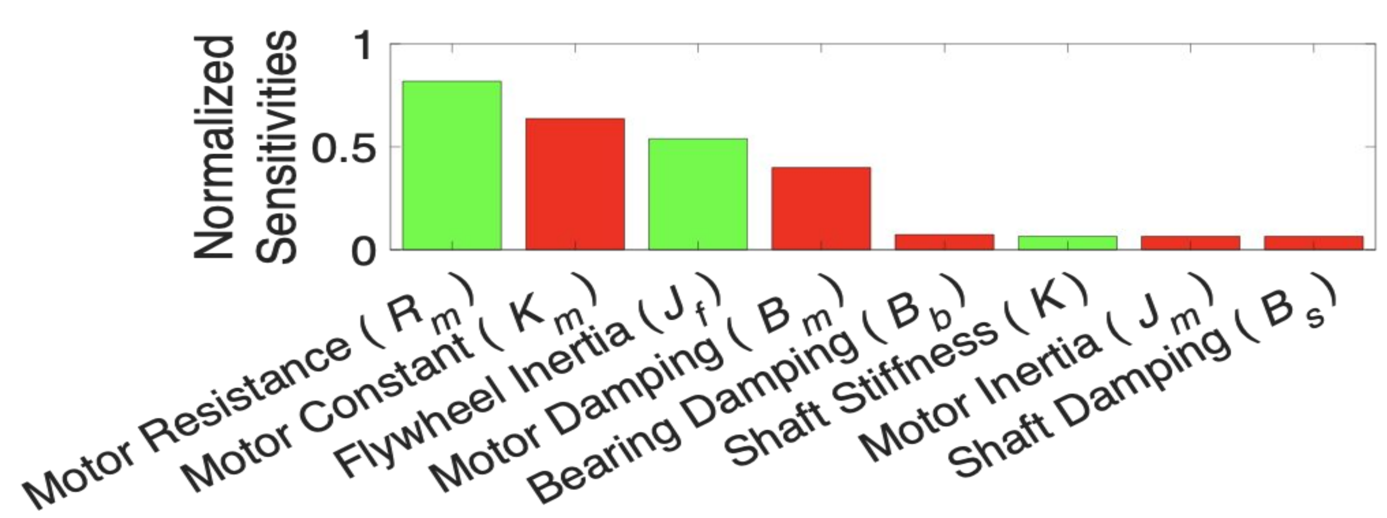


Nonlinear Model Incorporates Nonlinear Friction Behavior



Linear and Nonlinear Models Drive Design Recommendations

Linear Model Predicts Adjustable Parameters With Greatest Sensitivity to System Behavior



Nonlinear Model Predicts Recommendations to Reduce Passenger Discomfort due to Vibrations

1: Motor Resistance (R_m)
Increase by 22%
= Lowers Peak

2: Wheel Inertia (J_f)
Decrease Diameter by 14%
= Shifts Peak out of Discomfort Region

3: Wheel Inertia (J_f)
Reduce Inertia by 45%
= Shifts Peak out of Discomfort Region

4: Shaft Stiffness (K)
Decrease Diameter by 18%
= Shifts Peak out of Discomfort Region

Nonlinear Model Validates Recommendations to Reduce Passenger Discomfort due to Vibrations