Case Study: **Scania**

Advanced Powertrain Dynamic Analysis and Development Using Adams

Overview

Scania transmission components are developed as part of Scania's integrated powertrain with a perfectly matched specification for each individual demand. The gearboxes are designed to suit the high-torque Scania engine range. The multitude of drive axle and bogie options provide optimum strength without inducing a weight penalty. Integrated powertrains are offered to customers on a modular basis in which nearly any gearbox can be combined with nearly any engine.

Scania modular system

Detailed Modeling and Accurate Dynamic Analysis for Transmission Systems

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Erik Gomez, Senior Engineer for Scania

Challenge

The traditional approach to the design of gearbox and powertrain components involves creating an initial design based on one-dimension powertrain models and engineering calculations and then building and testing a prototype. With this approach, undesirable properties are identified during physical testing at a late stage in the design process when changes are expensive. Another concern was that the cost involved in building and testing different gearbox-engine combinations can be very high, especially if prototypes have to be rebuilt and retested because the design did not match what was intended the first time.

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Solution/Validation

Scania has addressed this challenge by making extensive use of MSC Software’s Adams multibody simulation (MBS) 3D powertrain models that accurately predict transmission dynamic behavior. Scania powertrains are now developed in a virtual environment in which a large number – often thousands – of design alternatives are simulated and evaluated as software prototypes. Simulation predicts the performance of design alternatives prior to committing to the time and cost involved in building and testing physical prototypes.

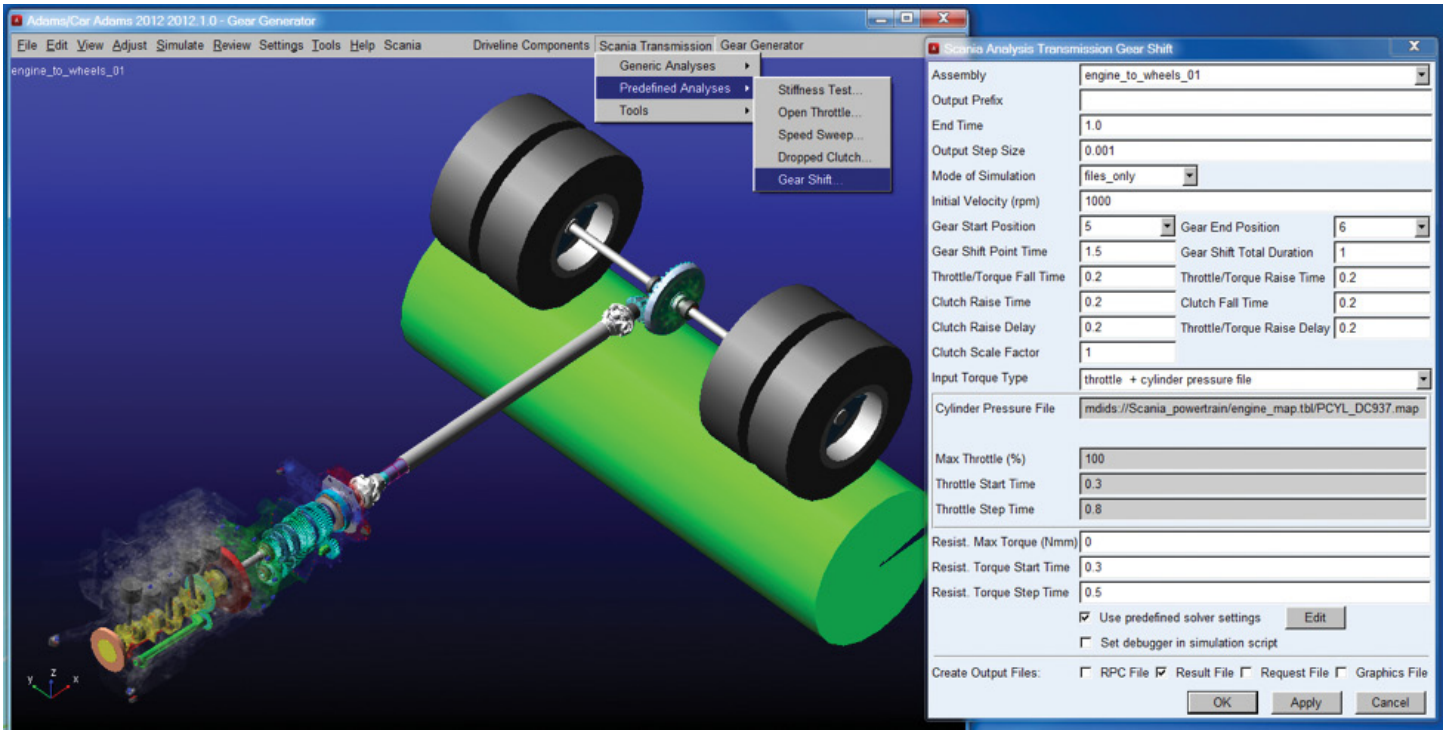
Key Highlights:

Product: Adams

Industry: Automotive

Benefits:

- Quickly model and evaluate power transmission assemblies and components
- Excellent correlation between simulation and measurements in NVH and gear rattle
- Solved quality issues 30 percent to 40 percent faster than using physical test alone

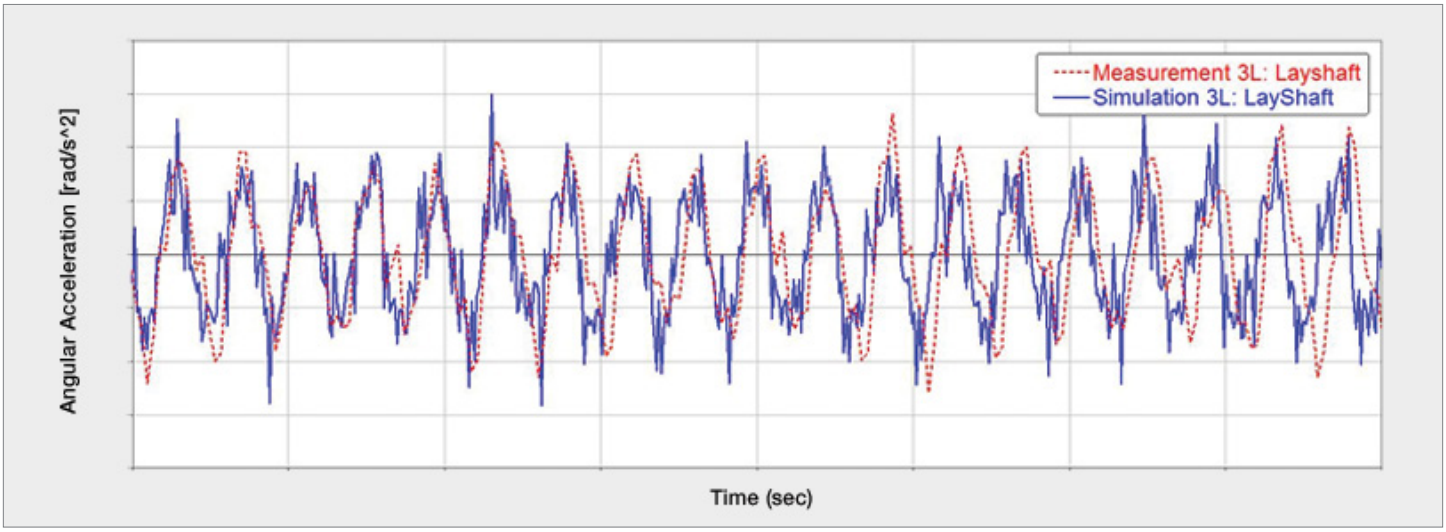


Custom environment for powertrain analysis

In order to improve the efficiency of the simulation process, Scania worked with MSC to develop structured MBS methods to standardize the work frame and interfaces used to develop powertrain models and enable a single MBS model to address the complete design process. MSC and Scania developed powertrain test rig models that simulate assembly or component models undergoing standard physical testing routines. Using the same technology as Adams/Machinery, the productivity tool provides users an easier way to incorporate detailed Gear and Bearing models into the systems, increasing the accuracy of the simulation. The Scania Transmission Plugin also applies different motions and torques in the assembled model based on inputs such as user defined toque or motion, torque/velocity/displacement time histories, engine map torques or speed controller torques. The plugin can be set up to provide input at locations such as the engine, flywheel or gearbox input and output at the gearbox output, wheels, etc. To date, five predefined analyses have been created to run simulations of the gearbox. The plugin is configured so that users can easily set up any combination of powertrain and test rig actuator settings to run a series of tests without user input.

Excellent correlation between simulation and measurements in gearbox stiffness test

For example, the gearbox stiffness test involves applying a torque to the input shaft of a gearbox while holding the output shaft stationary. The input torque is applied as a sinusoidal function with a frequency of 2 seconds. The deflection of each of the 14 gears in the gearbox is measured as a function of torque. This predetermined analysis was validated by simulating an existing gearbox for which test results were available. The simulation predictions closely matched the physical measurements collected during the test. The same model was used to predict Eigen frequencies of the 14 gears in the gearbox. Again the simulation results were very close to physical measurements that were previously made on the gearbox.



Excellent correlation between simulation and measurements in NVH

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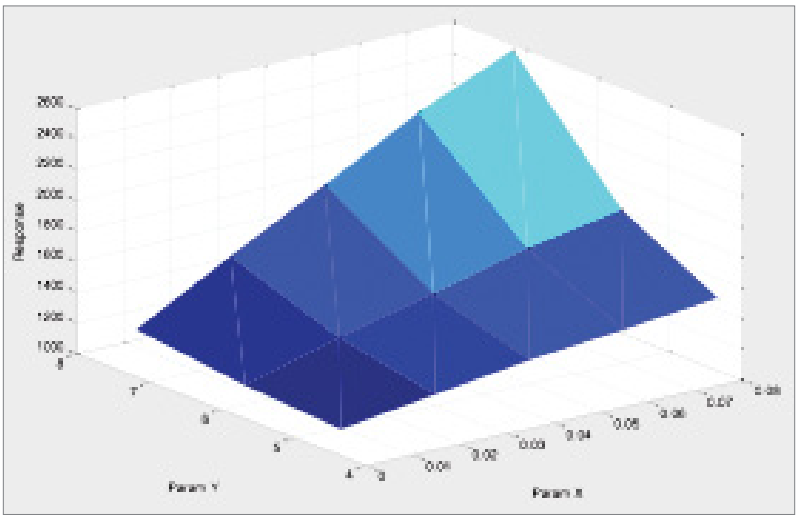
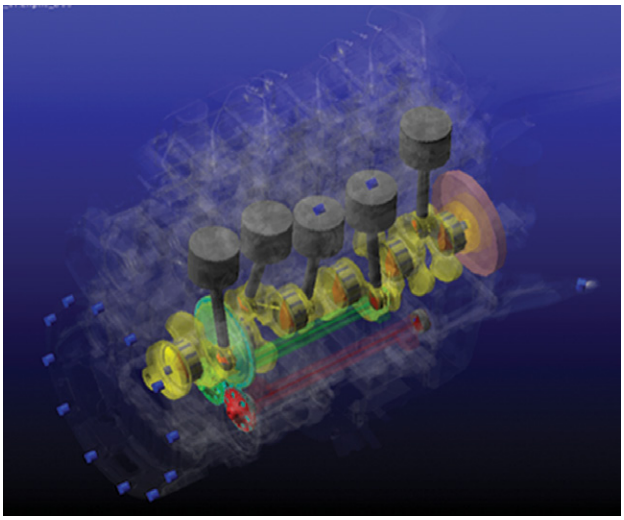
The Adams model was also used to study how engine torque irregularities affect NVH. Torque irregularities are damped by a mechanical filter on the clutch. Simulations and measurements were performed to determine the irregularities upstream and downstream of the mechanical filter to evaluate the effectiveness of the filter. The simulation and test results matched closely and showed that the filter is effective in reducing engine irregularities. The simulation results also revealed high frequency content in the downstream simulation results that were not captured by the physical measurements. After studying these results, engineers made changes to the measurement methods to increase their ability to capture high frequency content. After validating the simulation, Scania engineers made changes to the model to evaluate different methods of improving NVH . They identified design changes that significantly improved NVH and these changes will be applied to future products.





Response surface map used to display analysis of different powertrain combinations in gear shift test

The gear shift test involves measuring the velocity of various shafts in the gearbox during a gear shift event. Again the simulation generated results that closely matched physical testing results. With the simulation validated, engineers ran a series of parametric studies analyzing different drive configurations, axle types, prop shaft types and lengths, engines, etc. The results were depicted on a response surface map that helped engineers identify the optimum combination of parameters to achieve their objectives.

Results

Simulation enables Scania engineers to quickly evaluate functional virtual prototypes of power transmission assemblies and components. Working in the MSC Software Adams simulation environment, Scania engineers can exercise powertrain designs under a wide range of conditions using the same tests they normally perform in a test lab but in a fraction of the time. Modifications are validated in the virtual world, which saves a significant amount of time and money in the design process. In some cases engineers have solved quality issues 30 percent to 40 percent faster when running simulation and measurements in parallel due to better understanding of the product.

About Scania

Scania AB is a Sweden-based company engaged in the development, manufacture and marketing of heavy trucks, buses and engines for the automotive and marine industries. The company focuses primarily on producing trucks with gross weights of 16 tons or greater.

For more information on Adams and for additional Case Studies, please visit **www.mscsoftware.com/adams**

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