# DAF Trucks Simulates Flexible Valve Train

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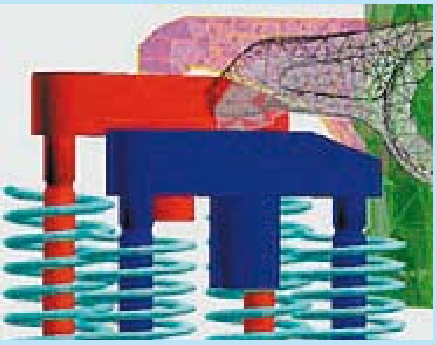
ENGINEERING INNOVATION



## The Mission

The valve train is an important element of modern engine design due to increasing demands for durability, fuel economy, and lower emissions standards.

DAF Trucks, located in the Netherlands, had a mission to perform detailed flexible body simulations of the valve train in a newly developed six-cylinder diesel engine for the XF-95 truck. DADS was chosen to perform simulations of the new valve train.

## The Right Product

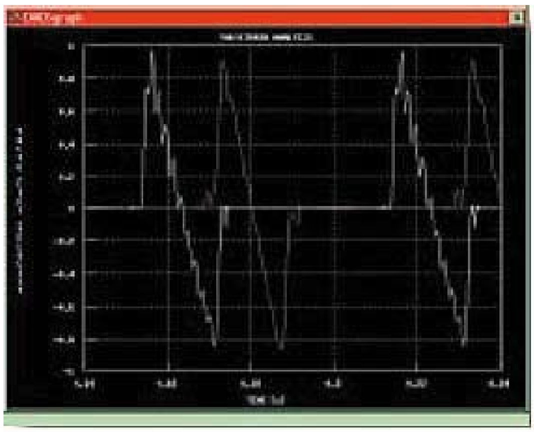
DAF Trucks chose LMS DADS because it provides the capability to accurately simulate and animate flexible bodies. DADS uses component modal synthesis to simulate flexible characteristics of rigid body motion which is critical for accurate representation of modern lightweight, high-speed mechanical systems. Flexibility data is automatically extracted from the results of popular FEA programs for use in DADS analysis and animation. The resulting DADS simulation provides realistic system force and loading conditions which can be used as inputs for advanced FEA. Flexible animation provides powerful feedback for a wide variety of flexible body and vibration analyses.

## The Simulation

Tabular cam profile data used multiple fifth-order polynomial functions to represent the cam shape. These functions were used in the force relationship to determine the contact location and depth of penetration of the cam and follower. Using a force element rather than a kinematic constraint for the cam and follower relation allows accurate prediction of cam and follower separation. Nonlinear stiffness and damping properties are defined for the cam and follower separation. The gas force acting on each valve was applied as a nonlinear function of the cam angle. These forces are due to compression of fuel and air in the cylinder and subsequent expansion of the combustion gases. The DADS model shows the flexible rocker arms, pedestal, and springs where the deformation has been scaled up by a factor of 100. Wireframe geometry displays the flexible mesh that originated in finite element models of each of the parts. Several flexible static modes are selected to best represent how a given part can deform under the constraint and loading conditions. DADS uses the modes as generalized coordinates during the actual simulation. Mode amplitude, velocity, and acceleration are reported as part of the results. Mode amplitude is then used to determine the shape of the flexible geometry during the animation of the results. Likewise, specific node locations, velocities, and accelerations can also be plotted. Experience has shown that treating all parts as rigid is not an acceptable assumption in cases where a high level of accuracy is required.

## The Results

Results of the simulation were position, velocity, and acceleration for bodies and flexible modes in the valve train. Reaction forces for all joints and force elements were also reported. The higher frequency signal present in the valve lift velocity, shown in the graph, is due to the flexible deformation of the valve train. Precise load results were then used to perform stress analysis on individual parts. DAF's simulation of valve train components provided them with a high fidelity model that predicted dynamic response and system loads more efficiently and accurately then previously possible. ■



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