USER CASE STUDY

Transmisiones y Equipos Mecánicos S.A. de C.V.

Customer Profile: Joel Ortiz

Joel Ortiz is a Concept Engineer at Transmisiones y Equipos Mecánicos S.A. de C.V. (TREMEC) in Querétaro, Mexico. TREMEC is a leading producer of rear wheel drive light duty manual transmissions. Ortiz and other TREMEC engineers are responsible for ensuring that the performance of TREMEC transmissions matches up to demanding customer expectations. In the past, the only method available to resolve performance issues in prototypes was to go through the time-consuming and expensive process of making modifications to the prototype and hoping for the best.

Challenge

In testing an early prototype of a six-speed manual transmission, jumps were seen in the force applied to the shifter lever and felt by the driver of the vehicle. These jumps in shifting effort, called nibble by transmission manufacturers, do not affect the performance or durability of the transmission, but they are important because the reaction force against the gear shift helps define the shift quality of the transmission for the driver.

Solution

Adams multibody simulation software.

Benefit

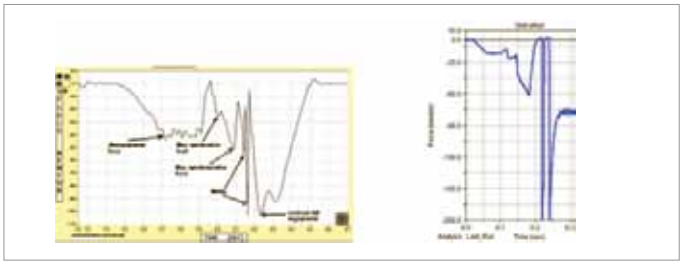
Ortiz used a virtual prototype to reduce nibble by 93% from the early prototype to the production model, contributing to rave reviews from automotive journalists.

Case Study

Nibble is normally attributable to the operation of the synchronizer which is used to drive the two sets of gears at the same speed just before they are engaged when shifting into a new gear. It is typically caused by a speed differential generated during the period between indexing and final engagement. In this case, the prototype experienced nibble during up-shifting at a temperature below 20°C.

When the driver shifts into a different gear, the shift lever moves a fork in the transmission which in turn activates a synchronizer ring that engages the proper conical clutches to move the two gears that will be engaged at the same speed. TREMEC was determined to maintain as uniform of a reaction force as possible because it wanted to maintain its reputation among automotive enthusiasts for producing some of the best manual transmissions in the world. Engineers tried to peer into the transmission through a clear panel while it was running to diagnose the problem but found that their vision was blocked by the transmission fluid.

Ortiz created a virtual prototype of synchronization mechanism in Adams with 17 parts including the shift rail, fork, roller detent, gear synchronizer cone, inner synchronizer ring, blocker ring, strut, sleeve, intermediate ring, clutches and gears. The geometries of these parts were based on the measurements of the prototype transmission. The model did not include any flexible elements. Ortiz applied a force to the shift lever representing the driver shifting from first to second. He applied an angular velocity to the input shaft. He lumped the forces exerted by the engine and the oil at -10°C into a resistance torque.

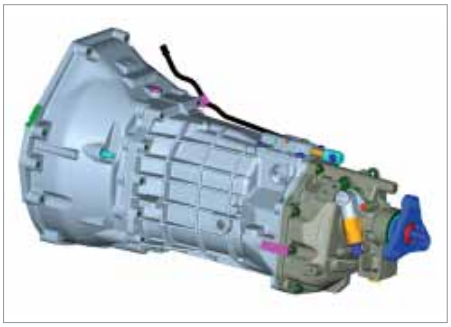


Shift effort based on physical measurements (left) and simulation (right)

> “I was pleasantly surprised at how accurately simulation could predict the performance of design variants.”

“I executed the model and evaluated its predictions of the force exerted on the shift lever,” Ortiz said. “The simulation results showed the same jumps in shift effort that were measured on the prototype transmission. A key advantage of simulation is that I was able to evaluate the displacement and forces of each component. I could also easily make changes to the model to evaluate the impact of design changes. I tried changing the stiffness of different parts and the oil properties.”

“The solution turned out to be changing the geometry of the teeth on the synchronizing ring,” Ortiz added. This change reduced the jump in the reaction force by 95.5%, to well under the average for transmissions of this type. This design change was applied to the physical prototype and test results verified that the nibble was reduced by 93%. I was pleasantly surprised at how accurately simulation could predict the performance of design variants.”



TREMEC Product TR - 6060; 6-speed

TREMEC’s new six-speed transmission has received rave reviews. Automobile Magazine said that the 2008 Chevrolet Corvette, which uses the new transmission: “Another massage of the old faithful Tremec (Mexican-made six-speed manual shared with the Ford Mustang and Dodge Viper) has achieved shorter throws with lower effort. Thanks to friction reductions and synchronizer improvements, shifting is now more wrist action and less elbow crunching.”

MSC Software

MSC Product Used:

Adams

Capabilities

- Creation or import of component geometry in wireframe or 3D solids
- Extensive library of joints and constraints to define part connectivity
- Internal and external forces definition on the assembly to define your product's operating environment
- Model refinement with part flexibility, automatic control systems, joint friction and slip, hydraulic and pneumatic actuators, and parametric design relationships
- Ability to iterate to optimal design through definition of objectives, constraints, and variables
- Automatic generation of linear models and complex loads for export to structural analyses
- Comprehensive linear/nonlinear results for testing complex, large-motion designs
- Superior contact capabilities supporting 3D contact between modal flexible bodies and solid geometry

High Performance Computing (HPC)

- 64-bit support on Windows and Linux platforms
- Parallel processing support for Adams/Tire results
- Shared Memory Parallel solver
- Obtain nonlinear results for testing complex, large-motion designs

Adams Package includes:

- Adams/Solver
- Adams/Linear
- Adams/View
- Adams/Flex
- Adams/Durability
- Adams/Vibration
- Adams/Controls
- Adams/Exchange
- Adams/Foundation
- Adams/Insight
- Postprocessor
- Shared Memory Parallel (SMP)
- Tire API

Optional Modules

- Adams/Tire FTire

Company Profile

TREMEC was founded in Querétaro, Mexico in 1964, and has been building light-duty manual transmissions for high-performance sports cars and pickup trucks. The TREMEC goal is to provide the smoothest shifting, longest-lasting, most reliable transmissions available, furthermore TREMEC builds components for other markets, such as military applications, tractors and scooters.

A Kuo Group company, TREMEC is a Tier 1 and Tier2 Original Equipment supplier to top automotive brands in America, Asian Pacific and Europe.

On the other hand, TREMEC also produce aftermarket models for auto enthusiasts looking to boost performance and fuel economy, and participate heavily in motorsports worldwide. Aftermarket products are sold primarily in the United States by licensed distributors, but TREMEC also has a Network of distributors in Australia, Canada and Mexico.

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