Technical Center of Dongfeng Motor Corporation

Automaker uses LMS Imagine.Lab Amesim to shorten development cycle by optimizing simulation design

Siemens PLM Software solution enables Technical Center of Dongfeng Motor Corporation to improve accuracy of steering-force models

Getting off to a good start

The increasingly fierce competition in the auto market not only poses more demanding requirements for manufacturers to improve productivity and lower processing costs, but it also challenges them to significantly shorten the design development cycle of vehicles and related products. As one of the chassis’ four main systems, the steering system is a vital part of the structure. With the continuous innovation in steering system products, the electric power steering system (EPS) is gaining popularity.

To guarantee product quality and sound vehicle performance, it is critical to get the design and development work just right in the early stages. As a leader in the auto industry, Technical Center of Dongfeng Motor Corporation has invested heavily in the design and development of EPS using the modeling simulation platform provided by LMS Imagine.Lab Amesim™ software, part of the Simcenter™ portfolio. Dongfeng Technical Center builds EPS simulation models while effectively optimizing product designs with data analysis and comparing test results, leading to sound product performance and a shorter development cycle.

Insight into market transformation

The steering system mainly consists of three parts: the steering control mechanism, steering gear and steering linkage. The steering system has evolved from mechanical steering (MS), hydraulic power steering (HPS) and electrohydraulic power steering (EHPS) to EPS. And EPS is growing.
In 2014, the global automotive steering system market had a total of 90 million units, with a sales volume of $31.1 billion. As the Chinese automotive market continues to expand, so does its automotive steering system market, which has many independent brands. In 2014, China’s automotive steering system market reached a total of 23.89 million units, including 19.92 million units of steering systems for passenger cars.

As the automotive emission regulations become ever tighter, the Chinese market holds great potential for developing EPS systems. Unlike traditional HPS systems, EPS can be independent of the engine and reduce fuel consumption by around 2 to 5 percent, increasing demand for EPS products that are poised to supplant HPS as the most popular steering system. In regions with highly developed auto industries, such as Europe, the United States and Japan, the utilization rate of EPS is greater than 50 percent, and even as high as 90 percent in Japan.

EPS not only enables the integration of electronic control technology, micro motors and high-precision sensors, but it also supports improved energy efficiency, environmental performance and safety. As the Chinese government further promotes the use of energy-efficient cars, EPS is becoming a standard feature, and suppliers and original equipment manufacturers (OEMs) are paying more attention to developing the core technologies behind EPS systems.

“The main reason for this is because domestic independent suppliers and OEMs currently have little experience with the development of EPS systems in many areas such as system matching and calibration,” says Dr. Li Lingyang, senior engineer of application and development of CAE technology at Technical Center of Dongfeng Motor Corporation.

To break the constraints of conventional methods and improve the design and analysis capabilities of the EPS system, Technical Center of Dongfeng Motor Corporation reached out to external resources and sought better development solutions by combining physical testing and modeling simulation. According to Li, the objectives of this research program were to control the early stages of development and design to establish the capability of EPS modeling simulation, and learn the decomposition method of system performance indexes, including:

- Modeling simulation methods for various types of EPS
- Selecting and analyzing key parameters of various components of the EPS system
- Jointly simulating the analysis of system and vehicle
- Comparing and analyzing system analysis and actual test results, trying to quantify the subjective perceptions
- Using hardware-in-the-loop test (HiL) method

Select the right partner

Based on years of cooperation and after comparing many products, Technical Center of Dongfeng Motor Corporation chose Siemens PLM Software as its partner and LMS Amesim as an important application tool for helping to expand to new markets. LMS Amesim from Siemens PLM Software provides a multi-domain, complex system modeling and simulation platform. On this single platform, users can create complex multi-domain system models, and then perform simulations, computations and in-depth analysis.

**Tackle development challenges**

All Technical Center of Dongfeng Motor Corporation passenger cars are equipped with EPS, which are delivered by domestic independent suppliers. This means there are more precise requirements for matching and designing systems. As a result, in recent years there have been many issues in two primary areas: defects in the control logic of the EPS in commercial vehicles, and the tediousness of the chassis-tuning process hinders overall vehicle performance (it could take three to four tunings to obtain the expected target).

**Results**

- Shortened development cycle by optimizing simulation design
- Enhanced accuracy of steering-force characteristic models
- Enabled separate simulation analysis of EPS system models
- Significantly increased efficiency of EPS system parameter calibration

“By working with the engineering consultation department of Siemens PLM Software, Technical Center of Dongfeng Motor Corporation has improved and refined our product development process, and established a complete index system for the steering system and vehicle integration, greatly improving the vehicle performance.”

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Senior Engineer, Application and Development, CAE Technology
Technical Center of Dongfeng Motor Corporation
technical performance. LMS Amesim is an excellent tool for research and development (R&D) departments in the auto industry, enabling engineers to take full advantage of the complete set of integrated LMS Amesim libraries to design a system. All the models from different physical domains have been verified using strict tests and experiences. Using LMS Amesim enables engineers to rapidly achieve the ultimate goal of modeling simulation, simulation analysis and optimized engineering design to help reduce development costs and shorten the development cycle.

"Based on our cooperation in the past and the recommendation of other enterprises, we believed LMS Engineering services from Siemens PLM Software could bring us more and better added value," says Li. "Furthermore, Siemens PLM Software greatly outmatched other service suppliers with much more comprehensive and reliable solutions and services."

Technical Center of Dongfeng Motor Corporation project

Technical Center of Dongfeng Motor Corporation conducted a project on EPS modeling and optimizing simulation analysis. The object of this project was a Class A vehicle with five seats and an EPS system (in China cars are defined according to capacity and wheelbase. Class A is the largest). This model is now being mass produced. LMS Amesim and hardware-in-the-loop are being used in modeling and simulation analysis, and the components and systems have proven to be relatively stable.

Figure 1 is a schematic diagram of the project. LMS Amesim is used to create the EPS system simulation models, implement the main components from the LMS Amesim library for existing component models, benchmark the parameters against bench test results, and then

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analyze and verify the sensitivity parameters after corrections are made. The analysis process created according to the project objectives is shown in figure 2.

For the modeling process, Li conducted a detailed analysis of the prototype pinion electric power steering (P-EPS) system model. As shown in figures 3 and 4, this simplifies the use of components and select models from the library.

The subject of the research project, the test equipment and requirements for the main mechanically-related components (steering gear, worm gear, motor and column assembly) in the P-EPS system, are shown in figure 5.

In addition, Li said that Technical Center of Dongfeng Motor Corporation created the EPS controller model based on the LMS Amesim platform according to the electronic control unit (ECU) specifications provided by the supplier, which was the most important part of this research project. When running on a vehicle, the P-EPS system provided two versions of controller parameters to serve as the calibration basis for models using the ECU control strategy.

With the speed and steering wheel angle signals of the vehicle test as the inputs for model simulation, the simulation outputs, such as lateral acceleration, yaw velocity, vehicle roll angle and steering wheel torque, were benchmarked against the vehicle test results. The driver made a subjective and separate assessment on the effects of the two versions of controller parameters of the P-EPS system, which combined with the objective measuring results, could be used as a directional reference for the subsequent sensitivity analysis.

After benchmarking, it showed the margin of error for the EPS system model simulation results and test measurements was within 10 percent, and the model was more precise than that.

Realize win-win innovation

Li praises Siemens PLM Software and LMS Amesim because it provides Technical Center of Dongfeng Motor Corporation with graphic, modularized multi-domain system modeling; mathematical models based on lumped parameters and physical components; simulation models consisting of multiple physical component models in which each of the physical component models is represented by icons and can be fully parameterized; and an extensive library of components that covers all the analysis domains that may be used.

The software can be used to create multi-layer, multi-level models of different complexities: For different subsystems, it can be used for multi-domain, multi-
It resolved the issue of inaccurate steering-force characteristic models that had been a long-time headache in vehicle handling stability simulation. The capabilities of joint 1D and 3D simulation enables not only separate simulation analysis of EPS system models, but also joint simulation analysis of the combination of EPS system models and the vehicle multibody system dynamic models.

The company has also established standards to acquire key parameters of EPS systems as well as subsystems and components for test, and developed an approach to conduct reverse analysis and modeling of controllers. The EPS system models are

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Customer’s primary business
Dongfeng Automobile Co., Ltd. is one of the key enterprises in China's auto industry, with core business covering the entire series of commercial vehicles, passenger vehicles, auto engines and parts.

Customer location
Wuhan, Hubei China

of relatively higher precision, and the company has also developed tools to automatically analyze the sensitivity and optimization of EPS system parameters, leading to a significant increase in the efficiency of EPS system parameter calibration.

"By working with the engineering consultation department of Siemens PLM Software, Technical Center of Dongfeng Motor Corporation has improved and refined our product development process, and established a complete index system for the steering system and vehicle integration, greatly improving the vehicle performance," says Li. "We look forward to continuing to work with Siemens PLM Software to build a multi-domain design analysis platform for the chassis and the steering system."

Technical Center of Dongfeng Motor Corporation and Siemens PLM Software have formed a strong alliance and are poised to contribute to the continued development of China's auto industry.

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