Product
Simcenter

Business challenges
Address customer preferences for increasingly higher vehicle comfort

Keys to success
Focus on engine improvement, the biggest source of noise
Set up a dedicated NVH development team
Build an advanced NVH laboratory
Employ Simcenter solutions to optimize diesel engines

Results
Typically lowered diesel engine noise by 2 to 3 dBA, thus reducing the noise in the cab by about 1 dBA and vehicle pass-by noise by 1.5 dBA
WP3 diesel engine now parallels the quality/comfort level of comparable high-end vehicles worldwide
WP4.1 diesel engine regarded as “the most silent diesel engine in the industry”

Weichai Power applies Siemens PLM Software’s Simcenter technology to diesel engine NVH development

More demanding expectations
Increasingly, global markets and users are demanding significantly improved automotive vehicle performance in terms of engine economy, performance and comfort, and governments are continually imposing more rigorous requirements for environmental protection and emissions.

On the strength of its strong research and development (R&D) capabilities, Weichai Power Co., Ltd. (Weichai Power) is meeting and exceeding those preferences and requirements.

“Weichai Power’s goal is to optimize its engines in terms of fuel economy, emissions control, reliability, driving comfort and power/performance,” says Dr. Li Qin, senior advisor to board chairman and technical planning director at Weichai Power.

Advanced anechoic chamber built by Weichai Power for NVH development.

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**Focus on engine optimization**

Engines are the main source of noise in vehicles, so it is increasingly important, if not critical, to improve the company’s development work in the area of noise, vibration and harshness (NVH) performance. For this purpose, Weichai Power, as the leading internal combustion engine manufacturer in China, set up a dedicated NVH development team and built an advanced NVH laboratory for diesel engine NVH development and optimization using Simcenter Testlab™ software for testing, Simcenter SCADAS™ hardware for data collection and the simulation solution from the Simcenter portfolio. The Simcenter solutions are from product lifecycle management (PLM) specialist Siemens PLM Software.

NVH development generally includes two primary functions: simulation and experimentation. The development work runs through the whole lifecycle of the diesel engine, including upfront development, subsequent market maintenance, trouble shooting, etc. NVH simulation and NVH experimentation evolve from stage to stage. For example, at the design layout stage, simulation work enables the high quality of the NVH structural program, while significantly reducing design cycle time; at the product development stage, experimentation and testing results verify the simulation results and the feasibility of the program, while providing feedback regarding simulation.
The WP3 diesel engine – superior quality, noise reduction

Let’s take the WP3 diesel engine NVH improvement project as an example of the significant gains Weichai Power is realizing. During the development process, from market research, conceptual design, layout design, detailed design and prototype development to market verification, batch production and product maintenance, Weichai Power conducted extensive NVH simulation, testing and analysis, achieving productive and highly meaningful results.

During the upfront research part of the WP3 diesel engine improvement project, NVH work focused on testing and analysis. Based on the market positioning of WP3 product, engineers conducted detailed NVH testing of competing products using the Simcenter SCADAS data collection device and Simcenter Testlab testing and analysis platform. The data provided detailed data references to realize the development goals of the WP3 product, while delivering essential information for subsequent WP3 product designs.

After defining the market positioning of the new WP3 model, the company proceeded to the conceptual design stage, where engineers used NVH simulation as the main tool. Specifically, the team used AVL software and the simulation solution from the Simcenter portfolio to predict the engine’s vibration and radiated noise. The structure obtained from up-front competing product analysis was integrated into the conceptual design. After several rounds of simulation, computation and optimization, the product’s conceptual design platform was finalized – an impressive low-vibration, low-noise package.

Subsequent layout design work also focused on simulation. Specific to the characteristic parts, components and systems, the simulation solution from the Simcenter portfolio was used to optimize radiated noises to enable the low noise level of designed structures. Meanwhile, in combination with AVL software and Simcenter simulation solution, work was done to minimize the noise produced by piston knocking and gear driving as well as the vibration produced by axle twisting. Ultimately, this enabled the enhancement of all parts, assemblies and systems.

At the detailed design stage, another optimization was performed to further fine-tune NVH performance.

After trial manufacture, the new WP3 diesel engine model entered the prototype development stage. This stage focused on NVH testing and analysis in conjunction with NVH simulation. Based on using Simcenter Testlab, the development team conducted comprehensive and detailed NVH testing on individual parts/components of the diesel engine as well as on the diesel engine itself. This included modal testing, vibration testing and vibration fatigue testing on parts/components, and vibration testing, axle twisting vibration testing, noise testing, combustion noise testing and noise quality testing and acoustic contribution analysis on the diesel engine.

At this stage, NVH problems were fully revealed and resolved by using testing/analysis and simulation in concert. The test data of Simcenter Testlab was seamlessly transferred to Simcenter simulation solution for model correction and benchmarking. The simulation results were conveniently used to direct and design the testing program in order to enable comprehensiveness and accurate results.

After completion of the new WP3 diesel engine model development, the Simcenter NVH development tool was used for the vehicle suspension system matching. Experimentation was used to obtain the power assembly’s rotational inertia and the mass center location; simulation was used to obtain suspension parameters including location, angle and cushion rigidity. Upon completion of the suspension matching, vibration testing was conducted to assess whether the matching was successful.

“It is critical to achieve a combination of simulation and experimentation with a seamless connection of experimental data and simulative data in NVH development. This is where the biggest advantage of the Simcenter NVH solution lies. It makes our NVH development process convenient and efficient.”

Wen Zhiyong
Head of NVH Room
Technical Center
Weichai Power
“As the business of Weichai Power grows, the company will continue to work closely with Siemens PLM Software’s Simcenter NVH products and support team in order to advance diesel engine innovation.”

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“All such work guarantees the very high NVH level of the new WP3 diesel engine model – 76 dBA at idle speed, 95 dBA under standard operating conditions, and good acoustic smoothness with very low vibration energy under a wide range of operating conditions,” says Wen Zhiyong, head of the NVH Room, Technical Center, Weichai Power. “After vehicle matching, the noise level in the cab was below 52 dBA, reaching the level of imported high-end vehicles.”

NVH work continued after launching of WP3 diesel engine. The development team paid close attention to further opportunities for improvement and promptly fine-tuned NVH performance based on customer feedback in the market.

**WP4.1 – the most silent engine in the industry**

Based on the same development method and process, including instrumental use of Simcenter solutions, Weichai Power’s NVH development team achieved outstanding results in the WP4.1 NVH improvement project.

WP4.1 is an optimized and improved product developed on the basis of the Weichai Power 4105 diesel engine. The development team conducted noise-reducing work for the diesel engine’s powertrain, accessories, in-cylinder combustion system and other components, including use of high-precision gear, booster BPF noise suppression, pre-sprayed benchmarking for lowering combustion noise and acoustic hood. This enabled a reduction of diesel engine noise by 2 to 3 dBA, in-cab noise by 1 dBA and vehicle pass-by noise by 1.5 dBA. “Thanks to the efforts of our team and Simcenter solutions, the WP4.1 diesel engine has achieved superior NVH performance and is regarded as ‘the most silent engine’ in the industry,” says Zhiyong.

The success of the WP4.1 noise reduction project is attributable to the subject matter expertise and hard work of the Weichai Power NVH team and Siemens PLM Software’s NVH solution as well as ongoing help from other Weichai Power departments. During the NVH development process, Weichai Power accumulated invaluable best practices and optimization practices specific to noise-reducing measures, which are now leverageable for other products.

**Criticality of seamless data connection**

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Wen Zhiyong
Head of NVH Room
Technical Center
Weichai Power
Solutions/Services
Simcenter CAE Simulation
Simcenter Testlab
Simcenter SCADAS

Customer’s primary business
Weichai Power Co., Ltd. primarily produces power assemblies (engines, gearboxes and axles), vehicles, hydraulic controls and auto parts/components. In 2015, Weichai Power was ranked No. 70 among Top 500 Enterprises in China and No. 2 among Top 500 Enterprises in China’s machinery industry.
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