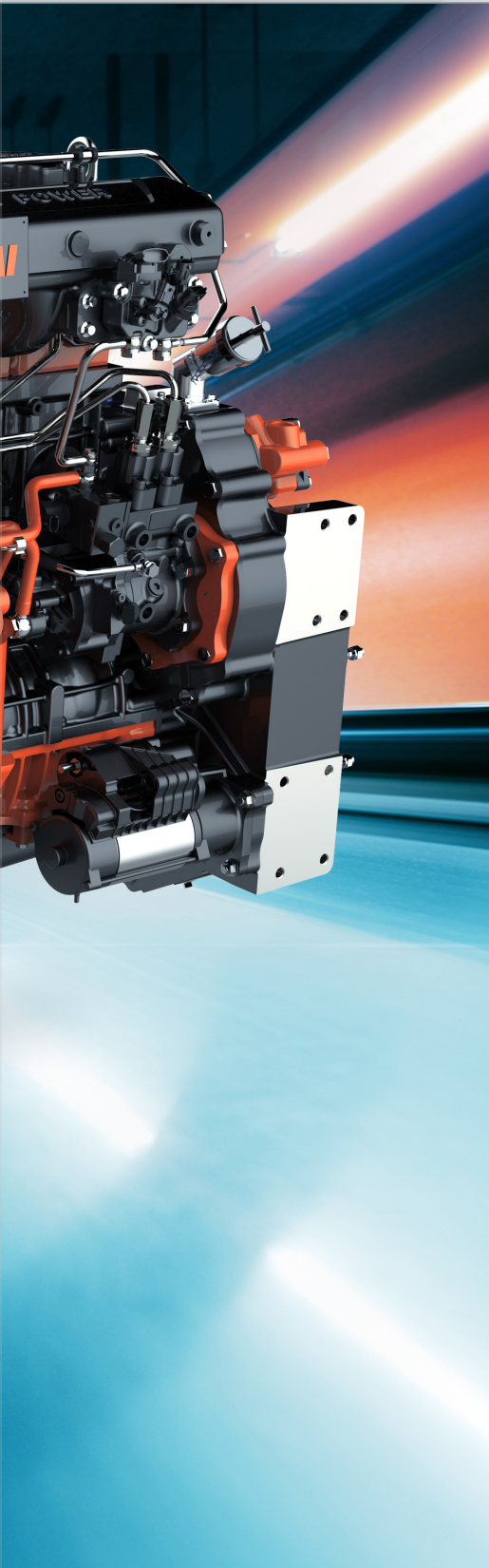


Customer-specific simulation models
for highly efficient truck engine technology

Modeling the Future

To meet new requirements for the exhaust behavior of combustion engines, the relevant development and test environments have to be continuously developed as well. For new engine generations, Weichai therefore uses dSPACE Automotive Simulation Models and dSPACE SYNECT.



Since the emission regulations for passenger cars and trucks are becoming stricter, the controls for diesel engines are becoming more complex. In addition to engine speed and torque, a growing number of emission-relevant factors, such as injection volume, nitrogen oxides and particulate emissions, have to be captured and controlled. To comply with the stipulations of the Euro VI standard, the Chinese engine manufacturer Weichai introduces numerous technological innovations for its existing Euro IV/V engines (figure 1). To precisely simulate these innovations in a hardware-in-the-loop (HIL) environment, the simulators for validating the electronic control units (ECUs) had to be modified to fit the new functionalities.

Models and Parameterization

In addition to its own models, Weichai uses the dSPACE Automotive Simulation Models (ASM) for engine modeling, e.g., the real-time-capable ASM InCylinder models. They can not only be used to simulate the in-cylinder pressure and the temperature in diesel engines. They can also perform specific calculations for fuel injection, such as an immediate calculation of the rail pressure (figure 2). Because the ASMs act as an open model library, dSPACE Engineering Services was able to pre-

cisely adjust them to the technological requirements of Weichai's latest engine generation. The ASM InCylinder model can also be parameterized in a way that lets it simulate various diesel engine variants (figure 3). These include inline engines with a fuel system, one air path, and one exhaust path, V engines with two air paths and exhaust paths, as well as V engines with two air paths and one exhaust path. Therefore, Weichai no longer has to change the entire model structure when it wants to test a different engine variant. The company only has to modify a few parameters.

Flexibility

In addition to the HIL tests for diesel engine ECUs, Weichai modifies the HIL simulators for developing and testing ECUs of alternative drives as well. This includes hybrid drives and compressed natural gas (CNG) engines, that comply with the Chinese emission regulations China IV and China V and are produced in smaller numbers. The simulation model used for the CNG engines is based on the ASM InCylinder Gasoline model, in which fuel and ignition systems as well as the air paths are adjusted to the real characteristics of the Weichai engines. Only little effort was required for the commissioning and parameteriza-

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“With dSPACE SYNECT, we succeeded in significantly simplifying model management and test management.”

Yupeng Wang, Weichai Technology Research Institute

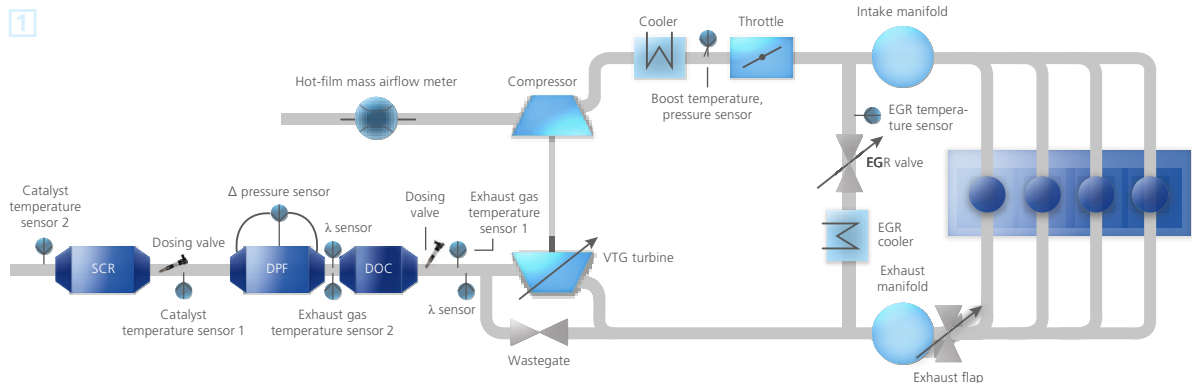


Figure 1: Technical diagram of Weichai's Euro VI diesel engine. A wide variety of components must be precisely controlled to comply with the more stringent emission regulations. This includes the throttle valve, the exhaust gas recirculation (EGR) valve, the variable turbine geometry (VTG) of the turbocharger, the diesel oxidation catalyst (DOC), the diesel particulate filter (DPF), and the selective catalytic reduction (SCR) of the exhaust emissions.

“With the dSPACE HIL platform and the ASM tool suite, we were able to perform the many challenging ECU tests for the Euro VI engines of our fleet.”

Hengfeng Yu, Weichai Technology Research Institute

tion in order to use the models for HIL testing. The development of the HIL platform for testing engine ECUs of hybrid drives was similar (figure 4). Here, the ASM libraries and dSPACE Real-Time Interface (RTI) were also able to help increase the development efficiency, which resulted in a shorter time to market for new products.

Test Management

In the past, the great variety of plant models, test cases, and test plans

made it difficult to manage the data for the HIL test platform at Weichai. Now, with the centralized management of data in dSPACE SYNECT, the developers are supported in their day-to-day work (figure 5). In SYNECT, Weichai manages all HIL plant models for diesel engines, CNG engines, parallel and power split hybrid drives as well as drives for heavy construction equipment. Even tests for the same ECU can vary between the individual development phases, depend-

ing on the test requirements, test plans, and test cases. This is why Weichai prepared specialized test cases for each function and created its own test plans to implement an efficient test process. In dedicated test projects, the engineers used SYNECT to collect all data required for each ECU to be developed, from the basic test plans to the final reports on the results of the various tests. The results are particularly useful for assessing the test status, progress,

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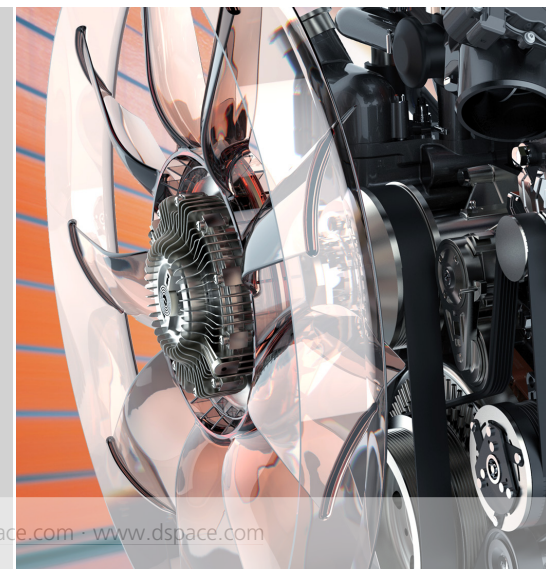


Figure 2: The model modified by dSPACE Engineering Services for the customer now allows for an immediate calculation of the rail pressure, among other things.

Figure 3: The ASM InCylinder can be parameterized to represent different combustion engine designs.

Figure 4: Setup of the HIL Test platform for Weichai hybrid drive ECUs.

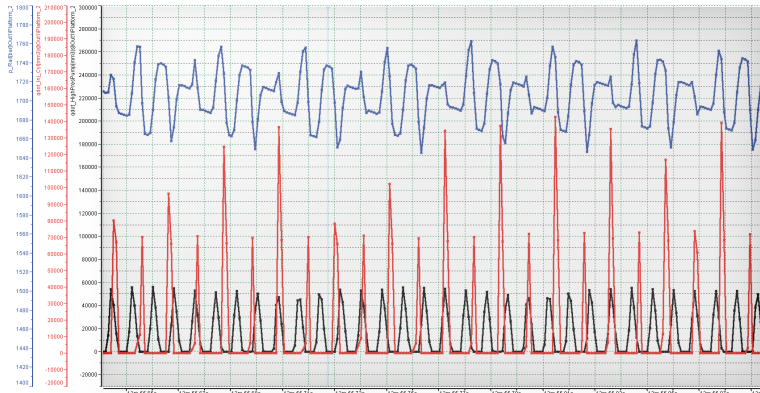
Figure 5: dSPACE SYNECT helps the developers at Weichai manage the high volume of test and model data sets.

and quality. Weichai defined different roles for the team leader and all engineers involved in the development to regulate the access to the HIL test data. In SYNECT, each role has individual read/write privileges for the HIL system, the test case, and the test implementation.

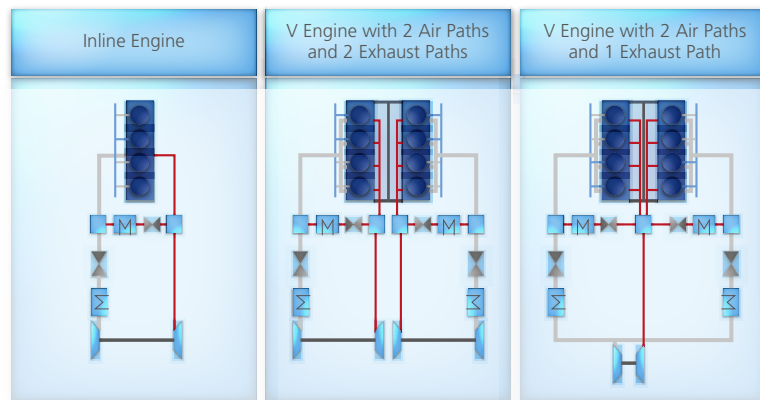
Conclusion and Outlook

With the dSPACE HIL platform, Weichai was able to meet all the requirements for the ECU tests of Euro VI engines. The support of dSPACE Engineering Services made it possible to implement more specific requirements in a customer-specific model. The dSPACE ASM models, which can be adapted for different model variants, were easy to integrate into the models developed by Weichai. Moreover, the use of dSPACE SYNECT made model management and test management much simpler. Therefore, the engineers were able to use the dSPACE tools to establish their own processes for plant model development and parameterization with little effort. Finally, the dSPACE HIL platform gives Weichai more flexibility, which not only reduces the time to market for new conventional combustion engines but is also suited for alternative drives, such as CNG and hybrid drives. ■

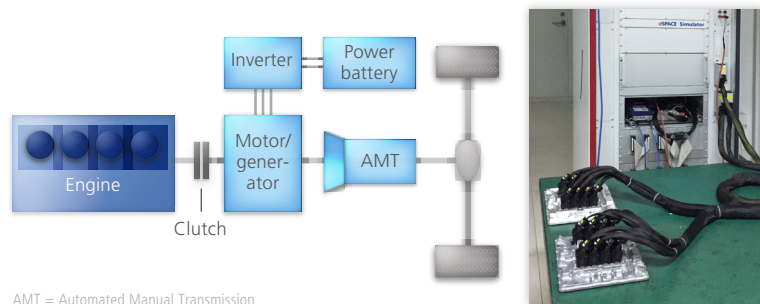
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AMT = Automated Manual Transmission

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