

The Evolution of Power Unit Development Process through MBD

- (Tenth Report) Deployment of 1D System Model to Performance Verification Phase -

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As one initiative toward realizing a sustainable society and human well-being, the adoption of mobility powered by carbon-neutral energy is required. Mobility offers a wide range of power unit options, including BEV (Battery Electric Vehicle), FCEV (Fuel Cell Electric Vehicle), PHEV (Plug-in Hybrid Electric Vehicle), and HEV (Hybrid Electric Vehicle). Authors hold the view that the optimal solution should be provided according to market needs and changes in regional infrastructure. While adhering to the aforementioned guidelines for providing diverse power units, meeting ongoing customer value in the market necessitates not only the evolution of power units and vehicle bodies but also the delivery of new customer experiences through intelligent technologies. Avoiding the expansion of automotive R&D scale will be difficult.

To address the expansion of automotive R&D scale, the authors have proposed the vehicle development through MBD (Model-Based Development). However, the implementation of MBD across the entire vehicle development process encompassing both a performance design phase and a verification phase has not been realized. Specifically, a process enabling the seamless implementation of 1D models constructed during the performance design phase into the performance verification phase remains unestablished.

This study implemented the following items to concretize application guidelines for standardized 1D system model in the performance verification phase, aiming to achieve high-efficiency power unit development through MBD application:

- Establishing the 1D model concept
- Planning the 1D system model lineup for the verification phase

A 1D model standardization concept as shown in Fig.1 was established. The concept was based on the 1D system model, where subsystem models of varying granularity were coupled and integrated with knowledge encompassing various scenarios and experimental models. The concept was developed assuming the implementation of the 1D system model in verification facilities.

The facilities applied to vehicle development in the verification phase and the 1D models implemented within facilities were summarized. Fig. 2 shows the 1D system model lineup for realizing the concept. The verification facilities used includes EiL (Engine-in-the-Loop), TiL (Transmission-in-the-Loop), PTB (Power unit Transient Bench), PU-HILS (Power Unit-Hardware-In-the-Loop Simulation), and a driving simulator. The model behavior requirements corresponding to these pieces of facilities were energy flow, thermal flow, fluid dynamics, vibration, electro-dynamics, motion, and sound. The 1D models satisfying these behavioral requirements were consolidated into the 1D system model lineup that can be constructed during the performance design phase.

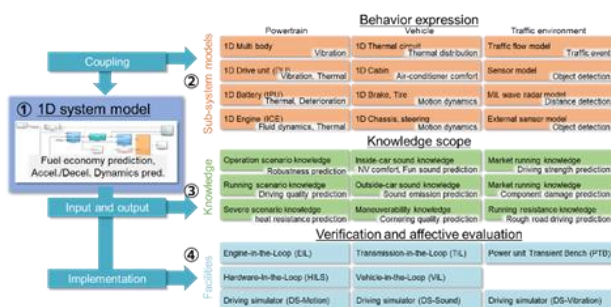


Fig.1 Concept of 1D model standardization

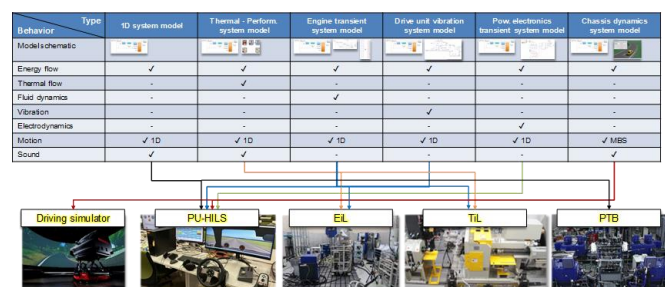


Fig.9 Model line up

Fig.2 Model line up