November 2023

electric & hybrid

vehicle technology international

URBAN FUTURE

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Škoda CEO Klaus Zellmer talks plug-in hybrids, charging strategies and the brand's EV plan of action

LINKING THE HYDROGEN CHAIN

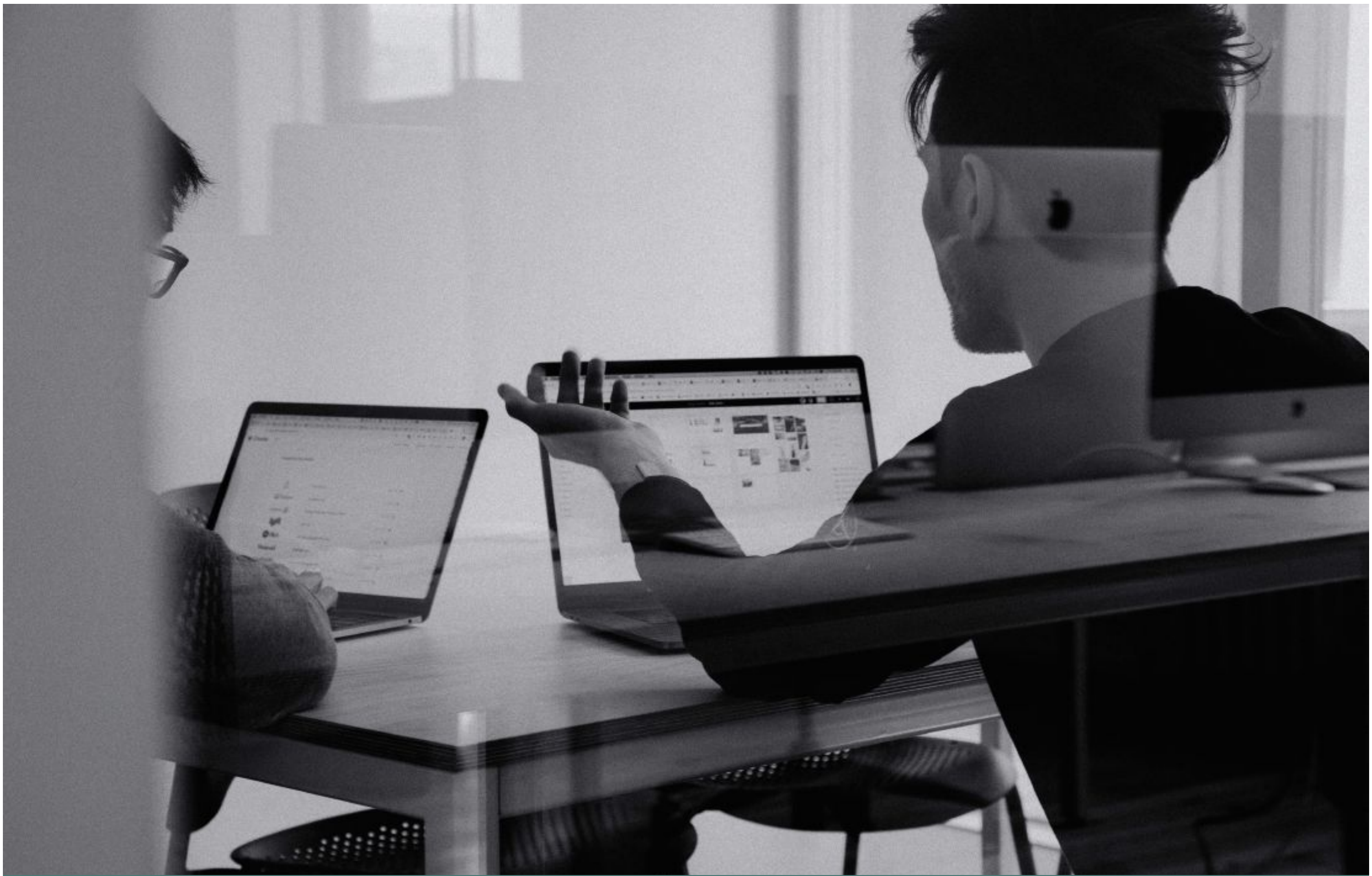
The global challenges facing a viable and scalable zero-emissions alternative to battery electrification

THE BIGGER THEY COME...

New charging management and battery chemistries for the next generation of heavy-duty vehicles

The many benefits of virtual twin modeling

Model based systems engineering that utilizes virtual twin modeling broken down into subsystems can save engineers not only time but also money



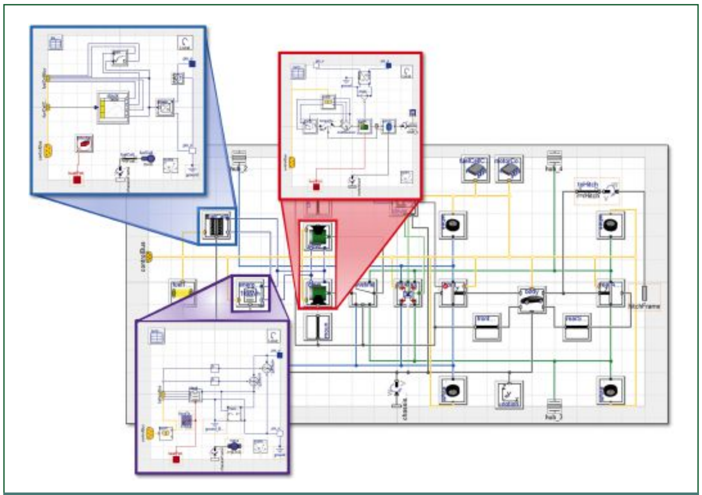
Using virtual twins as part of your MBSE processes can be an effective tool to drive collaborative approaches, enabling specialists from neighboring domains to work together

Modern electric vehicles (EVs) are complicated products. Many subsystems, of various technology types, must be brought together into a single design. Collecting all these subsystems into a whole combined system is hard, especially before any prototypes have been made. Teasing out the knock-on effects of a change to one component on the whole design can be very difficult early in the design process. Simulation of a virtual representation of the design, often known as a virtual twin, enables the knock-on effects of a change to one subsystem on another, or the whole design, to be understood easily as the design evolves. Time, and money, is saved as a result.

This can be considered a form of model based systems engineering (MBSE). At its heart, MBSE sees the design as it stands digitalized in one form or another. A term often used for this digitalization is 'digital twin'. Key to this is that the digital twin is the single source of truth i.e., it is the design as it stands at that point.

In some instances this could be the digitalization of written records. In vehicles, this is often a collection of the design contents and specifications in a single managed digital place. If we consider the digital twin as the design itself, then we can consider the virtual twin a simulation model of the digital twin.

As the digital twin will often be categorized into groupings based on component function, the virtual twin in this case should be similarly organized. We can think of it in the same way as an engineering



virtual twins can be made from subsystem models of each component, in a very recognizable form

organization is structured; there will be the team working on the powertrain and so forth. A virtual twin can have a model for each of these groupings, referred to as subsystems. Together, all these models constitute the virtual twin.

Ideally in MBSE, the digital twin and the virtual twin should be digitally linked. Data comprising the digital twin can be used to parameterize the virtual twin and its constituent subsystem models.

Simulating the virtual twin can generally be referred to as systems level simulation. Recreating the entire vehicle as a system of subsystems is the objective, although subsystem detail doesn't necessarily have to be flawless. Rather, fidelity can be tailored to the simulation purpose. Associated with this virtual twin are a collection (known as a 'library') of simulation experiments. Each experiment is like a real-world test, testing the virtual twin just as physical prototypes of vehicles or components were tested before. Simulation test cases in the library are not limited to those of the virtual twin as a whole, but also can be experiments of the subsystem models comprising it. So, the battery as a component will have its own set of specific experiments. Some will test it in isolation, others with important connected components, such as the charging apparatus.

When the digital twin is updated with a configuration change, the component subsystem model of the virtual twin can be updated to reflect it. The library of simulation experiments associated with the virtual twin can then be run. With each design iteration, no matter how small or localized, the whole design can be evaluated. Knock-on issues, usually found by physical testing later, can be identified much earlier.

Take the example of a change to the battery casing material to improve thermal performance. The resulting change in vehicle mass distribution can be understood quickly by running vehicle handling simulations using the virtual twin. The vehicle dynamics team can then update the requirements for the suspension components like spring stiffnesses or damping values to maintain the desired performance. Before, this could have required manufacturing a new battery casing and physically testing the new configuration, or the design group notifying the vehicle dynamics group of the change, resulting in an increase in time and money for the program. With the virtual twin, this change could be evaluated in minutes rather than days. Each team is working in tandem without costly organizational headaches.

As the overall system features elements from different physical domains, like mechanical, thermal, or fluid, a tool capable of supporting all together is needed. With Dymola, a modular approach to component modeling matches up with the requirements of the virtual twin. The same component model can be used in the subsystem and system experiments. Each physical domain can also be combined easily in the same model. Models don't have to be reformulated to suit deployment scenarios and applications either, making experiments easier to build.

Altogether, this means an MBSE approach utilizing a virtual twin broken down into subsystem models is a valuable tool. Knock-on effects between components can be quickly and easily understood and the collaborative aims of MBSE, in that engineering specialists from neighboring domains work together, can be realized.

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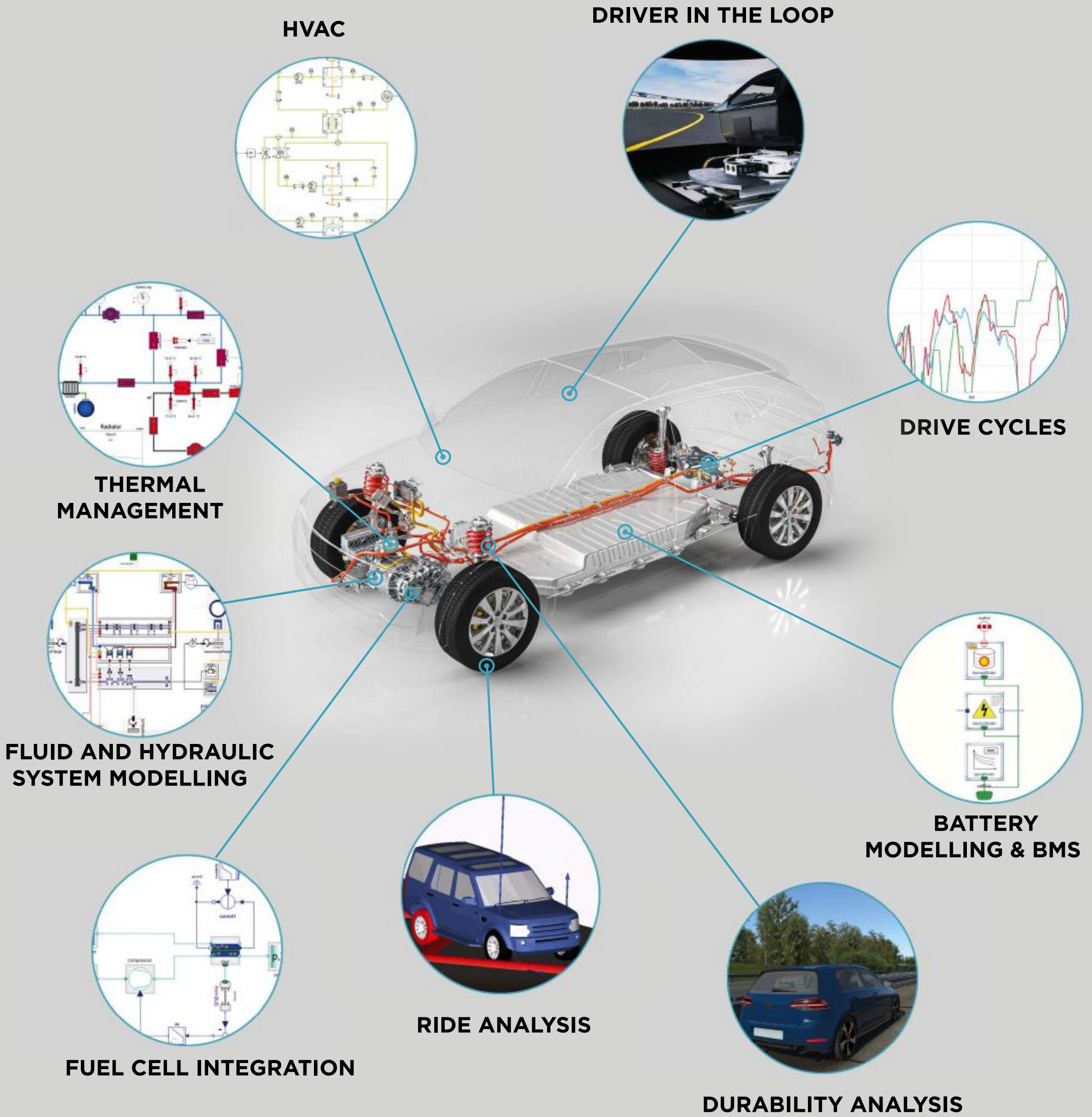
Traditional approaches to testing designs are expensive. Investing in virtual twins can reap substantial time and cost savings

As software takes an ever more crucial role in the modern vehicle, fault finding with physical prototypes is much harder than previously. Virtual twins enable the assessment of the design at each change/iteration

MULTI-DOMAIN MODELLING & SYSTEMS SIMULATION



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