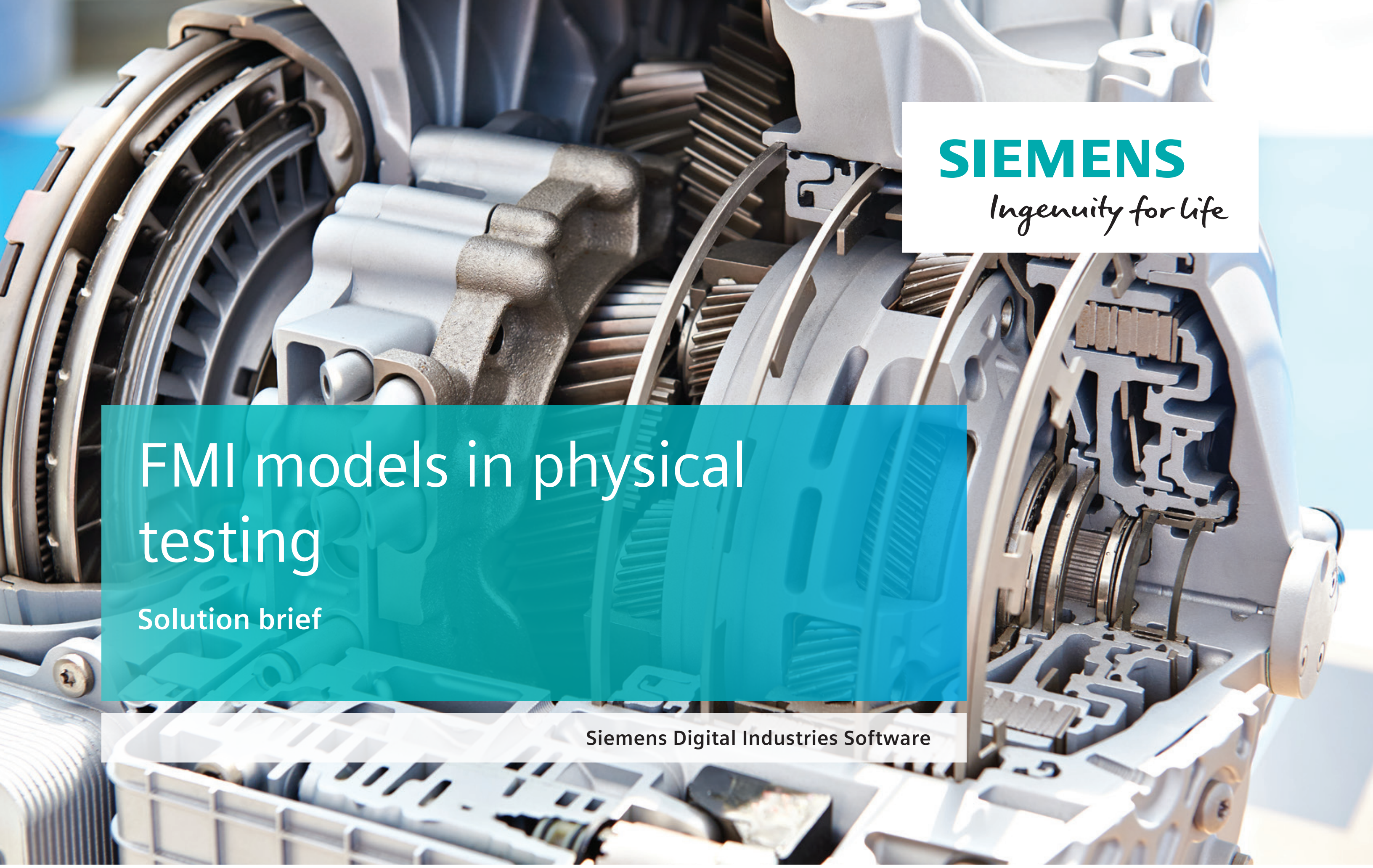


SIEMENS

Ingenuity for life

FMI models in physical testing

Solution brief

Siemens Digital Industries Software

Extend test measurements with FMI-based models

As system complexity increases, repeatedly creating and testing physical prototypes is a highly ineffective way of solving design problems. That is why product development processes are increasingly being driven by simulation. Together with the complex and personalized nature of designs, engineers must deal with more product variants, components and systems; and they must explore innovative designs and pay more attention to quality issues. That is a lot to test, validate, verify and certify.

To successfully develop these complex and smart systems, it is crucial that simulation and test engineers collaborate to improve product development efficiency. A product development approach that can merge these processes will be effective in finding the right balance between functional requirements. This requires testing solutions that can bridge the gap between test and simulation. The present solution is such a tool. It belongs to the field of Model Based System Testing, which aims at offering a broad and varied set of testing tools combining simulation and test.

Importing a Functional Mock-up unit

Simcenter Testlab™ Neo supports the latest version of the Functional Mock-up Interface (FMI) 2.0 for Co-Simulation which is an open standard to conveniently exchange models prepared in different simulation software environments. A model using the FMI interface is called a Functional Mock-up Unit (FMU). An FMU can be imported into Simcenter Testlab Neo Process Designer using the FMU method (a method is a calculation element in a process chain). This FMU method is a regular method in a user-defined process flow in Process Designer.

The equations contained in the FMU are solved by its embedded solver at the pace dictated by the sensor measurements flowing into Simcenter Testlab

Challenges

- Master system engineering complexity
- Assess influence of component dynamics into the full system
- Measure dynamic system behavior in inaccessible locations

Solutions

- Calculate full-system responses when testing at component-level
- Use model-based virtual channels for indirect measurements

Results

- Obtained insight into complex systems to support product engineering
- Shortened validation time of simulation models
- Decrease risk of late component flaw discovery
- Optimize process efficiency

Solution focus

Neo Process Designer. The latter acts as a co-simulation master (as a directed rooted tree) for each independent simulation throughout the processing phase.

FMI 2.0 for Co-Simulation is supported by more than 100 tools, including Simcenter Amesim™ since version 15 and the Simcenter 3D multibody simulation solution that will soon support FMI 2.0.

Calculate full-system responses directly in the test cell

The lower performance of a component in the full system may be revealed too late in the development cycle of a product. As a result, the targeted product quality may not be reached unless high re-engineering and production costs are engaged. It is challenging for component suppliers to have early access to a physical prototype of the full system for testing purposes or to assess a component's performance before a prototype is built. To accelerate the product development process, engineering teams may assess the component's dynamics on a dedicated test bench that will apply realistic system input loads. Bench input measurements can be directly fed into the FMU of the full system to generate results at any location in the model. The results can be connected to any other method of the Simcenter Testlab Process Designer workbook to support the system engineering process.

Example use case:
Validation of a torque converter

When developing torque converters, engineers need to assess and validate their performance. However, the performance of a torque converter is best assessed by evaluating its torsional behavior at the driveshaft level, close to the tire/road contact. By means of a validated model of the complete driveline and vehicle dynamics embedded in an FMU, the test bench operator can calculate the effect of the torque converter's dynamics on the torsional behavior of the driveline. The simulation model uses as inputs the measured quantities from the physical torque converter mounted on the test bench in order to obtain full insight into the driveline torsional behavior inside the vehicle.

Obtain better insight with model-based virtual channels

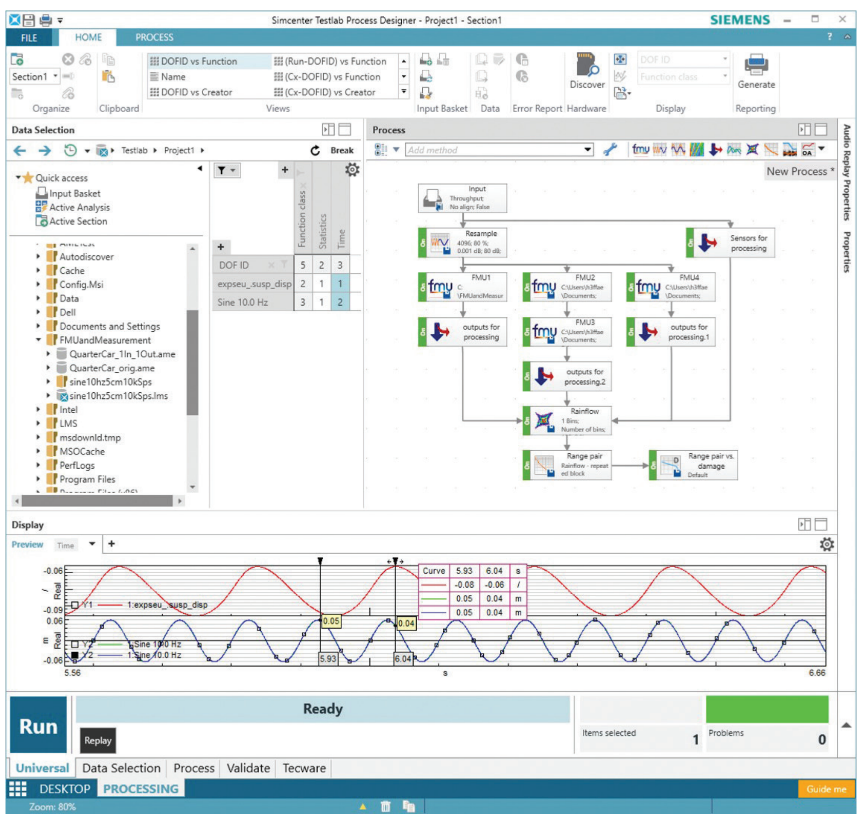
An FMU can provide additional insight into the operation of the system under test (SUT). For that, the FMU contains the SUT simulation model. The engineer can apply the measured inputs directly to the FMU to calculate its internal states during the product engineering process. This method allows extending the measured sensor data set with simulated internal behavior information, helping the engineer better understand the SUT dynamics.

Example use case:
Calibrating a vehicle suspension

During the calibration phase of a vehicle hydraulic suspension, access to the internal hydraulic pressures and flow rates provides additional engineering insight in support of optimal tuning.

Obtain better insight with virtual sensors

The FMU method can also be used to embed an observer for calculating virtual sensors. For example, virtual sensors can be created by using model-based observers. In this case, the FMU contains the simulation model and the observer. When it is used on Simcenter Testlab Neo Process Designer, it produces estimates of the missing measurements. These are then stored together with the standard measurement channels.



Using FMU methods in a user-defined process in Simcenter Testlab Neo Process Designer.

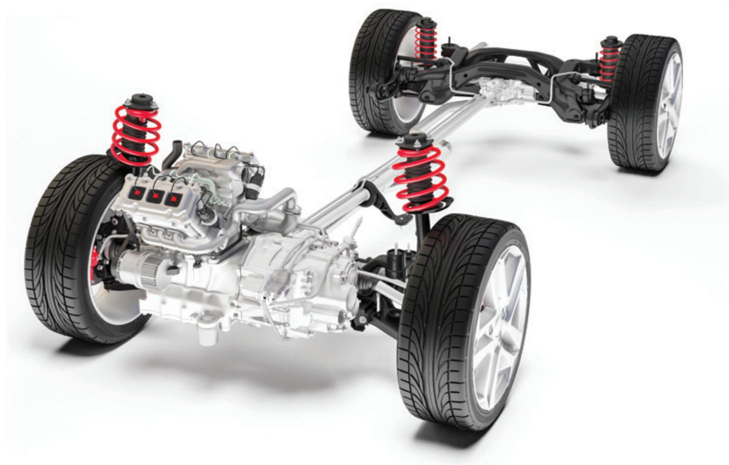
Example use case:
Estimating vehicle wheel forces

Wheel-force transducers provide accurate measurements of the wheel forces and moments, which are essential for assessing vehicle dynamics. They are used for advanced proving ground testing as they are expensive devices and cannot be universally fitted to any type of rim. When assessing wheel forces and moments on multiple vehicles simultaneously, the instrumentation costs become extremely high. In such case, the testing team can use model-based virtual sensors embedded in an FMU.

Optimize process efficiency

The FMU method optimizes the overall product development process in the following ways:

- Model parameter updating: it enables test engineers to define the optimal parameters for any model variant by recalculating the models for each new parameter set and assessing its performance against measured data
- Measurement quality check: Test engineers can immediately verify measured data against estimated simulation results, revealing possible instrumentation or measurement errors. Counter-measures can be applied quickly, avoiding extra testing costs to re-test the specimen
- Pre- and post-processing: Simcenter Testlab Neo Process Designer can pre-process measured data (filter noise, adapt sampling rate, etc.) before it is used as FMU inputs. It also let engineers apply a variety of post-processing methods on the FMU outputs



FMUs containing models and observers can be used in Simcenter Testlab Neo Process Designer to estimate magnitudes (wheel forces, sideslip angle, etc.) useful for vehicle dynamics testing.

Siemens Digital Industries Software
siemens.com/plm

Americas +1 314 264 8499
Europe +44 (0) 1276 413200
Asia-Pacific +852 2230 3333

72563-C15 7/19 H