PRODUCT PREVIEW

SIMPLORER® 6.0

SIMPLORER® 6.0

Transportation, Power Electronics, and Electric Drives System Simulation

SIMPLORER 6.0 represents a major advancement in simulation technology. With the new version, designers in the automotive, aerospace, railway, power-electronics, and electric-drive industries can design and analyze complex multi-technology systems more efficiently and cost effectively than ever before.

Modeling without Limits

VHDL-AMS

SIMPLORER's prolific simulator-coupling capability, which allows circuits, block diagrams, and state machines to operate simultaneously as default modeling languages, now includes VHDL-AMS. This release provides users with virtually unlimited simulation power. The Institute of Electrical and Electronics Engineers (IEEE) created VHDL-AMS (IEEE 1076.1 standard) to provide a general-purpose, easily exchangeable, and open modeling language for modern analog-mixed-signal designs. Desiring a nonproprietary solution for model exchange between OEMs and suppliers, the automotive sector was one of the key industries to adopt VHDL-AMS. However, the IEEE standard has a much larger impact on other design areas, providing a standardized modeling language for multiple domains far beyond electrical analog-digital design. SIMPLORER extends the flexibility of VHDL-AMS a step further by allowing it to be mixed freely with any of SIMPLORER's modeling languages. Besides flexibility, this assures minimum time during the simulation.

Figure 1 shows the new kernel design. In

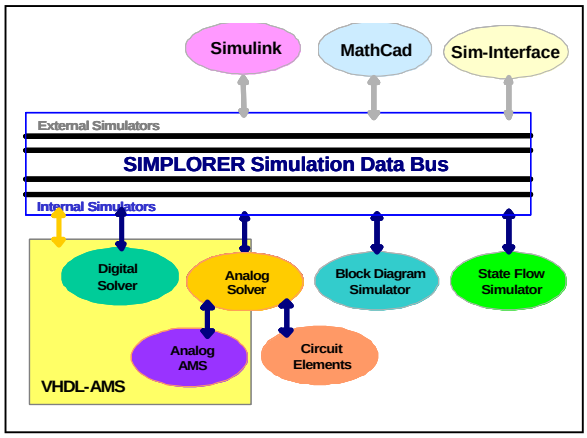

Figure 1: SIMPLORER 6.0 System Architecture

version 6.0, SIMPLORER's system architecture is extended by the addition of new analog and digital solvers. The analog solver handles both the analog part of a VHDL-AMS model and the circuit simulation. The digital simulator efficiently handles event-driven systems. To accommodate the advanced modeling features of VHDL-AMS, several extensions of the numerical algorithms were implemented, providing high simulation speed and conserving SIMPLORER's superior numerical stability. The multidomain modeling features of VHDL-AMS make it attractive for complex system designs typical of aerospace, automotive, and drive systems. Engineers can analyze mechanics, hydraulics, and thermal problems together with traditional electrical designs without using electrical analogies. VHDL-AMS is fully integrated into SIMPLORER's graphical interface. Users can simply draw a box on a schematic and assign VHDL-AMS as the modeling language. The embedded editor, complete with syntax coloring, automatical-

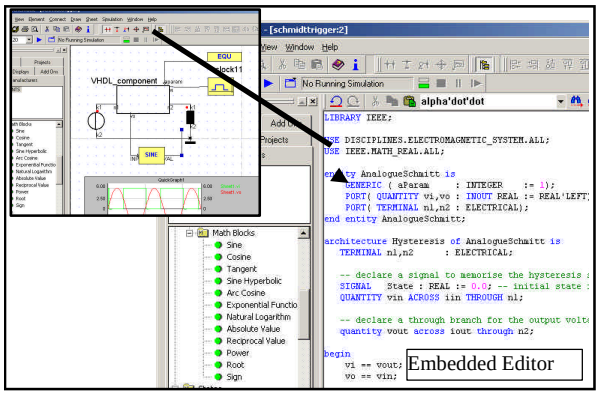

Figure 2: VHDL-AMS - Graphical Environment

ly opens and the user can generate the VHDL-AMS model (Figure 2). After the definition is complete, the schematic automatically generates the required pins and parameters. Once a model has been developed and verified, simple copy and paste operations transfer it to the model database for future use. The majority of components in the SIMPLORER basic library are implemented in VHDL-AMS. The models are open and available for editing, allowing easy access to the language. Figure 3 shows a simulation example for an automotive application. The MSR consortium in Germany developed it to benchmark VHDL-AMS simulators. It comprises powertrain, energy storage, and load models as they are typically found in vehicle system simulations. All models are described in VHDL-AMS; however, they also can be modeled and mixed with SIMPLORER's native SML models.

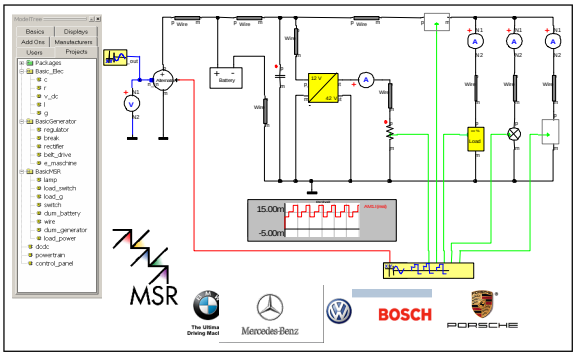

Figure 3: VHDL-AMS Automotive Power Net Example

SPICE: Preserve Existing Designs

SIMPLORER 6.0 contains a SPICE-compatibility mode to satisfy user demand for supplier models. Since many manufacturers provide SPICE models for download, Ansoft added a SPICE 3F5-compatible simulation engine that supports all SPICE semiconductor models as well as sources and other components. The compiler is able to handle most SPICE derivatives and automatically translates SPICE circuit files and libraries into SIMPLORER SML files. Models will be available for download from the SIMPLORER product page on the Ansoft Web site, http://model.simplorer.com, where users can search for models and/or request new models. The new SPICE compatibility supports all analysis modes from DC to AC to transient. Figure 4 shows the SPICE library containing all major generic models from BSIM to several MOS model levels.

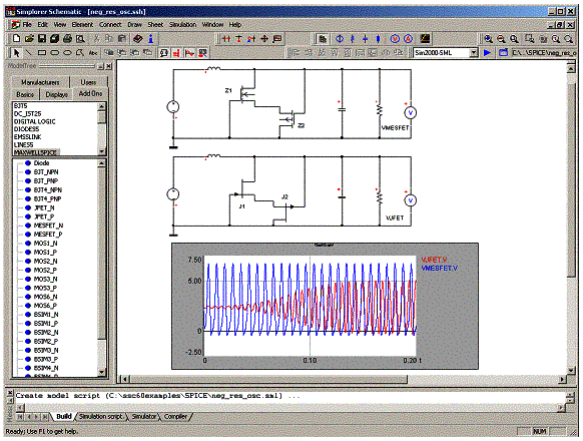

Figure 4: SIMPLORER Schematic with SPICE Generic Model Library

Complete Analysis Capabilities

SIMPLORER 6.0 extends beyond transient analysis; the new version also supports DC and AC analyses. Designers of switched-mode power supplies require AC analysis to determine the frequency dependency of their designs. SIMPLORER 6.0 provides small-signal AC analysis for electrical circuits and for block diagrams. This expands analysis capabilities far beyond traditional SPICE-based circuit simulators. Engineers now have the choice of different modeling levels and analysis types. Figure 5 shows the new parameter dialog for general simulation settings, where users can select between DC, AC, and transient analyses. For convenient visualization, special frequency-domain active elements are implemented to show bode plot, root locus, and Nyquist® diagrams.

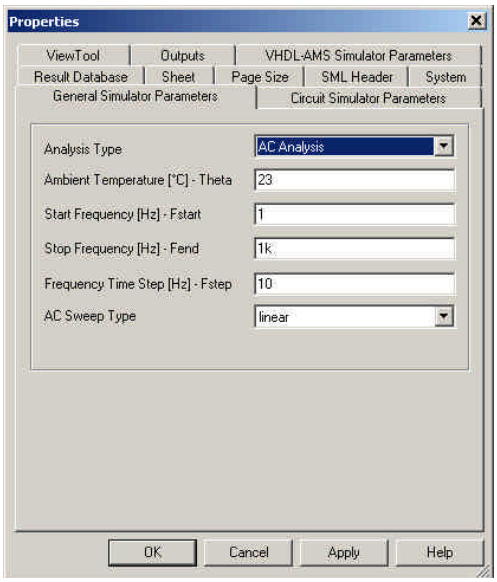

Figure 5: AC Analysis Settings

New Model Libraries

Another significant improvement in SIMPLORER 6.0 is the availability of additional libraries. The new hydraulics library provides a set of sophisticated models for powertrain and other hydraulic applications. All models are available as SIMPLORER C-models or VHDL-AMS. They contain basic hydraulic structures, such as orifices, valves, volumes, pipes, and sources. Like most other SIMPLORER models, they can be parameterized with the aid of easy-to-use component wizards. Figure 6 shows available components and an example for the simulation of a hydraulic circuit.

Another domain for SIMPLORER simulations is the automotive community. OEMs increasingly face the need for extensive analyses of the complete electrical system of vehicles. The addition of electronic convenience and safety features in modern

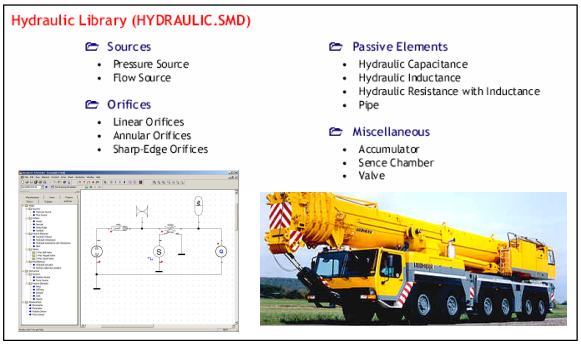

Figure 6: Hydraulic Library

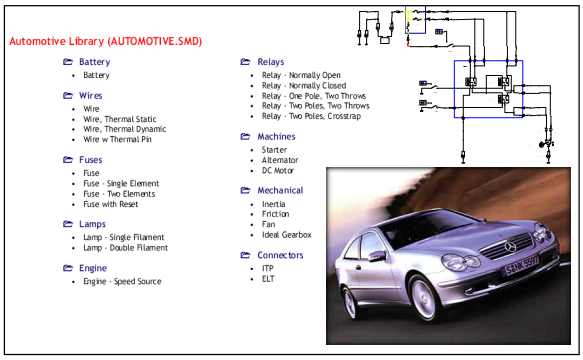

Figure 7: Automotive Library

automobiles requires more power and therefore a precise prediction of power usage, battery state of charge, and the influence of temperature changes. The automotive library provides a comprehensive set of models suited for system-level analysis. Like the hydraulic library, it is available in both SML and VHDL-AMS. Figure 7 shows an overview of available models and a system-level automotive electrical simulation that includes wires, fuses, a cooling fan, and a battery.

An accurate model of the battery is an important precondition for accurate modeling of the power balance of vehicles. The automotive library also contains the first version of a detailed battery model. The model is modular and can be expanded to any voltage level. Figure 8 shows the battery parameter dialog.

Most automotive manufacturers and governmental agencies are researching electric and hybrid-electric vehicle concepts. Fuel cells are considered the key feature for these propulsion systems. To accommodate this research, Ansoft added a fuel-cell model to SIMPLORER. Figure 9 shows the parameter dialog; Figure 10 shows a battery-charging system with a fuel cell as a low-voltage power source, a boost converter to output the 42-volt bus voltage and the battery. The fuel cell and battery are represented by the new models and provide fully dynamic behavior.

Interoperability: Maxwell®

Using Ansoft's unique model-extraction technology (ECE), users can generate highly accurate system-level models based on the results of parametric finite-element analysis performed with Maxwell.

Additionally, Ansoft's Xprt-series products—RMxprt™ and PExprt™—link directly with SIMPLORER. They can generate both a project for a finite-element analysis or a system-level model for SIMPLORER. Figure 11 depicts the design flow with the next integration step; the dashed line represents the direct transient co-simulation between SIMPLORER and Maxwell.

Figure 12 shows an example of Maxwell's model-extraction capabilities. The electrical machine is a permanent magnet synchronous motor for a traction application driven by a system-level model including control in SIMPLORER. The motor design was completely done in Maxwell. After the motor design is optimized using Maxwell, the model may be imported to SIMPLORER simply by placing a link symbol on the schematic and selecting the model file. Real-world system behavior of the motor, drive, and control may then be simulated within SIMPLORER.

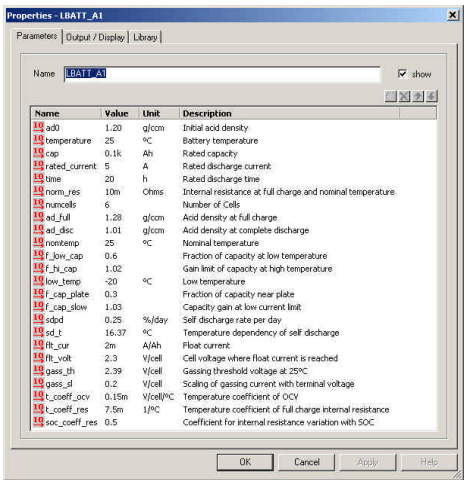

Figure 8: Battery Parameter Dialog Box

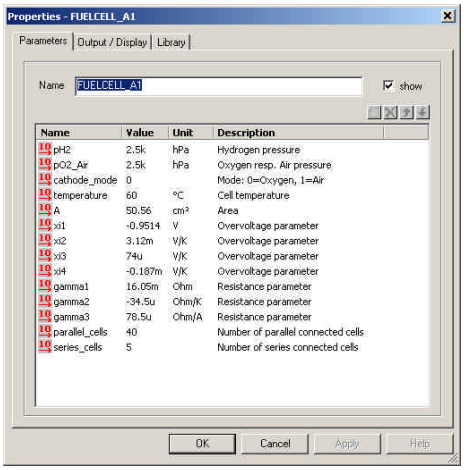

Figure 9: Fuel-Cell Parameter Dialog Box

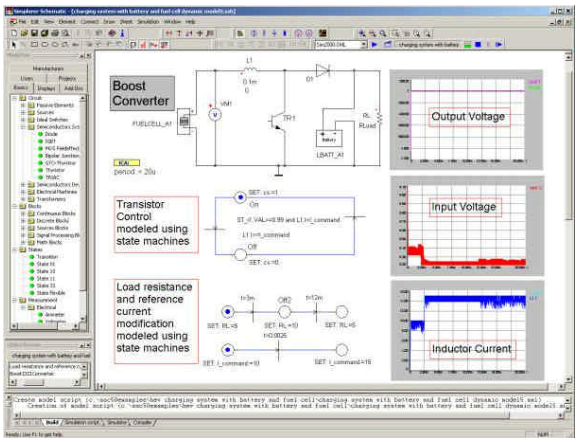

Figure 10: Battery-Charging System with Fuel-Cell & Battery Models

Interoperability: Open Environment

SIMPLORER 6.0 will continue to integrate seamlessly into existing design environments. Based on the easy-to-use SIMPLORER-Simulink® co-simulation interface, Ansoft implemented a link between SIMPLORER and ADVISOR, a vehicle-level analysis tool from the National Renewable Energy Laboratory (NREL) (www.nrel.gov) to analyze fuel economy and emissions. This link allows designers to simulate high-level system models of vehicles in ADVISOR with accurate models of the electrical subsystem, including alternative propulsion systems, in SIMPLORER.

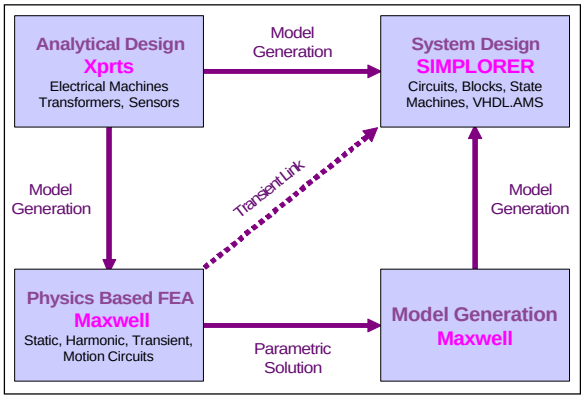

Figure 11: Ansoft EM Design Flow

Figure 13 shows a model setup for ADVISOR. The SIMPLORER link block receives all required data (switching signals for loads, engine speed) and transfers back all data required by ADVISOR to

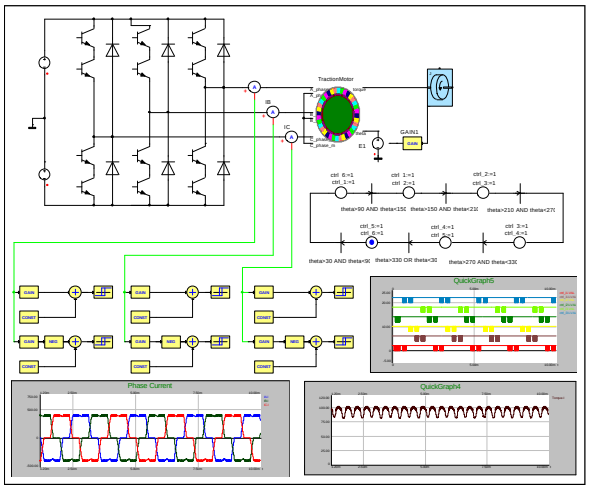

Figure 12: Traction System Using Maxwell ECE Modeling Capabilities

evaluate the energy balance of the vehicle.

Figure 14 shows the setup for SIMPLORER. Both systems run simultaneously and exchange data at given sampling times. In between these synchronization events, SIMPLORER operates with a variable step size to meet the accuracy requirements for the electrical subsystem.

Conclusion

SIMPLORER 6.0 includes many technical advancements, making it the new choice for complex multidomain simulation. The addition of VHDL-AMS and SPICE compatibility facilitates model exchange between component, subsystem, and system developers. New libraries ensure that designers can easily create simulations. The combination of Maxwell and SIMPLORER significantly increases accuracy and accelerates the design process by eliminating barriers between design levels and organizations. Finally, SIMPLORER 6.0 helps to preserve your investment in specialized tools, such as Simulink and ADVISOR by co-simulation and, consequently, reusing existing designs.

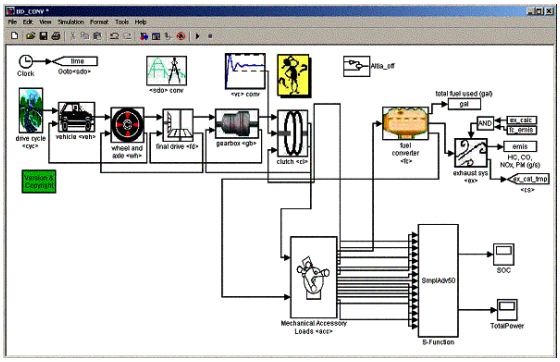

Figure 13: SIMPLORER Link Setup in ADVISOR

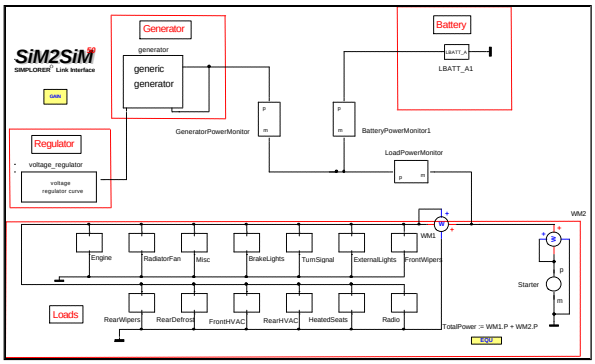

Figure 14: SIMPLORER Small Car Platform Model for Co-Simulation