

System-Level Simulation

- **Simulating automotive software systems**
- **Closed-loop simulation supported**
- **Realistic, ECU-close simulation**

Errors in the logical links between functionalities are often not found until after the electronic control units (ECUs) are implemented by suppliers and integrated by the OEM. So if any errors occur in the modeling of new functionalities, they need to be identified in the early stages of the development process. With the SystemDesk Simulation Module, a vehicle manufacturer can detect any problems as early as the specification or implementation stage.

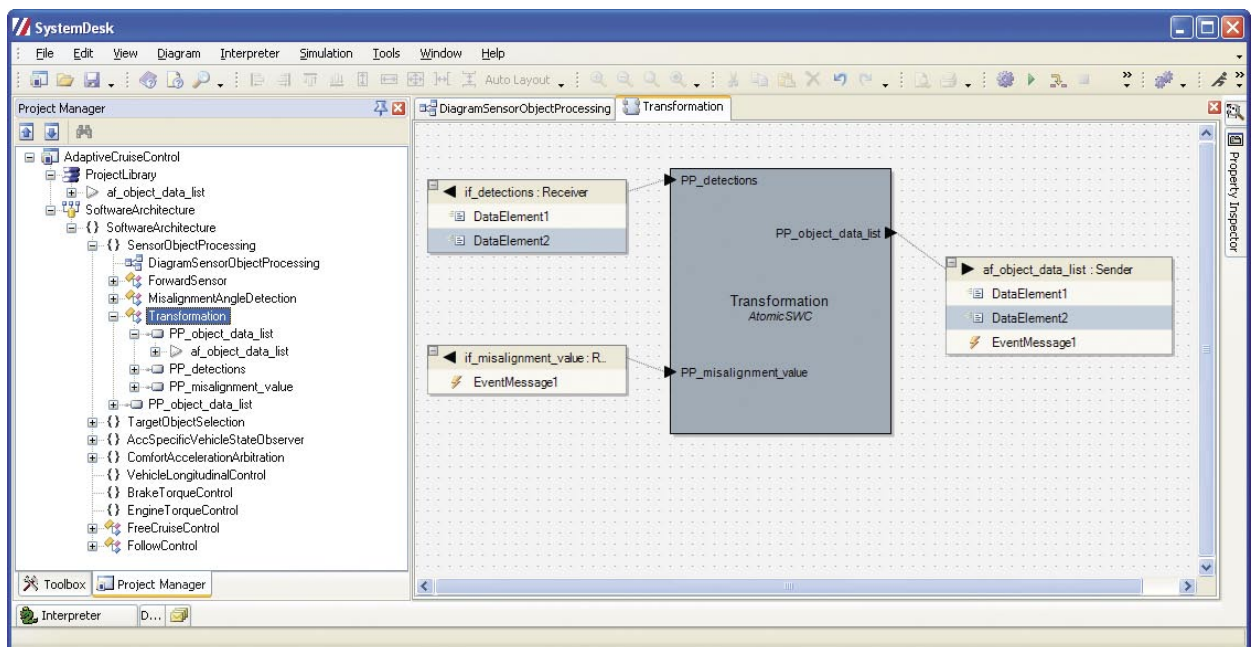
The new architecture tool SystemDesk can be used for model-based development right from system level. It supports tasks such as describing software architectures, defining hardware topologies, and mapping software components to hardware, whilst ensuring compliance with the AUTOSAR standard. In the near future, users will be able to simulate and verify ECU systems with SystemDesk.

Verifying the Software Architecture

For example, a vehicle manufacturer who wants to develop a control for a direction indicator can enter all the software components involved and their interconnections. To verify the behavior of the software

architecture, the manufacturer can use SystemDesk to simulate the models and their implementations offline on a PC. Such simulations help to detect situations where all individual functions work correctly, yet problems occur in the system's overall behavior. SystemDesk will support open-loop and closed-loop simulation. Developers can also insert errors to analyze how the functionalities behave in critical situations. A useful feature for function designers is that after developing functions separately, they can test them as an overall system.

Sometimes software components have to be distributed to the actual ECUs in an early phase of development, for example, for bus simulation. For CAN



▲ A model on the logical level. The design definition is repeatedly refined until it consists entirely of atomic functionalities.

buses, effects such as arbitration or bus capacities can be simulated. This enables users to make a rough estimation of bus usage.

All SystemDesk's simulation options can be controlled via integrated scripting options or the COM-based automation interface. This allows users to integrate the simulation into their testing and development process and to automate test execution.

Integration of Plant Models

For closed-loop simulation at system level, both Simulink®-based plant models and other vehicle models can be imported by means of C code. This code is used to build a Windows® DLL, which is loaded to SystemDesk by the simulation engine. Both the ECU code and the plant model are simulated by the simulation engine. Simulink continues to be used at function level.

Testing the Implementation Models

Frequently, various parts of the overall system are developed by suppliers. And within OEMs, different development teams are responsible for different functions. It is therefore vital to test the overall system. In this stage of the development, the production ECUs are known, and the corresponding production code is available. Users can therefore simulate several new effects that are associated with production ECUs. The most important issues are:

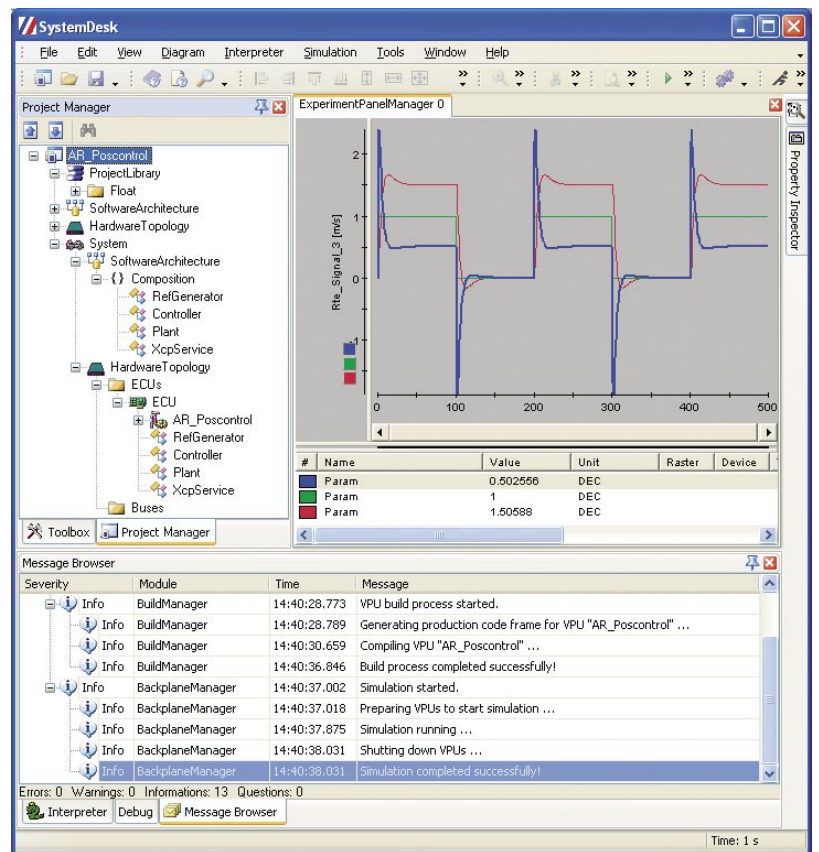
- Communication buses: testing bus capacities, failures, arbitration, and transfer times
- Integrating compiled object files for a specific processor (with evaluation boards)
- OSEK operating system simulation for simulating the application's scheduling behavior
- Fixed-point properties (such as scaling)
- Memory consumption (especially ROM and stack usage)
- Emulating the basic software

SystemDesk currently emulates the following basic software modules:

- Mode management: For example, simulating ECU power-up and shutdown
- Error management: Users can check which error codes have occurred during a simulation
- NV-RAM manager
- AUTOSAR COM layer
- Operating system

Summary

SystemDesk is designed for the model-based development process at system level, with a Simulation Module that supports the simulation of production code and plant models. It also allows the whole system to be simulated. Users can simulate and verify the behavior of the overall system at an early stage of the process. The simulations are extended in later development phases by simulation of the ECU behavior, implementation code, or communication buses. SystemDesk 1.0 will be released in the summer of 2007. The SystemDesk Simulation Module will follow in a later version.



▲ Simulation run with SystemDesk.

Glossary

Open-loop simulation –

This uses simple stimulus generators, constant values, or replays of recorded data.

Closed-loop simulation –

The ECU system must be connected with plant models.