Drive Safely – Virtual Euro NCAP Tests

Translation of "Sicher ankommen – Virtuelle Euro-NCAP-Tests"
Published at: Automobil Elektronik 12/2014

As Euro NCAP requirements get tougher, the cost of developing active safety and advanced driver assistance systems has to stay manageable.
dSPACE provides a consistent tool chain for validating the associated ECU software. This makes it possible to conduct Euro NCAP tests in the simulation and test the robustness of the system.

Euro NCAP: Five-Star Safety

The rigorous evaluation criteria used in the European New Car Assessment Programme (Euro NCAP) are presenting carmakers with new challenges. Euro NCAP tests new vehicle models – for example, by performing crash tests – and gives each one a safety rating of up to five stars. The ratings cover four areas: adult occupant protection, child occupant protection, pedestrian protection and safety assist.

Crucial: Active Safety Systems

Active safety systems are becoming increasingly important for obtaining the highest rating of five stars. In concrete terms, lane departure warnings (LDW) and autonomous emergency braking (AEB) for urban use (AEB City) and rural use (AEB Inter-Urban) will be included in Euro NCAP assessments from 2014 onwards. Starting in 2016, autonomous emergency braking will include the detection of vulnerable road users (VRUs) such as pedestrians (AEB VRU or AEB Pedestrian). The challenge here is to design safety systems that react as intended in any danger situation – such responses are called true positives – but do not overreact (false positives), for example, by initiating emergency braking unnecessarily. Only the true positives are currently important for Euro NCAP. However, such robustness tests mean additional work for car manufacturers. dSPACE offers a comprehensive test environment including model-in-the-loop (MIL), software-in-the-loop (SIL) and hardware-in-the-loop (HIL) simulation for validating active safety systems. Virtual test drives based on the EURO NCAP test protocols make it possible to test the associated ECU software and assess the active safety system even at an early development stage. Figure 1 shows the MIL/SIL test environment that comprises the following components:

- VEOS, the PC-based simulation platform for the virtual validation of ECU software
- Automotive Simulation Models (ASM) for simulating vehicle behavior, environment sensors, the driver and the traffic environment
- ModelDesk for defining test scenarios and parameterizing the ASM
- MotionDesk for a 3-D visualization of virtual test drives

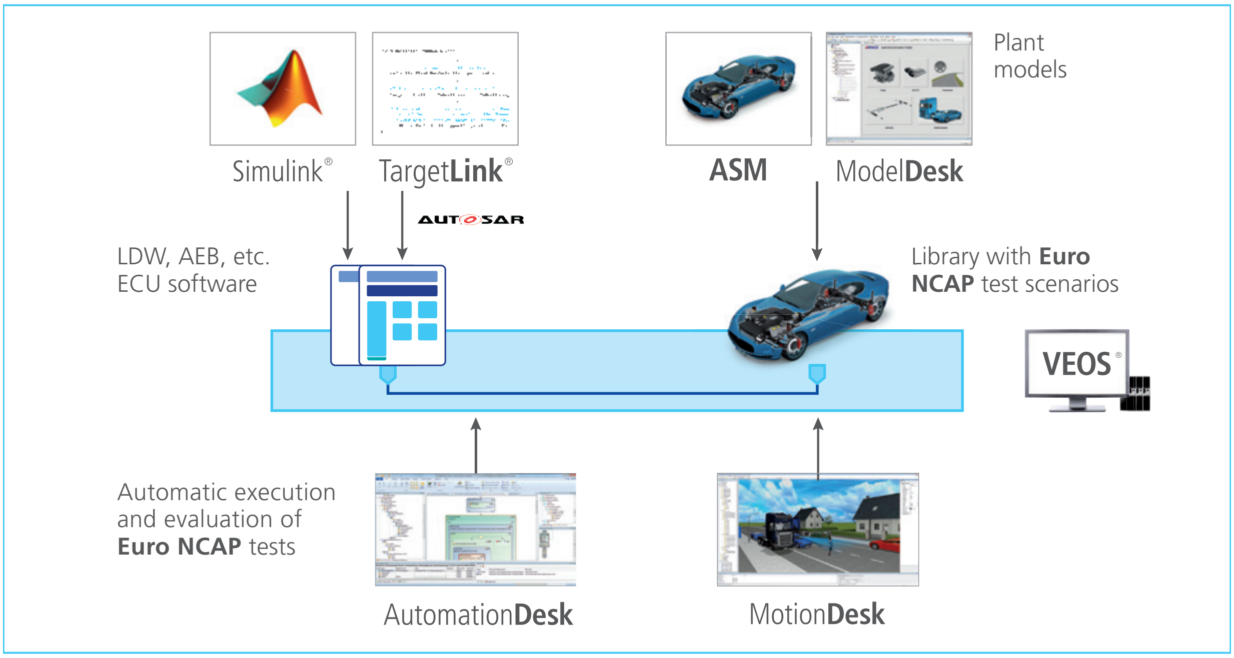

Figure 1: Simulation environment for executing virtual Euro NCAP tests.

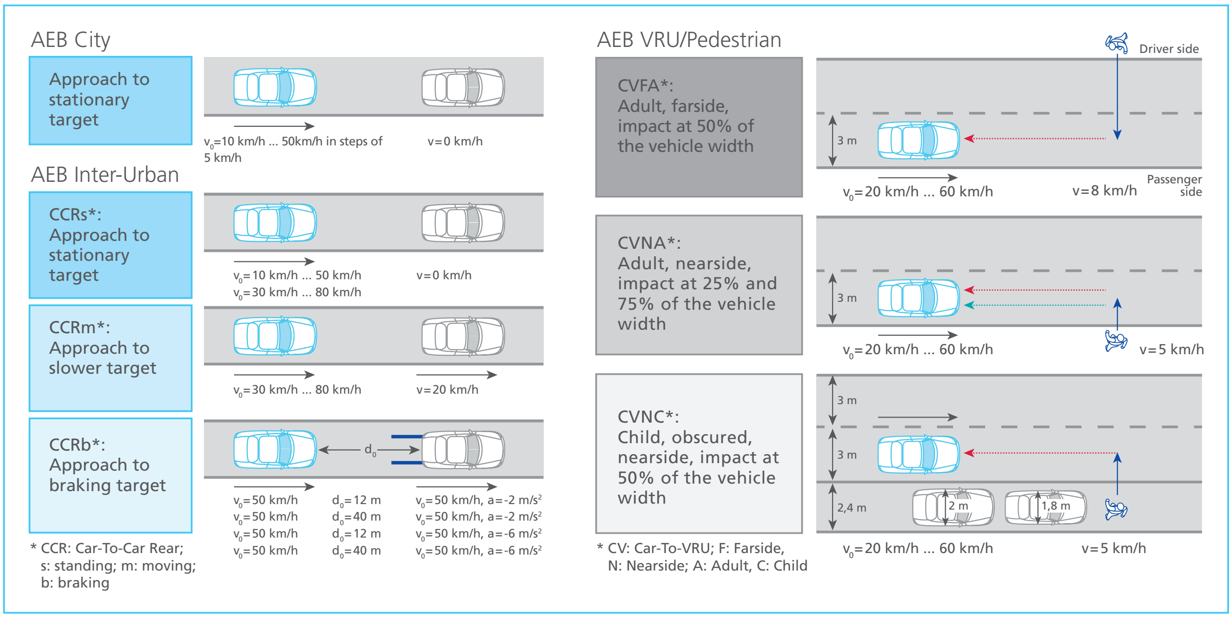

Figure 2: Euro NCAP test scenarios for AEB City, AEB Inter-Urban, and AEB VRU/Pedestrian.

- AutomationDesk for a graphical description of test sequences, automated testing and evaluation
- TargetLink for automatic production code generation from Simulink®/Stateflow®

Testing for Euro NCAP Specifications

ModelDesk includes a library of ready-to-use Euro NCAP test scenarios that comply with Euro NCAP's testing protocols for use cases such as AEB City, AEB Inter-Urban and AEB VRU/Pedestrian. Figure 2 shows selected test scenarios. Note that the Euro NCAP definitions for active pedestrian protection protocols are not final. The associated AutomationDesk project and the visualization of a test scenario in MotionDesk are shown in Figure 3. AutomationDesk has a catalog of preconfigured tests that have been designed for easy handling. After loading a test project, users can select the ECU functionality to be tested (autonomous braking, collision warning), either together or individually, and specify the planned testing depth according to the Euro NCAP categories. The entire project can be started with just a few clicks.

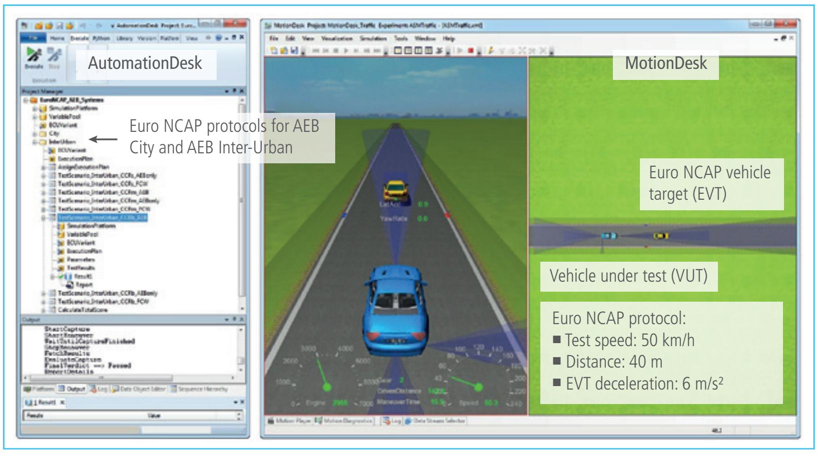

Figure 3: AutomationDesk project (left) and visualization in MotionDesk (right).

During automatic test execution, the individual components of the test environment are remote-controlled via dedicated libraries. The process guarantees that each single test scenario is selected, parameterized, executed, evaluated and precisely logged in compliance with Euro NCAP. MotionDesk shows developers the progress of each test so that they can assess its plausibility. When test execution completes, AutomationDesk generates a report comprising all the relevant information at three different levels of detail. First there is a concise overview (Figure 4) of the total score for a test area (AEB Inter-Urban in this example). It includes graphical descriptions of associated test scenarios and a table of individual scores. Users can navigate to more detailed reports on individual test series from the result tree (on the left of the screenshot). These reports contain the main results of each test run in the test series together with the number of points awarded and the scores. There are also links to detailed reports on the individual test runs themselves. These contain all the details from the individual parameterization to tables and graphics of the measurement results, as well as the final verdict.

Optimized Test Frame for Driver Assistance Systems

Test execution in AutomationDesk employs a test frame that was specially developed for validating driver assistance systems. The frame is extremely easy and convenient to use, and subsequent tests can also be based on it with very little additional effort. Once a user has defined the test scenarios in ModelDesk, it basically takes just three steps to create the final test. The first step is to configure the test frame so that it fits the test environment, in other words to define the test platform (VEOS or HIL simulator), the signals to be measured, the test parameters, the final ModelDesk test scenario, and so on. In the second step, the test scenario can be parameterized separately for each individual test run (e.g., vehicle speed). For the third step, the test frame provides a special area where users can integrate their own test evaluation and logging setups. All the other steps necessary for test execution – selecting and activating the test scenarios in ModelDesk, downloading test parameters to the platform, maneuver control, data capture, etc. – have already been integrated into the test frame. These tasks automatically start running in the background at the appropriate times. Thanks to this development environment, test developers can concentrate on their essential tasks and need no other special knowledge, such as how to handle tool automation.

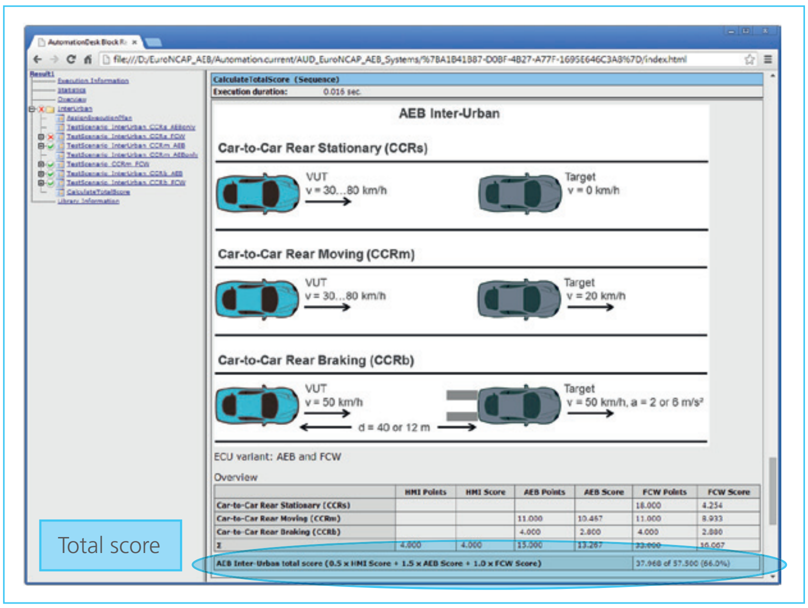

Figure 4: Euro NCAP test report generated by AutomationDesk.

Testing More Than Euro NCAP

The presented test scenarios are typical for validating specified system behavior in predefined situations. They often treat safety-relevant aspects and are therefore mandatory. However, this classical approach is no longer enough to test systems with environment sensors, which are confronted with a variety of unexpected traffic situations every day. To ensure the necessary robustness and increase customer acceptance, these systems have to be tested beyond their behavior in expected normal and extreme situations. Especially false reactions in irrelevant situations (false positives) have to be tested as well. This might require developers to change their way of thinking.

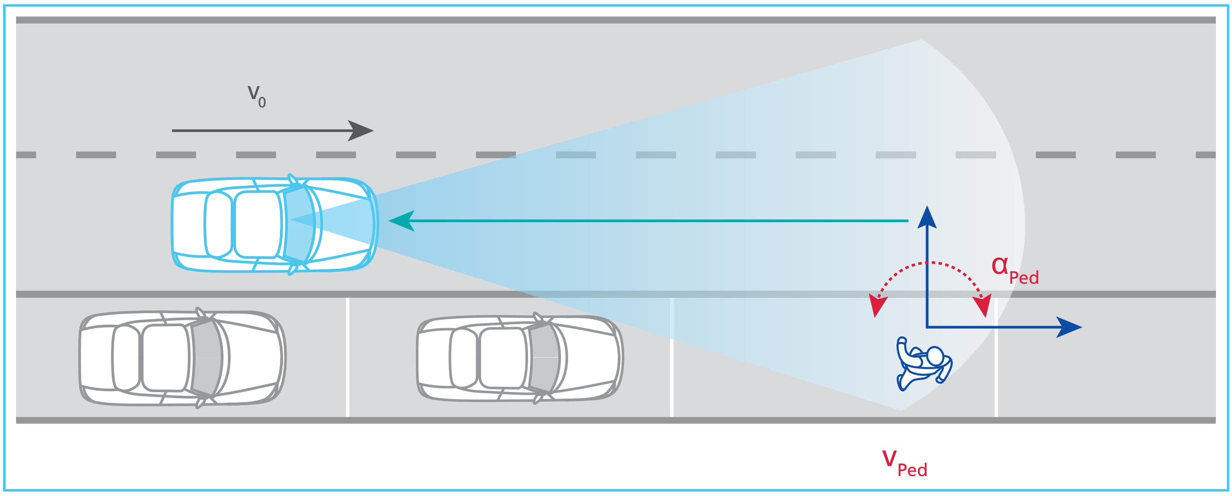

Figure 5: Expanding the parameter set for Euro NCAP tests.

But many available Euro NCAP test scenarios can be reused by expanding their parameter set (Figure 5). This is especially true for systems with pedestrian detection. Here, new parameters that go beyond Euro NCAP provisions were added to the existing set, such as a pedestrian's walking direction (α_{Ped}). The walking direction is specified as the angle of the pedestrian's orientation in relation to the relevant roadside. An obtuse angle means that the pedestrian moves alongside a road in or against the driving direction and therefore does not cause a reaction in a robust system. A 90° angle, on the other hand, covers the initial scenario of Euro NCAP. The relatively easy variation of the angle already makes it possible to address the classical and the true positive tests. A next step could be to expand the parameter set with pedestrian speed (V_{Ped}). In particular, by combining the walking angle and speed, the thresholds for the system's sensitivity can be examined more closely. The Automotive Simulation Models (ASMs) include the appropriate sensor and object models for evaluating the system already during the simulation. Users can then determine the rate of false positives very early on and modify the software accordingly during system design. It is possible to define characteristics (such as height and leg length) of adults and children in ModelDesk, evaluate these characteristics by using the sensor models in the simulation and animate the movements realistically in MotionDesk. This is particularly important for camera-in-the-loop HIL systems.

Gregor Hordys
is Research Engineer for Product Management at dSPACE GmbH in Paderborn, Germany, and expert for topics such as V2X, Euro NCAP and test automation.

André Rolfsmeier
is Lead Product Manager Advanced Applications and Technologies at dSPACE GmbH in Paderborn, Germany.

www.dspace.com

Company Headquarters in Germany
dSPACE GmbH
Rathenaustraße 26
33102 Paderborn
Tel.: +49 5251 1638-0
Fax: +49 5251 16198-0
info@dspace.de

United Kingdom
dSPACE Ltd.
Unit B7 · Beech House
Melbourn Science Park
Melbourn
Hertfordshire · SG8 6HB
Tel.: +44 1763 269 020
Fax: +44 1763 269 021
info@dspace.co.uk

France
dSPACE SARL
7 Parc Burospace
Route de Gisy
91573 Bièvres Cedex
Tel.: +33 169 355 060
Fax: +33 169 355 061
info@dspace.fr

China
dSPACE Mechatronic Control Technology (Shanghai) Co., Ltd.
Unit 1101-1105, 11F/L
Middle Xizang Rd. 18
Harbour Ring Plaza
200001 Shanghai
Tel.: +86 21 6391 7666
Fax: +86 21 6391 7445
infochina@dspace.com

Japan
dSPACE Japan K.K.
10F Gotenyama Trust Tower
4-7-35 Kitashinagawa
Shinagawa-ku
Tokyo 140-0001
Tel.: +81 3 5798 5460
Fax: +81 3 5798 5464
info@dspace.jp

USA and Canada
dSPACE Inc.
50131 Pontiac Trail
Wixom · MI 48393-2020
Tel.: +1 248 295 4700
Fax: +1 248 295 2950
info@dspaceinc.com

12/2014

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