Case Study: **Opel**

Adams Simulation Reduces Full Vehicle Test Time by 30%

Based on an interview with Jens Jaeckering, Technical Integration Engineer for Opel

**Industry Challenge**

Opel continually updates its fleet, developing new models that provide innovative styling, features and functionality to maintain its leadership position. Prior to launch, every new vehicle model is subjected to exhaustive durability testing to ensure that critical components of the vehicle will not suffer from fatigue failure over its lifetime. Obviously, there is not enough time during the product development process to put enough miles on a prototype vehicle to match the vehicle’s lifetime. A common solution to this problem is mounting a prototype vehicle on a road simulator with each wheel attached to an actuator. The actuators apply forces to each wheel that mimic the forces applied by the road 24 hours a day without requiring a driver and a calibrated and running engine. The time required to perform the tests is greatly reduced by just applying large and potentially damaging forces, such as when the vehicle hits a pothole, while not bothering to duplicate the vast majority of the vehicle’s lifetime when much smaller, nondamaging forces are applied to the wheels.

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“Simulation makes it possible to more completely remove the less damaging portions of the road simulator drive signal so time required to test each of the two vehicles we run on the road simulator is reduced from 13 to 10 days. As a result, the vehicle test is completed 16 days or 30% earlier, reducing the time required to bring the vehicle to market.”

Jens Jaeckering, Technical Integration Engineer, Opel

Traditionally, the forces that are applied to the vehicle’s wheels are determined by attaching instruments that measure forces and moments at the wheel centers of a real vehicle as it is driven over a test track, a process called road load data acquisition (RLDA). Other critical components of the vehicle are instrumented with sensors that measure acceleration, strain and other engineering values and these may be used to develop fatigue testing drive signals for individual components. The test track in Opel’s providing ground in Dudenhofen, Germany has been constructed to replicate the most damaging events experienced in a typical vehicle lifetime including belgian blocks, cobblestones, potholes, humps and a washboard surface. Approximately 10 days are spent instrumenting and running the vehicle over the track to obtain time history measurements. Then another 10 days is spent processing the data to create a program for the road simulator consisting of one damaging event after another to replicate the lifetime of a vehicle in the least possible testing time.

“We wanted to improve this process because traditional RLDA cannot begin until the first vehicle prototypes are available late in the product development process,” said Jens Jaeckering, Technical Integration Engineer for Opel. “This puts vehicle durability testing on the critical path with the entire program waiting for it to be completed. Furthermore, the prototype used for RLDA costs several hundred thousand dollars to build and considerable additional costs are required to instrument the vehicle and drive it day and night over the test track.”

**MSC Solution**

1) **Create a digital proving ground from measurements**

Opel engineers hired a service bureau to perform a 3D optical scan of the providing ground tracks used for endurance testing to produce a surface model accurate to better than 5 mm. This high-fidelity digital road surface file was leveraged in the simulation to accurately represent the actual proving ground.

**Key Highlights:**

| **Product:** Adams |
| **Industry:** Automotive |
| **Challenge:** To reduce the vehicle test time for fatigue/durability evaluation |
| **Solution:** Apply Adams Car with the Virtual Proving Ground for Road Loads Generation |

2) **Model upcoming vehicle design in MSC Adams**

Opel engineers originally used Adams Car to quickly model the various subsystems of their vehicles, including the steering system, the suspension, and the front and rear drivelines - the components needed to simulate and optimize dynamic vehicle behavior. Now, having modeled most of their existing product line in Adams, Opel engineers begin modeling next generation vehicles by starting with a model of the current model that has been validated against physical measurements. They transform the current model into the new model by replacing components of the vehicle. The tires are one of the most important components from an RLDA perspective. Opel engineers model the new tires using Adams FTire software based on data provided by the tire manufacturers and incorporate the new tire model into the vehicle model. In modeling a new version of the Astra compact hatchback, Opel engineers used finite element analysis software to create flexible body models of several critical components.

![Opel proving ground](image1.jpg)

![Adams Car model of Opel Astra](image2.jpg)
including the unibody, front cradle that connects the engine to the body, rear axle and control arms. They exported the modes of the flexible body model as a modal neutral file (MNF) and incorporated it into the Adams model.

3) Simulate new vehicle running on proving ground

Opel engineers take the original driving instructions from the proving ground such as gear shift positions, speed limits and braking as input for the driver model. The driver’s steering and throttle behavior were taken from several data recordings and implemented in the driver model of Adams Car. An automated process in Adams Car was created to run all the relevant durability tracks. Adams Car calculates the same parameters as measured by sensors on the proving ground and exports the time histories on the relevant channels. Opel engineers process the time histories of the wheel forces to produce the actuator drive signals for the road simulator. Time histories of strain data for critical components are used to produce drive signals for component level fatigue testing.

Results and Correlation

Simulation results (blue) correlate well with providing ground measurements (red)

Opel engineers have used these methods to produce virtual RLDA time histories for a considerable number of vehicle models. Engineers have run instrumented vehicles over the test track to check the accuracy of the RLDA simulations. The peak loads, PSD’s and relative lifetime measured on the track closely matched simulation predictions.

“Virtual RLDA makes it possible to begin the vehicle durability testing process before vehicle hardware is available, saving the 10 days previously spent on the proving ground,” Jaeckering said. “Simulation makes it possible to more completely remove the less damaging portions of the road simulator drive signal so time required to test each of the two vehicles we run on the road simulator is reduced from 13 to 10 days. As a result, the vehicle test is completed 16 days or 30% earlier, reducing the time required to bring the vehicle to market.” Time savings of 18 days are achieved on component level fatigue testing. Opel also saves the cost of the vehicle prototype which previous was dedicated to RLDA and the cost of the testing program, saving several hundred thousand dollars.

About Opel

Opel is one of Europe’s largest automakers and has been part of the French automotive company Groupe PSA since August 2017. In 2016, Opel sold approximately 1.2 million vehicles. The company has ten manufacturing plants, one development and one test center in six European countries. It has over 37,000 employees with more than 19,000 of those in Germany. Opel and its British sister brand Vauxhall are present in over 50 countries around the globe.

For more information on Adams and for additional Case Studies, please visit: www.mscsoftware.com/adams