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# Inverse load identification

## LMS Engineering services identify component and subsystem interface loads based on measured responses

**Benefits**

- Use an inverse approach to identify excitation loads when they are not directly measureable
- Determine component loads to analyze fatigue life and test more efficiently
- Isolate component loads without considering the full vehicle or system
- Reduce the complexity of measurement instrumentation
- Gain insights into the durability of a subsystem
- Benefit from full or partial technology transfer

**Summary**

LMS™ Engineering services has developed a methodology for identifying component loads by inversion. Instead of measuring the loads directly, LMS experts derive all relevant load characteristics by virtually simulating the stress on a particular component with measured response signals (inputs) featuring a unique technology called time waveform replication (TWR).

Ecological trends, performance considerations and fuel economy concerns have motivated car manufacturers to develop increasingly lighter vehicles. At the same time, safety and durability standards cannot be compromised. As such, today's car owners expect their vehicles to last for at least 300,000 kilometers, be more fuel efficient, provide higher quality and be less expensive to operate than in the past. The key to reconciling these seemingly contradictory demands lies in developing a precise and comprehensive estimate of component and subsystem loads. Identifying the latter allows you to develop a detailed and accurate prediction and analysis of their fatigue life and, more generally, enables the thorough evaluation of the design of a product as well as its integration into the vehicle as a whole.

Identifying loads directly, however, is often deemed an extremely complex, expensive and, therefore, undesirable exercise. LMS Engineering experts have combined test and simulation techniques to develop an inverse methodology in which they measure the local structural response of the component instead of directly measuring the excitation loads. By simulating the component's response under loading, they are able to acquire all necessary insight to identify the outer excitation loads at play. This approach has not only reduced rework, but is also vastly more efficient when dealing with complex cases.

# Inverse load identification

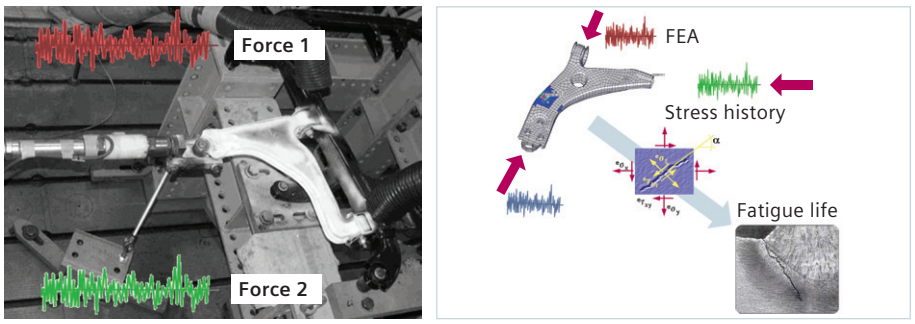
A typical inverse load identification project is comprised of the following phases:

**Data acquisition and processing**
In order to acquire all necessary information for accurate and detailed modeling, the local stress level of the respective component is carefully measured by means of strain gauges and accelerations. These measurements require a considerable amount of knowledge about the origins and transfer paths of outer excitation loads. A thorough understanding of which loads do and don't apply to a particular component is required.

The data is acquired, processed and represented in time domain by means of dedicated data acquisition hardware and software, such as LMS SCADAS™ hardware, LMS Test.Lab™ software and LMS Tecware software. The measured levels of strain serve as target responses for the next phase.

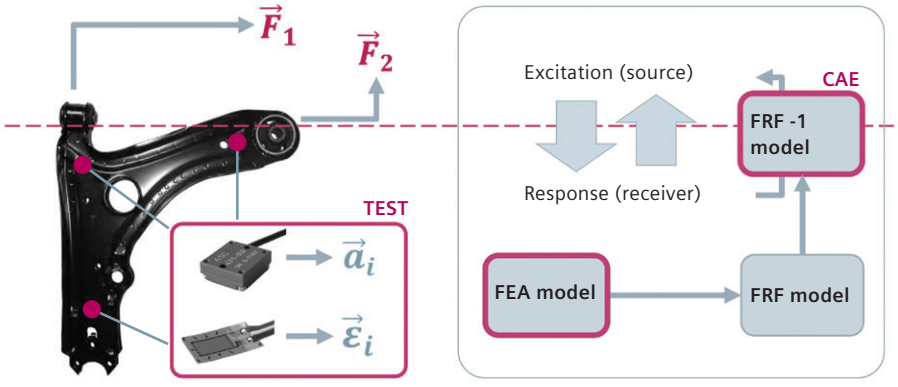
**Simulation**
LMS engineers simulate loads in the form of signals using a finite element model (FEM) of the component under investigation. By using LMS Virtual.Lab™ Motion software for time waveform replication (TWR), any type and number of signals can be easily applied as excitation. The results are included in a detailed frequency response function (FRF) model describing the behavior of the component in different scenarios.

The TWR software is used to evaluate the extent to which the simulated stress levels correspond with the targeted response. It will indicate if, and how much, the input signal simulating a particular load amount will need to be adjusted in order to adhere as closely as possible to reality.




Using excitation loads for physical (left) and FEM-based (right) component fatigue testing.

**Optimization**
In a final phase, LMS experts make targeted proposals for modifying the design and integrating the component and/or subsystem. By developing a detailed estimation of the acting outer loads, you are able to gain insights into the durability of a subsystem. That enables durability engineers to more precisely compute the fatigue life analysis of the component, which in turn yields all required information for optimization.




The inverse load identification methodology combines measurements and simulation.

**Siemens PLM Software**
**www.siemens.com/plm**

Americas +1 314 264 8499
Europe +44 (0) 1276 413200
Asia-Pacific +852 2230 3308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