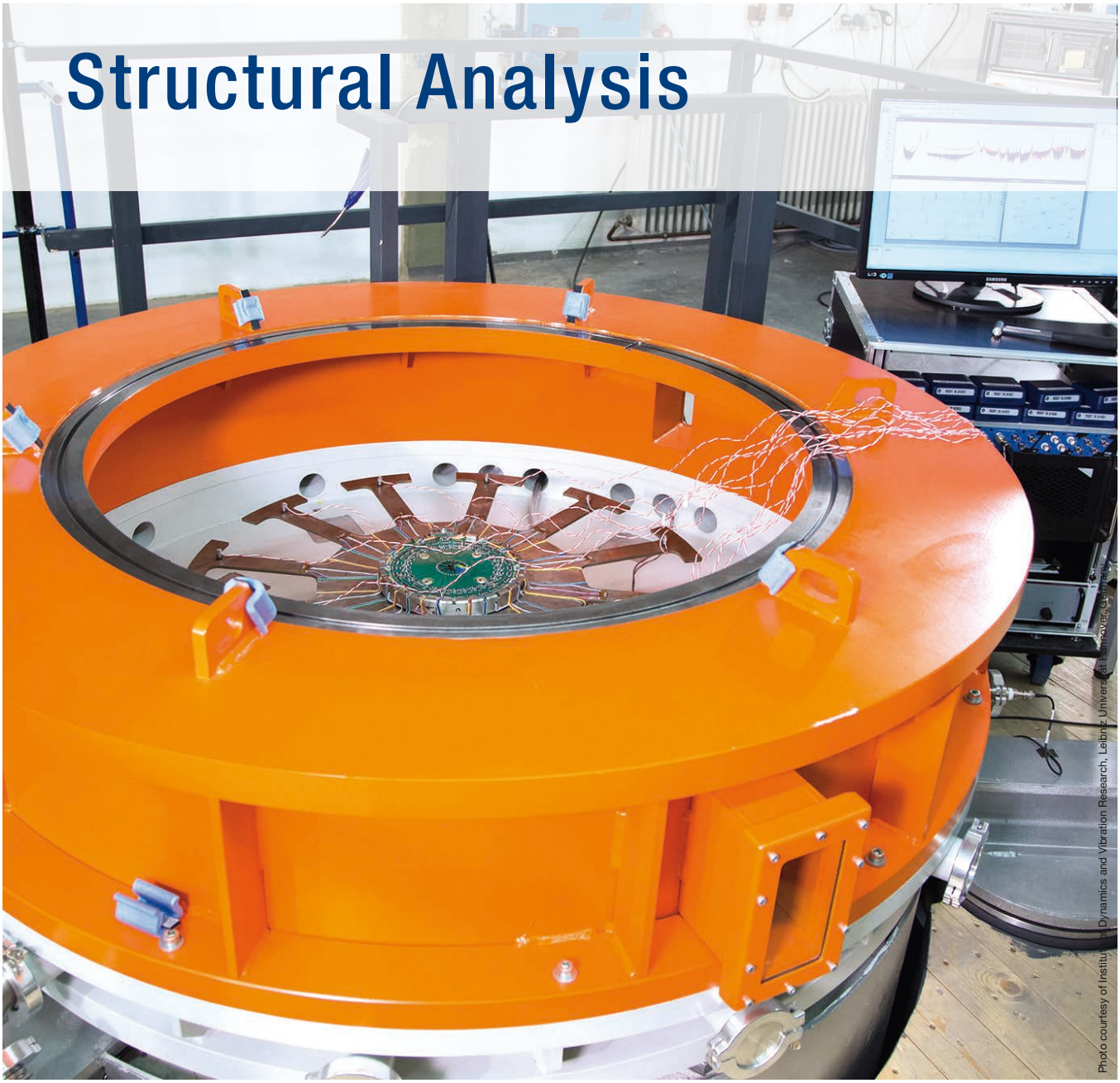
Structural Analysis



m+p Analyzer's structural analysis package provides a complete set of tools for observing, analyzing and documenting the vibrational behaviour of machines and mechanical structures. Different software modules cover a wide range of techniques including impact testing, shaker measurements (SIMO and MIMO), experimental and operational modal analysis, ground vibration testing, operating deflection shape analysis, and modal model validation.

The standard structural dynamics package includes:
- Impact testing using a modal hammer
- Creation of component-based geometries
- Operating Deflection Shape (ODS) analysis

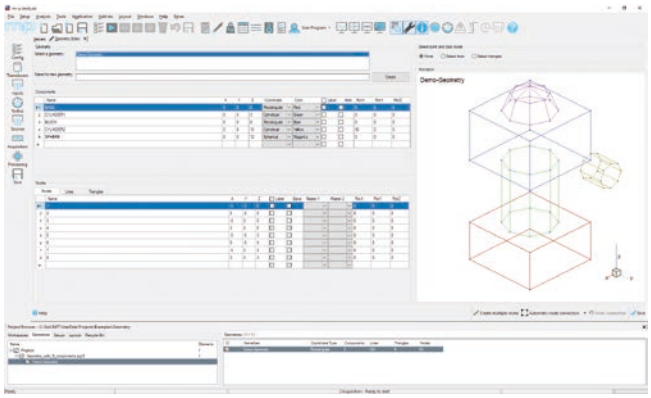
Optional software modules are available to cover the most demanding and advanced modal analysis applications:
- Single Degree of Freedom (SDOF) analysis
- Multiple Degree of Freedom (MDOF) analysis
- Circle fit wizard to review and validate FRF data and mode shapes
- Operational modal analysis (OMA)
- Modal model validation (MAC, MPD, MPC, MOV, MIF)
- Polyreference Time Domain algorithm (PTD/PolyTime)
- Polyreference Time Domain Plus algorithm (PTD+/ Polytime+)
- Polyreference Least-Squares Complex Frequency domain algorithm (p-LSCF/Polyfreq)
- Multiple Input/Multiple Output (MIMO) analysis including multi-source outputs
- Swept and stepped sine analysis
- Ground vibration testing (GVT) with Normal Mode Tuning (NMT)
- Interface to FEMtools for Structural Dynamics Modification (SDM) analysis

YOUR BENEFITS

- **Fully integrated measurement and modal analysis for efficient testing**
- **Wizard guidance simplifies process for all experience levels**
- **Advanced Guided Impact Hammer wizard for single operator hands-free operation**
- **ODS wizard for rapid assessment of vibration shapes**
- **MDOF analysis using the latest algorithms that handle the widest range of applications**
- **Modal Model Validation to check modal data and compare with FE shapes and data**
- **Integrated signal sources for multi-shaker excitation**
- **MIMO analysis to resolve coincident modes**
- **Normal Mode Tuning with search and tune using live mode shape animations and MIF**

Geometries and Animation

m+p Analyzer makes it simple to create a model of the structure's geometry and animate its modal deflection shapes. The geometry editor allows intuitive creation of geometry models. Substructures, nodes, connecting lines and triangles can be entered by keyboard, pasted from a spreadsheet or imported from CAD programs via STL file format.



Geometry creation

Impact Testing

Our Advanced Guided Impact Hammer wizard assists the user in running impact tests. In a step by step wizard, the user is guided to define all acquisition settings which makes it easy to set everything correctly even for inexperienced users. Predefining the points to measure enables a single operator hands-free operation which is especially useful on large structures. Online display of the coherence function, double impact warnings and a predefined customizable layout complete the impact testing capabilities of m+p Analyzer.

Impact hammer test of a rearview mirror

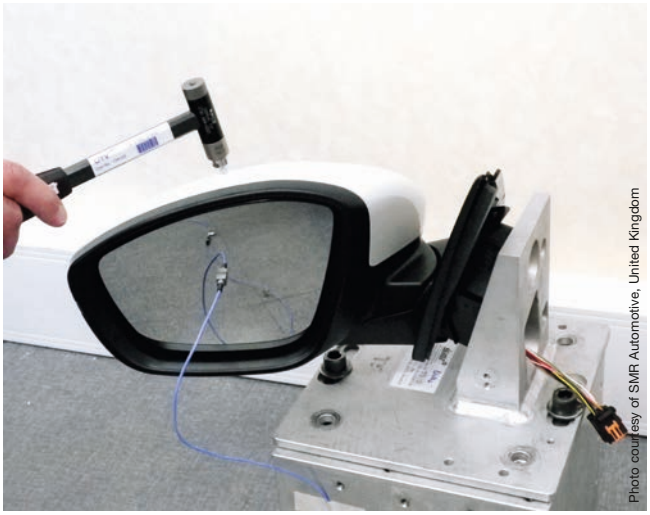


Photo courtesy of SMR Automotive, United Kingdom

Modal analysis on a train carriage

Photo courtesy of Bombardier, Germany

Wind turbine blade testing

Shaker Tests

m+p Analyzer supports several different source modes (e. g. random, burst random, swept sine, stepped sine, arbitrary etc.) for shaker excitation. Multiple sources are available as well as open- and closed-loop amplitude control.

Random and burst random modes are the methods of choice when broadband excitation e. g. in modal testing is required. They offer the possibility of exciting the structure with uncorrelated signals at different exciter locations using the MIMO capabilities of m+p Analyzer. Swept and stepped sine can be used for single- or multi-shaker excitation of larger structures when high input powers are required. A typical application of stepped sine testing in the space and aircraft industry is ground vibration testing also known as normal mode tuning. Arbitrary source mode allows the replay of recorded or synthesized excitation signals.

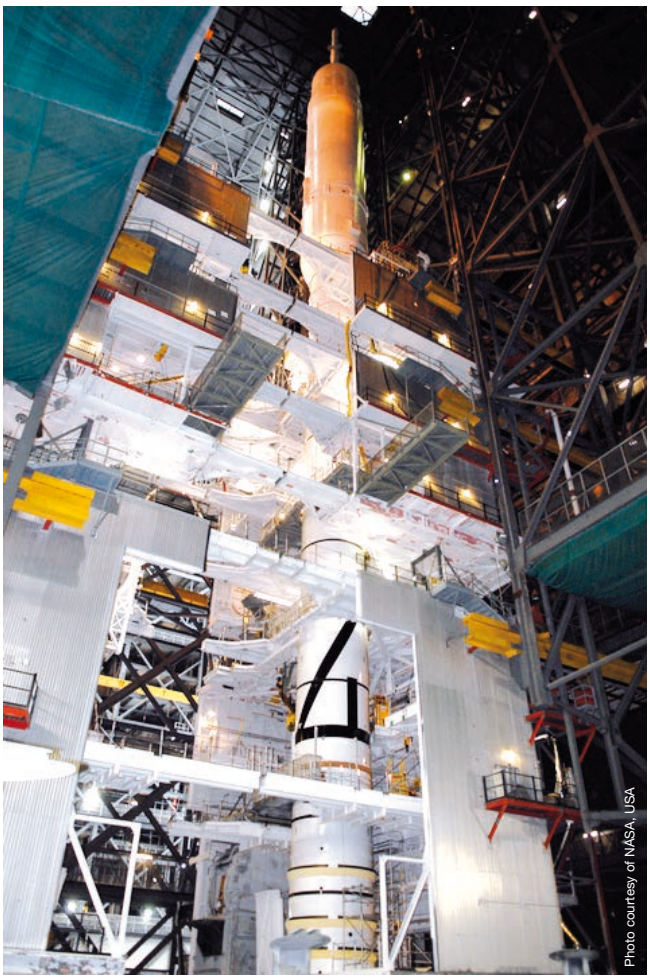
Modal Analysis

The experimental modal data is obtained by curve fitting a set of Frequency Response Function (FRF) measurements. Wizards take you through a simple series of steps to complete the acquisition and analysis process and also make accurate estimates of all analysis options. The Multiple Degree of Freedom (MDOF) wizard, for example, handles the most sophisticated modal analysis tasks, such as detecting repeated or closely spaced modes.

Industry-proven time and frequency domain curve fitting algorithms with wizard-guided operation simplify result interpretation. The time domain method is optimized for lightly damped structures and can also be enhanced by the optional PTD+ algorithm to filter spurious modes. The frequency domain algorithm is optimized for more heavily damped structures. All methods include clear stabilization diagrams and synthesized FRFs for optimum analysis. Mean-Phase-Deviation (MPD), Mean-Phase-Correlation (MPC), Mode-Overcomplexity-Value (MOV) and Mode-Indicator-Function (MIF) are additional measures that offer valuable clues to the quality of the extracted modal parameters.

Modal model validation is used for mode comparisons between different tests or between tests and FE analysis results. The Modal Assurance Criterion (MAC) is an effective way to compare the resulting mode shapes and check their agreement.

The m+p Analyzer software also features operational modal analysis based on response signals without the



Rocket evaluation

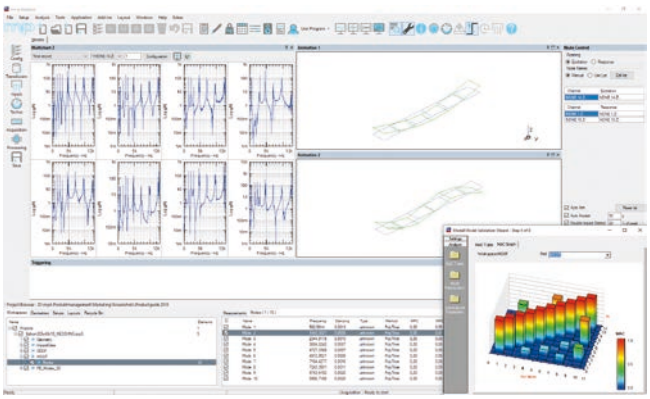
Modal analysis on a parallel robot

need to measure the excitation. Assuming broadband white-noise excitation this technique can be applied wherever natural excitations are present but excitation forces cannot be measured.

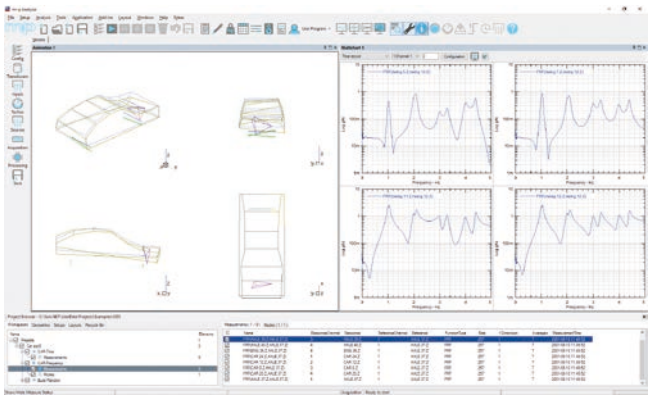
Ground Vibration Testing

In testing space and aircraft structures, ground vibration testing is a common method. In addition to conventional modal tests, ground vibration tests are used for further inspection of critical modes. Normal Mode Tuning uses several shakers to force the structure to vibrate in one single mode of vibration. By interactive tuning with online displays of mode shape, MIF, etc., the shaker excitation frequency and amplitudes are optimized. The Mode Indicator Function (MIF) indicates when the optimal tuning is reached.

Structural data analysis tools



Flexible derivation of ODS and mode shape animation



m+p international

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Founded in Hannover, Germany in 1980, m+p international develops and manufactures test and measurement systems for vibration testing, dynamic signal analysis, multi-channel data acquisition and monitoring and test stand engineering. Our product reputation and broad experience coupled with valuable user feedback have led to significant market share in numerous key industries worldwide.

The company has its headquarters in Hannover, Germany with sales/marketing subsidiaries in New Jersey (USA), England, France and China, along with representatives and agents in many countries.

Learn more on the full range of m+p international products and services and their applications. Select the m+p literature library on our website and download the desired product literature.

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