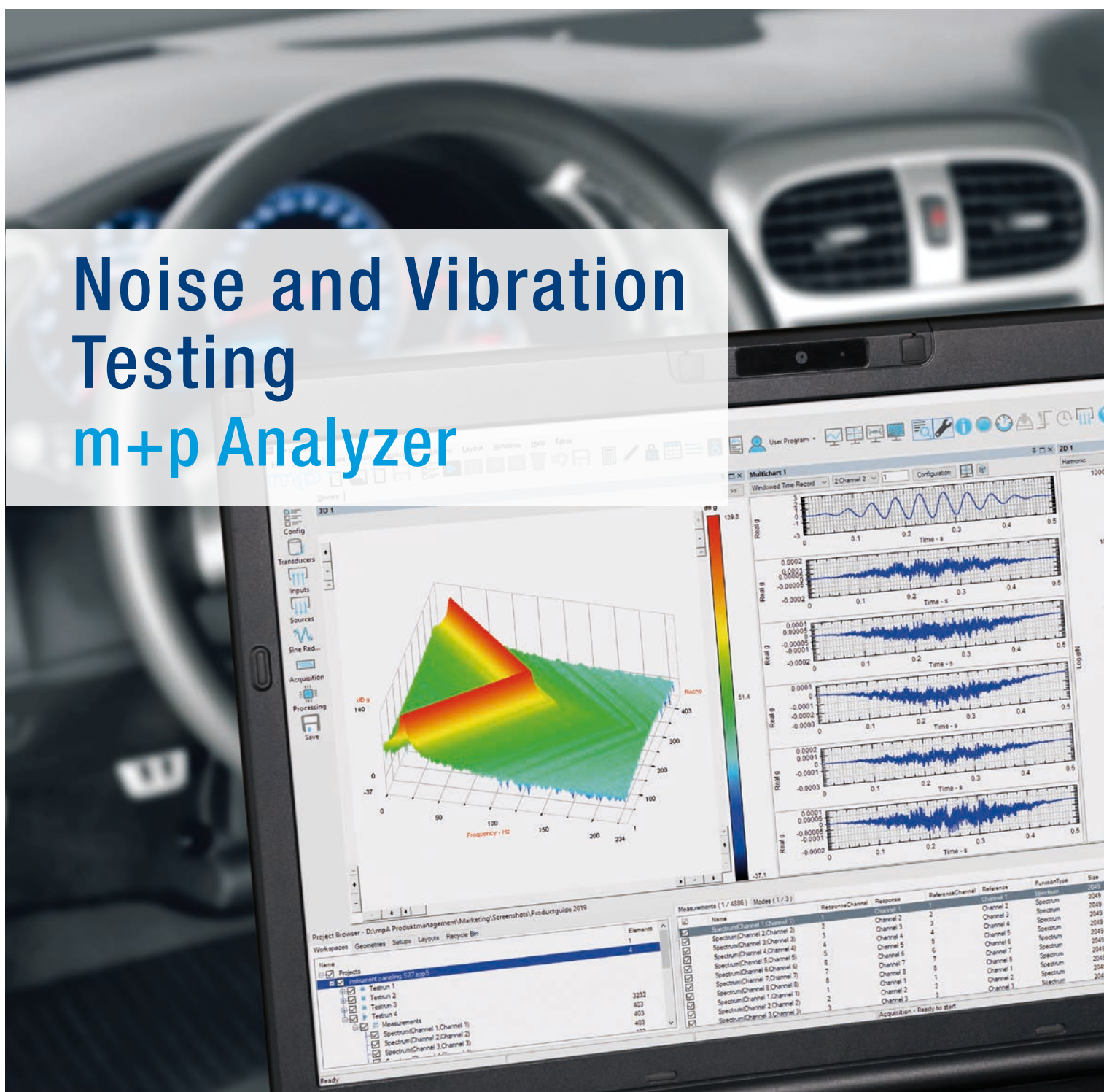


# Experts in Vibration

## Noise and Vibration Testing m+p Analyzer





# Dynamic Signal Analysis





## YOUR BENEFITS

- **Measurement, analysis and reporting in one application for minimal training and ease of use**
- **Supports standard hardware to suit all your projects**
- **Wide range of integrated applications to satisfy all your NVH needs**
- **Import 3<sup>rd</sup> party files for analysis and integration of all related data for common reporting**
- **High-speed SQL-based data storage for secure, fast and efficient data access**
- **Customization of macros and online functions to meet your specific requirements**
- **Mobile, laboratory and network based for optimal access and utilization**
- **Compatibility with wide range of sensors and signals for future-proofing**
- **Online and offline processing and data viewers for the clearest picture of your test**
- **Proven performance and product evolution for long-term reduced cost of ownership**

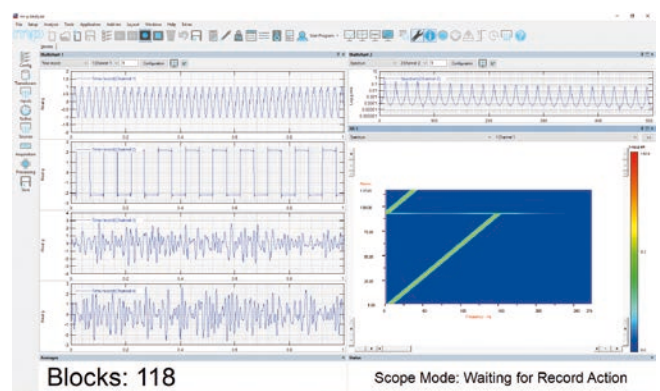
m+p Analyzer is a fully integrated solution for dynamic signal measurement, analysis and advanced reporting of all of your noise and vibration, acoustics and general dynamic signal applications. Comprehensive time and frequency analysis is available with both online and offline data processing. Complete with advanced application wizards the system makes light work of gathering data, displaying results, performing specialized analysis and generating customer ready reports – all within one user interface.

## Applications

- Data Acquisition with Time and Frequency analysis of all types of dynamic signals and sensors
- Time history recording and post-processing
- Structural Analysis data acquisition including geometry guided impact hammer, shaker drive outputs with random, swept and stepped sine, random and sine burst to drive one or more shakers with full MIMO analysis
- Modal Analysis with Operating Deflection Shape, Circle fit, SDOF and MDOF curve fitters, OMA and Modal Model Validation tools
- Ground Vibration Testing with Normal Mode Tuning handling multiple shakers
- Rotating Machinery Diagnostics with spectral mapping and order tracking with both online and offline analysis tools
- Octave Analysis with real-time fractional octave filters and sound meter functions meeting relevant standards – covering both acoustics and ultrasonics
- Sound Power measurements to IEC standards with ECMA tonality for assessing machines, components or sub-assemblies
- Sound Quality analysis for product refinement and diagnostics
- Sound Intensity measurements with acoustic intensity field mapping and sound power analysis
- Environmental Vibration testing with full compliance to vibration test standards such as MIL-STD 810, DEF STAN 00-35 and IEC 60068
  - Independent measurement of additional channels over those available on the vibration controller



Impact hammer testing



Acquiring dynamic data

- Random Data Reduction
- Swept Sine Tracking and Data Reduction
- Classical Shock Data Reduction with full limit overlays for shakers or drop tables
- Shock Response Spectrum analysis
- Acceptance and qualification tests of shakers



### Measurements

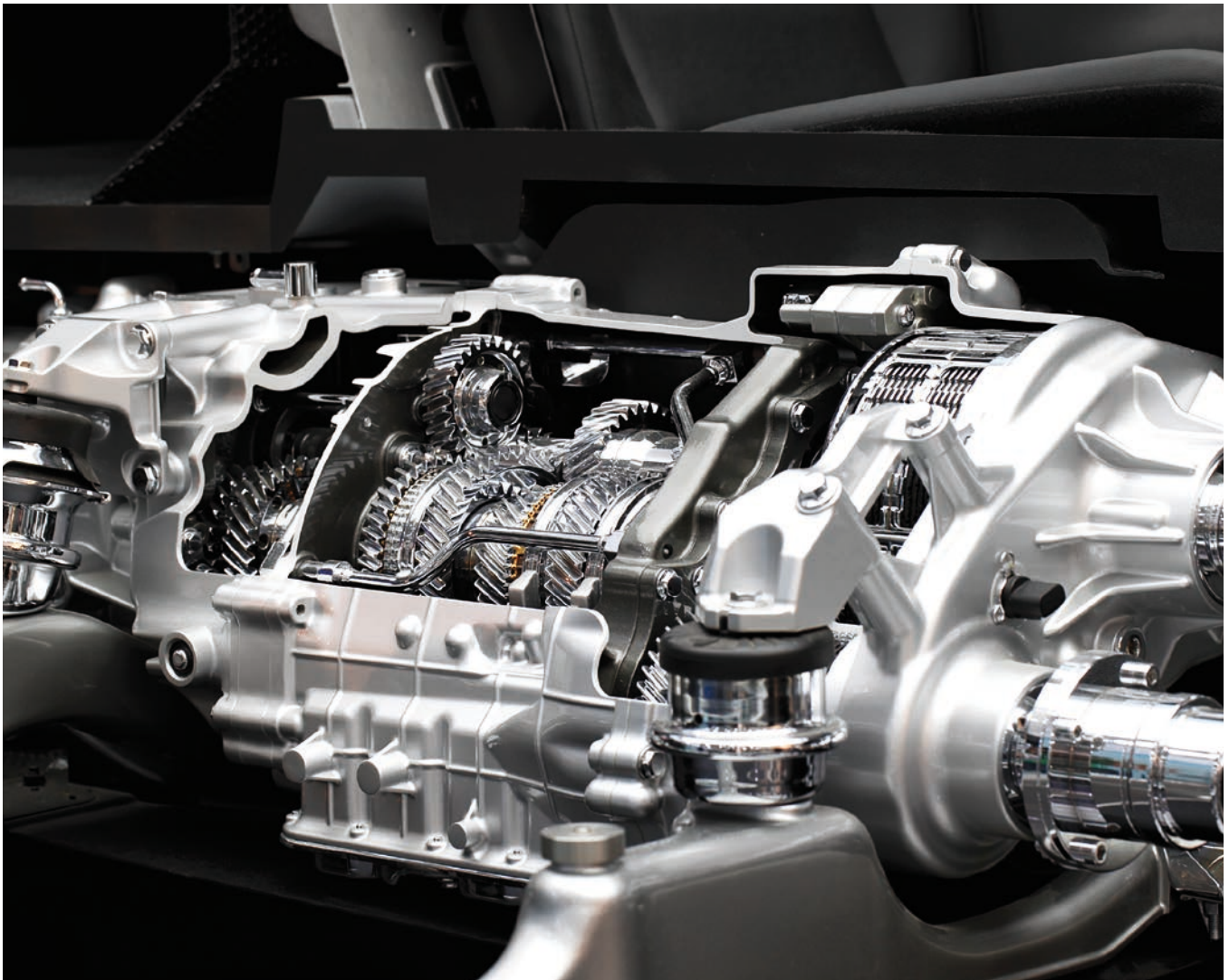
m+p Analyzer systems are available for field and laboratory use from two to hundreds of measurement channels. From gathering simple time history data to narrowband (FFT) spectra, fractional octaves, wavelets, shock response spectra and much more. m+p Analyzer can be used with a wide range of instrumentation hardware including our own m+p VibPilot, m+p VibRunner and m+p VibMobile systems as well as National Instruments (USB, CDAQ, PCI, PXI) and others. Low cost portable instruments to systems for distributed measurements can be configured for maximum flexibility. Measurement data from all sources are stored in a common format so it is easy to compare and handle results from any measurement source.

Continuous real-time and triggered data acquisition modes are set up by the operator offering sampling frequencies from 32 Hz upwards into the MHz range and with FFT block sizes up to 256 k for the highest frequency resolution.

Sampled data is fed to parallel processing streams so that time history recording, narrowband analysis and octave based analysis can all be done together. A scheduling function even allows repeated measurements at intervals over a long period of data acquisition.

Over 50 standard measurement functions are available from time, spectra and frequency response functions to histograms and statistical results. Instantaneous data blocks can be stored for spectral mapping and averaging methods include ensemble block average, exponential and peak hold modes. Custom online functions can be defined including cross channel calculations and averaging. All common weighting and windowing types are included as is online integration making easy work of deriving velocity and displacement results from acceleration inputs. Single-channel and cross-channel functions are all available for signal correlation and transfer function analysis including full matrix FRF computation for Multiple Input/Multiple Output (MIMO) applications. Additionally user defined online filtering and resampling can be applied when required.

Rotating machinery diagnostics





Powerful throughput to disc recording can store raw time history data at high throughput rates in parallel to normal analysis functions. All these recordings can then be used to perform offline post-processing analysis to review field data in more detail or revise analysis settings.

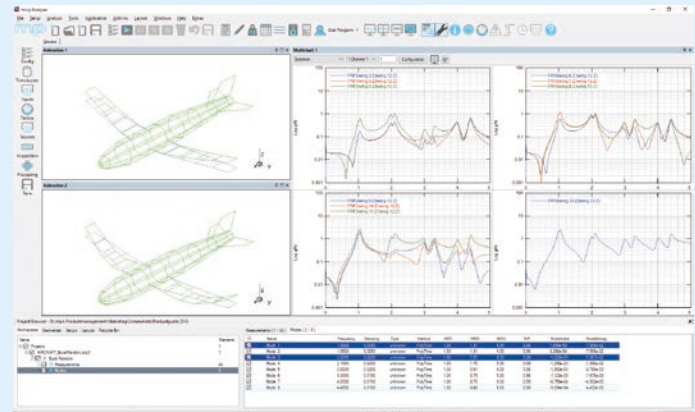
Flexible data import and export facilities enable post-processing of third-party data files. Stream based binary data files can be used directly as a post-processing data source simulating data direct from an online sampling system.

## Data Display

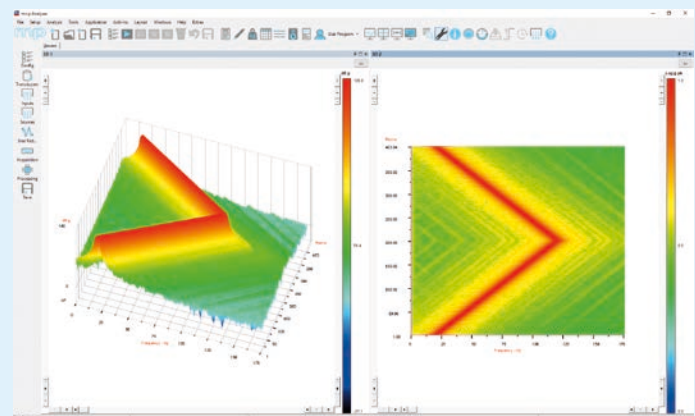
Chart displays are the key to viewing and analyzing dynamic data and the m+p Analyzer 2D, 3D and animation viewers have a wealth of functionality to satisfy any requirement. They are easy to use for new users and offer a wide range of features for experienced engineers.

Custom layouts can be defined using multiple 2D, 3D and animation viewers and these can be extended over multiple monitors for viewing large number of data channels. Real-time and offline data can be displayed and mixed as required.

- The 2D chart includes simple X/Y chart, bode plot and Nyquist formats with linear, log and dB axes together with flexible scaling and zooming modes including chart linking. Dual Y-axis scales allow different data types to be overlaid. Charts can be stacked or tiled or randomly snapped to size for layout flexibility.
- Each 2D chart can handle any number of overlaid traces for comparison, has flexible cursors, labels and markers as well as comprehensive computation of scalar properties and calculation functions such as FFT, Integration etc. for instant data conversions. Over 40 calculation functions are built into the chart and additional tool windows provide features such as trace, trigger, tacho, Least Squares Fit and upper/lower limit indicators.
- Multi-chart viewers display up to 64 individual channels with unlimited overlays for rapid review of many hundreds of channels in real-time.
- The 3D chart has both waterfall and colour map modes and like the 2D has a built-in calculator for XYZ and order cut calculations direct from the cursor positions.
- The animation viewer is used together with the various structural analysis tools for displaying and comparing mode shapes using wire frame geometry models.
- All chart viewers can be copied for instant paste into a report using a variety of formats including full ActiveX control in MS Office and video clips for reporting mode animation results.
- All data is also available in tabular form for copy and paste exchange with spread sheets etc. Comprehensive header and user Meta-data are included with bulk editing of parameters.



2D and 3D animation viewers



3D spectral map and 2D colour map displays



Ground vibration testing





Acoustic and Human Vibration Analysis

## Data Analysis

Time and frequency analysis are the mainstay of many applications and m+p Analyzer's drag/drop data handling makes it easy to get data into charts for investigation. The time domain stacked charts provide transient and sequence of events analysis and the frequency domain chart cursors can search for multiple peaks and calculate frequency, amplitude and damping on the fly. Chart legend and markers with over 50 built-in calculations produce report ready results quickly.

m+p Analyzer's powerful data browser handles a large quantity of data from multiple measurement runs or saved projects. The data can be sorted, organised and displayed for graphical comparisons and for more advanced analysis. An editable engineering units database ensures all data is fully calibrated and derived functions are correctly scaled and identified in ready to report formats. Data is converted and displayed in any engineering unit at the touch of a button ensuring maximum data integrity during analysis and reporting.

Sequence of event analysis is performed on large time history recordings which can be handled direct from file when they are too large to load directly into memory. Many gigabytes of data can be quickly scanned and zoomed across many channels of data making this an ideal tool for reviewing large data files such as those recorded by our m+p VibControl system.

The chart based calculator is further augmented with a full array calculator that uses a reverse polish stack to compute cross channel and cross function results using over 50 advanced operations. Equations can be stored as macros for repeated use.

For your own special calculations an online cross-channel calculator defines multiple user functions or a fully embedded Visual Basic programming language can also be used. You can create macros and add these to the standard menus for frequently repeated analysis operations. Advanced wizards guide the user through the most complex of applications analysis. These are available to assist with measurement procedures and for post-test

***m+p Analyzer's ease of use and flexibility to utilize our National Instruments data acquisition hardware as well as the 8-channel m+p VibPilot allows us to verify product quality prior to shipment with no process delays. Thanks to the excellent pre- and post-sales technical support from m+p we can respond to complex customer demands in a timely manner and continue to expand the system capabilities into modal analysis and FE model validation.***

Arthur Kohn, President of IVS Industrial Ventilation Systems, Houston, Texas/USA



analysis to ensure users of all levels of experience can derive the required results. These analysis wizards are available:

- Modal Analysis – ODS, SDOF, MDOF, Circle Fit, Geometry creation, Modal Model Validation
- Rotating Machinery – Tacho spline fit, RPM mapping, Order tracking, Orbit analysis
- Environmental Test – SRS, Sine Reduction, Classical Shock
- Acoustics – Sound Power, Sound Intensity mapping, Transmission loss, pitch and warble
- Time/Frequency analysis using Morlet wavelet transforms

## Report Generation

The m+p eReporter configuration is a powerful offline data analysis tool for reviewing and exchanging third-party data. Many standard import and export filters are provided and automated links to programs such as MATLAB are available. It is now possible to collect all of your dynamic data from any source into one common review, charting and reporting tool with m+p eReporter. In this configuration you can continue to enjoy all the post-processing and analysis wizard functionality.

For use across your site, the network based license server allows concurrent use by analysts anywhere on your network. This provides flexible and cost effective application deployment in large departments or where data is shared across different departments so the most effective and efficient use of the data can be employed.

From a simple copy and paste of a chart into a document to creating automated custom reports, m+p eReporter has a wide range of reporting capabilities to suit all needs. Graphical and tabular data can be copied to clipboard for instant reports or data exchange with a spreadsheet application making m+p Analyzer a great tool for use with all dynamic data reporting requirements.

Templates are used to define report layouts for frequently used reports which can be executed immediately from any measurement(s) or chart. The Reporting tool includes grouping, select and sort feature to handle large numbers of measurements and also uses templates to define multi-page reports with charts, tables and animations.

Data stored in m+p Analyzer contains comprehensive header data which can also be incorporated into report templates as text or tables and automatically filled from the selected measurements.

ActiveX charts and animations can be copied to Microsoft Word, Excel and PowerPoint. The documents are opened with the same chart functionality as available in the full application but without having m+p Analyzer installed.

The free m+p Analyzer Viewer is available from our website to share this functionality with your customer or a colleague who does not have an m+p Analyzer license.

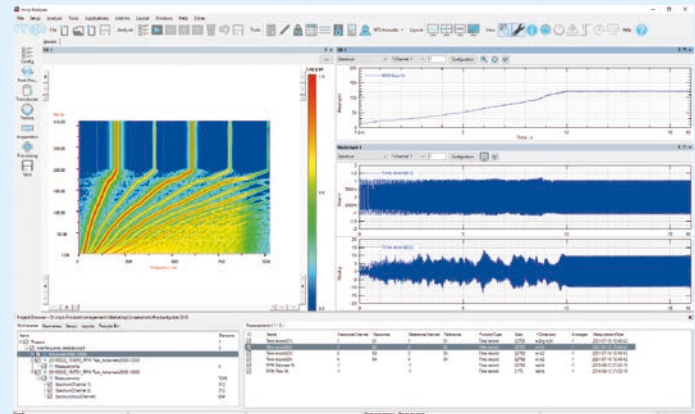
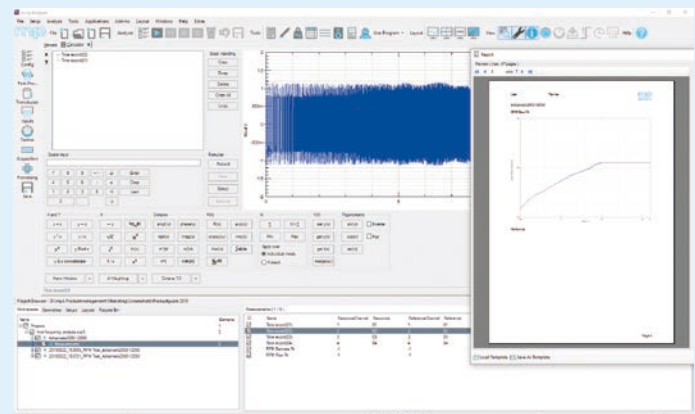
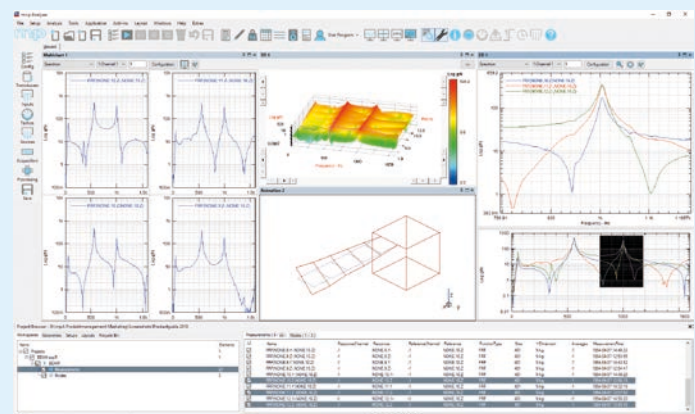


Chart displays for viewing and analyzing dynamic data



m+p eReporter for advanced data management and reporting



Comprehensive data analysis tools



# Structural Analysis

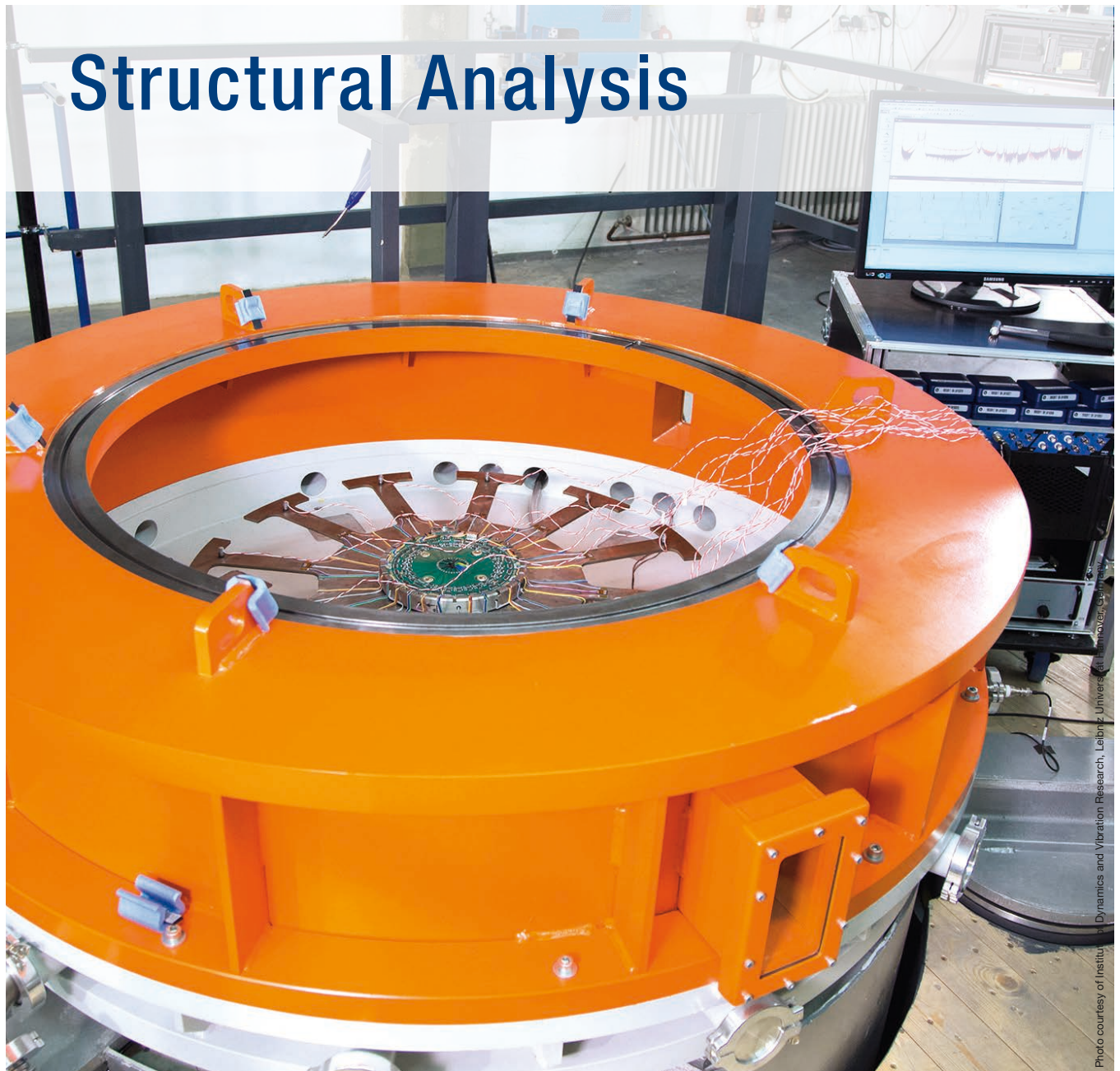


Photo courtesy of Institut für Dynamik und Vibration Research, Leibniz Universität Hannover, Germany

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

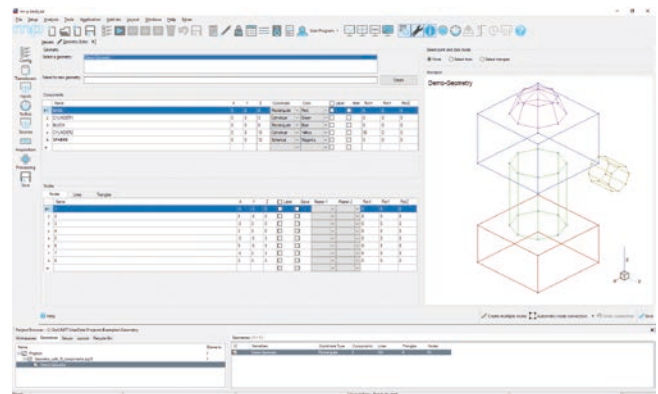
- Fully integrated measurement and modal analysis for efficient testing
- Wizard guidance simplifies process for all experience levels
- Advanced Guided Impact Hammer wizard for single operator hands-free operation
- ODS wizard for rapid assessment of vibration shapes
- MDOF analysis using the latest 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.

## 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.



Geometry creation

Impact hammer test of a rearview mirror

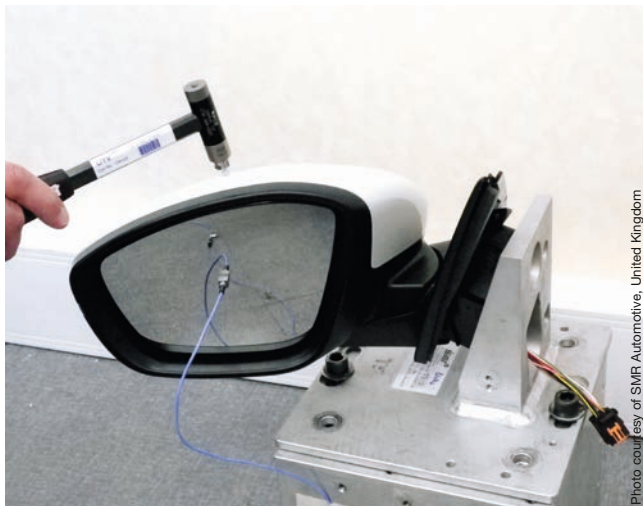


Photo courtesy of SMR Automotive, United Kingdom

Modal analysis on a train carriage



Photo courtesy of Bombardier, Germany





Wind turbine blade testing

Photo courtesy of Narec, United Kingdom

## 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

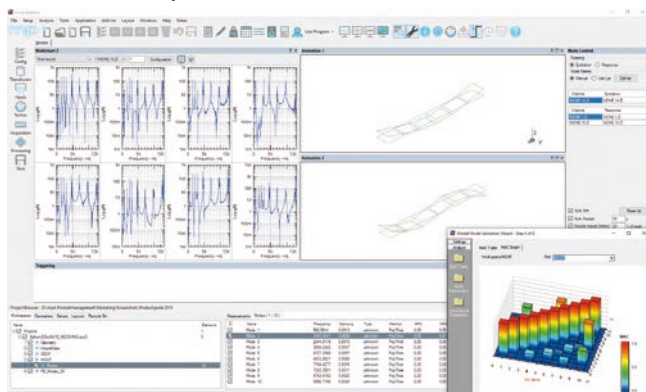
need to measure the excitation. Assuming broadband white-noise excitation this technique can be applied wherever natural excitations are present but excitation forces cannot be measured.

### Ground Vibration Testing

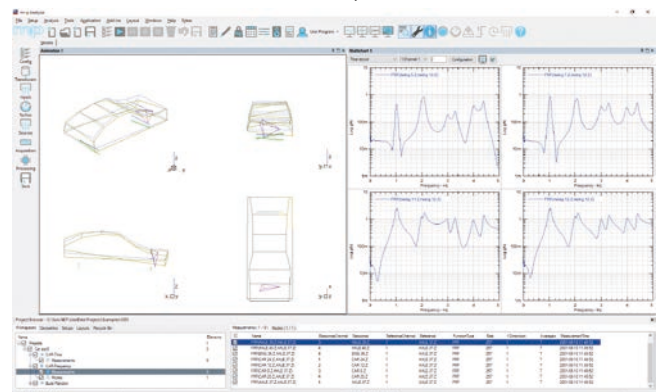
In testing space and aircraft structures, ground vibration testing is a common method. In addition to conventional

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

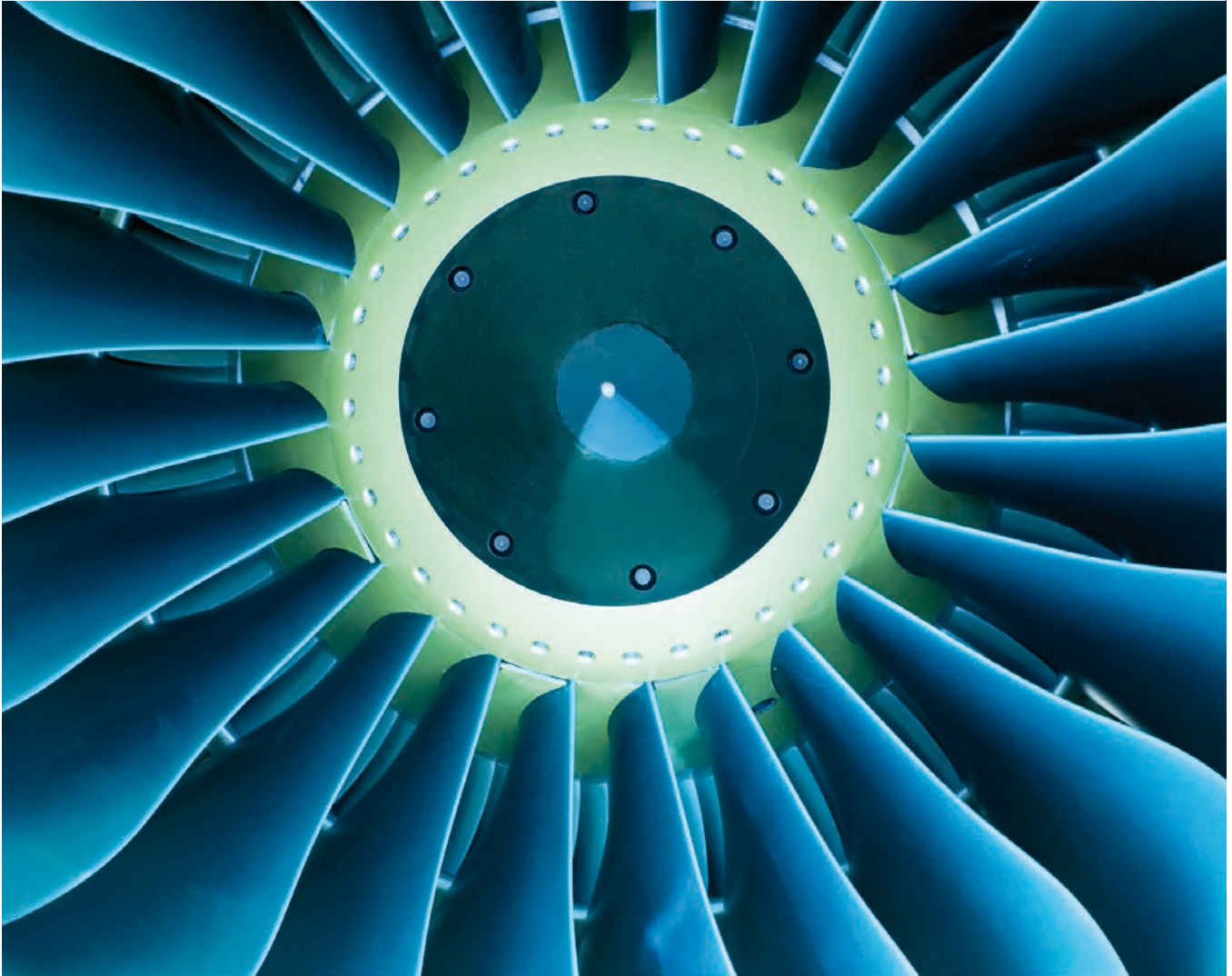


### Flexible derivation of ODS and mode shape animation





# Rotating Machinery Analysis



m+p Analyzer provides a complete package of data acquisition and analysis tools for capturing and understanding noise and vibration induced in rotating and reciprocating machines by their motion.

Fixed and variable speed machines are accommodated as are both structural vibration and condition monitoring diagnostics. Multiple tacho inputs can be processed for accurate speed tracking during analysis. Spectral mapping, order tracking, time history, orbit analysis, balancing and envelope analysis are all available.

## Spectral Mapping

A cost effective solution for investigating run-up and run-down vibration uses m+p Analyzer's real-time measurement

system and the built-in online and offline 3D waterfall and colour map viewer. Time-based capture of spectra can be augmented using an analog tacho input to provide RPM steps and if a tacho is not available, a simple tool will track using a dominant order response from the spectra.

XYZ + order cursors on the 3D chart read off RPM, frequency and amplitude information and the chart calculator computes order and frequency tracks directly from the waterfall data. Rotational and structural resonance components can be easily identified and quantified.

The advanced rotate module is fully synchronized to a tacho input for fixed RPM step analysis at any resolution and the analysis can accommodate the highest rates of change and high-speed machines.



## YOUR BENEFITS

- Flexible time, frequency and order domain analysis
- Narrowband and 1/3 octave analysis from vibration and microphone sources
- Analog and digital tacho inputs to suit any available sensor
- Spectral mapping for simple identification of order and resonant responses
- Order tracking for detailed analysis
- Orbit analysis, 1 and 2 plane balancing, envelope analysis
- RPM and time-based measurements cover all variable and constant speed machines

The Throughput to Disc time history recording is useful for post-processing in difficult measurement conditions where the offline post-processing wizard includes a spline fit tool to overcome noisy tacho signals followed by comprehensive spectrum and order tracking analysis.

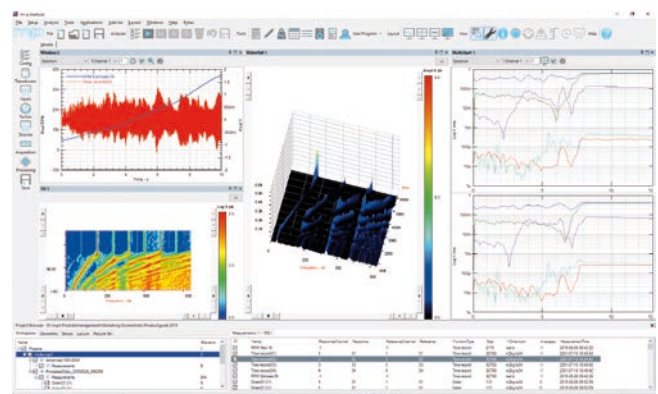
### Order Tracking

Tacho signals can be measured on both analog and high-speed digital counter inputs with order tracks computed from spectral data or using digital tracking filters for the highest resolution. Tacho pulse ratios can be used to compute any number of different order numbers in parallel. There are no restrictions on fractional order numbers that can be included so complex engine and gearbox order components are quickly identified.

The advanced TVDFT (Time Variant Discrete Fourier Transform) algorithm is applied for the computed order tracking analysis. This algorithm provides the benefits of both the computation speed of the FFT based order tracking and the precision of the resampling technique.

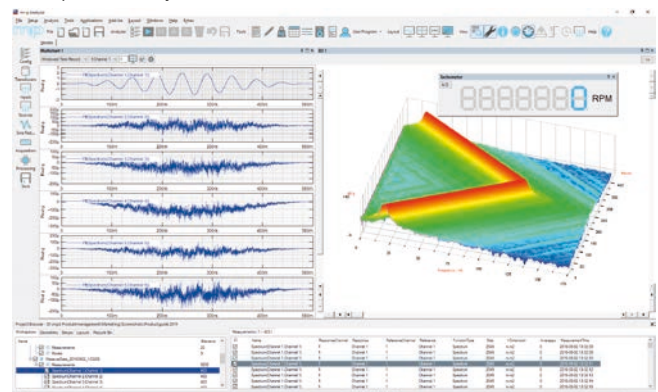
### Orbit Analysis

Online orbits can be displayed and monitored on a standard two-channel orbit diagram chart. Single rotations as well as multiple rotations are calculated and averaged over time. For advanced analysis a throughput recording including a tacho or TDC signal can be post-processed using the orbit analysis wizard. This provides averaging, filtering and order based orbit displays with a replay feature for visualizing changes over a change in machine speed. A simple configurable bandpass filter allows removal of unwanted signals and noise.



2D and 3D displays of rotational data

Run up/down analysis



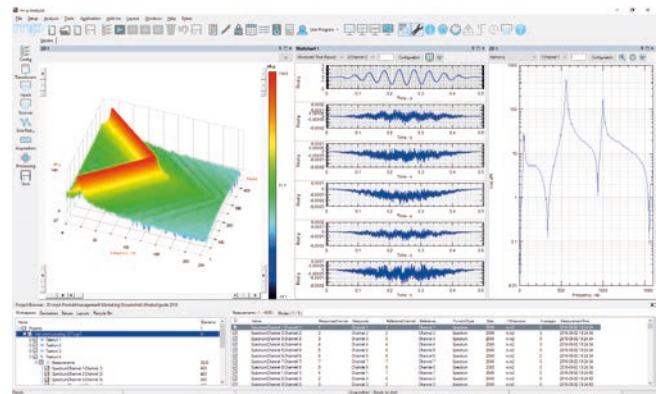


## Condition Monitoring

At the heart of machine condition metrics are acceleration, velocity and displacement measurements which can all be derived from a single sensor with time histories of peak, pk-pk and rms values in any engineering unit displayed. Both short-term measurements over seconds to long-term monitoring over days and weeks are possible. Flexible pre-filtering of signals meets the standard metrics available for different groups of machines.

History and trends can be based on machine speed or, when running at constant speed, with time-based logging. Both cases providing time history statistics, spectrum and order analysis with both amplitude and phase results. All these functions are available in parallel for complete and immediate online results and flexible post-test diagnostics.

Balance, bearing condition and performance characteristics can be evaluated meeting the requirements of the numerous standards in this area such as ISO 13373, ISO 7919, ISO 10816, VDI 2056, ISO 2372, NF 90-300/310, BS 4675 or the API acceptance testing series etc.



Multichart viewers

Condition monitoring of compressors



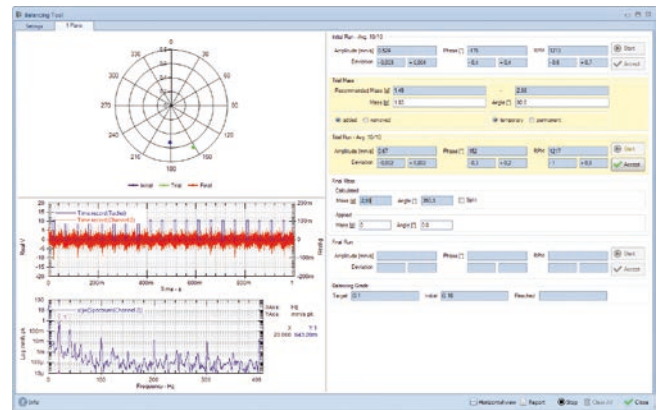


## Balancing

Rotating machines are often subject to high vibrations caused by unbalance, therefore balancing is important in the manufacture and maintenance process of machines to reduce these vibrations. m+p Analyzer provides single- and dual-plane balancing procedures. The task-oriented user interface enables simple test setup, acquisition, analysis and correction. Comparative results can be displayed from any previous data. For reporting purposes, a result sheet can be saved for each balancing procedure.

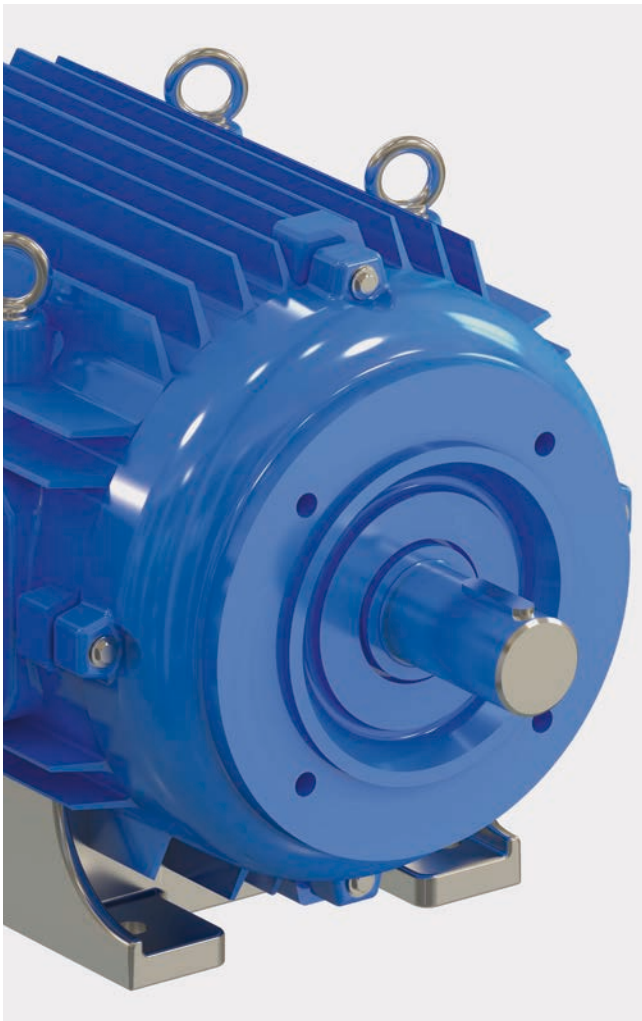
## Bearing Fault Detection and Diagnosis

Envelope analysis is a sensitive indicator of defects and can predict the location of developing faults. It is used as a diagnostics tool for ball and cylindrical roller bearings. Defects on a rolling-element bearing exhibit peaks of characteristic frequencies or orders in the power spectrum of the envelope signal. Time based condition monitoring of this data together with overall levels can also predict failure time and hence assist in maintenance scheduling.

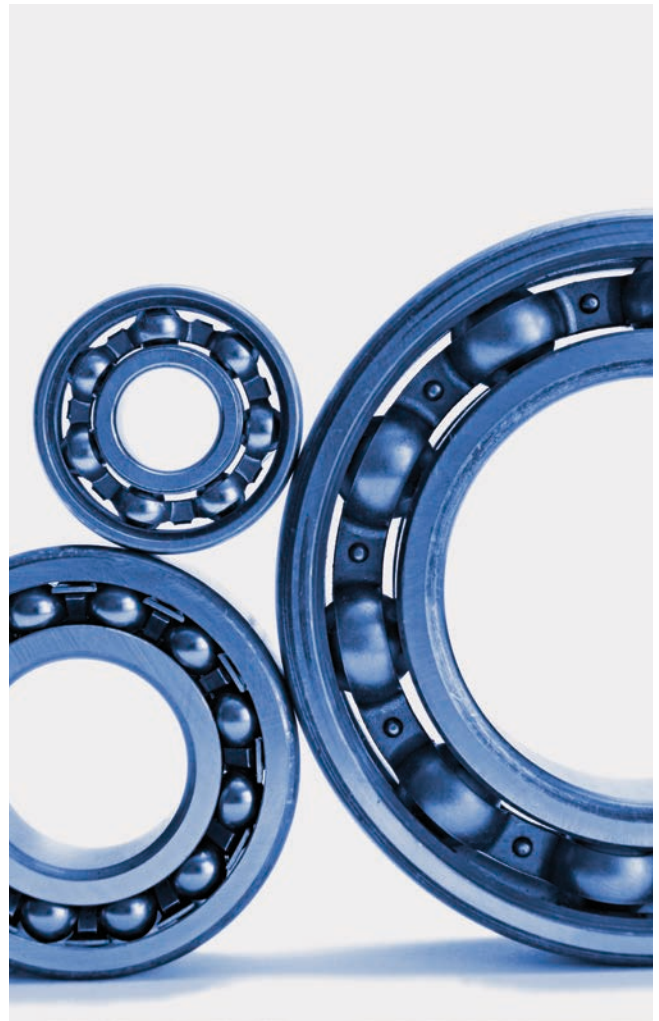


Trial run for calculating the balancing masses

Balancing the rotor of an electric motor

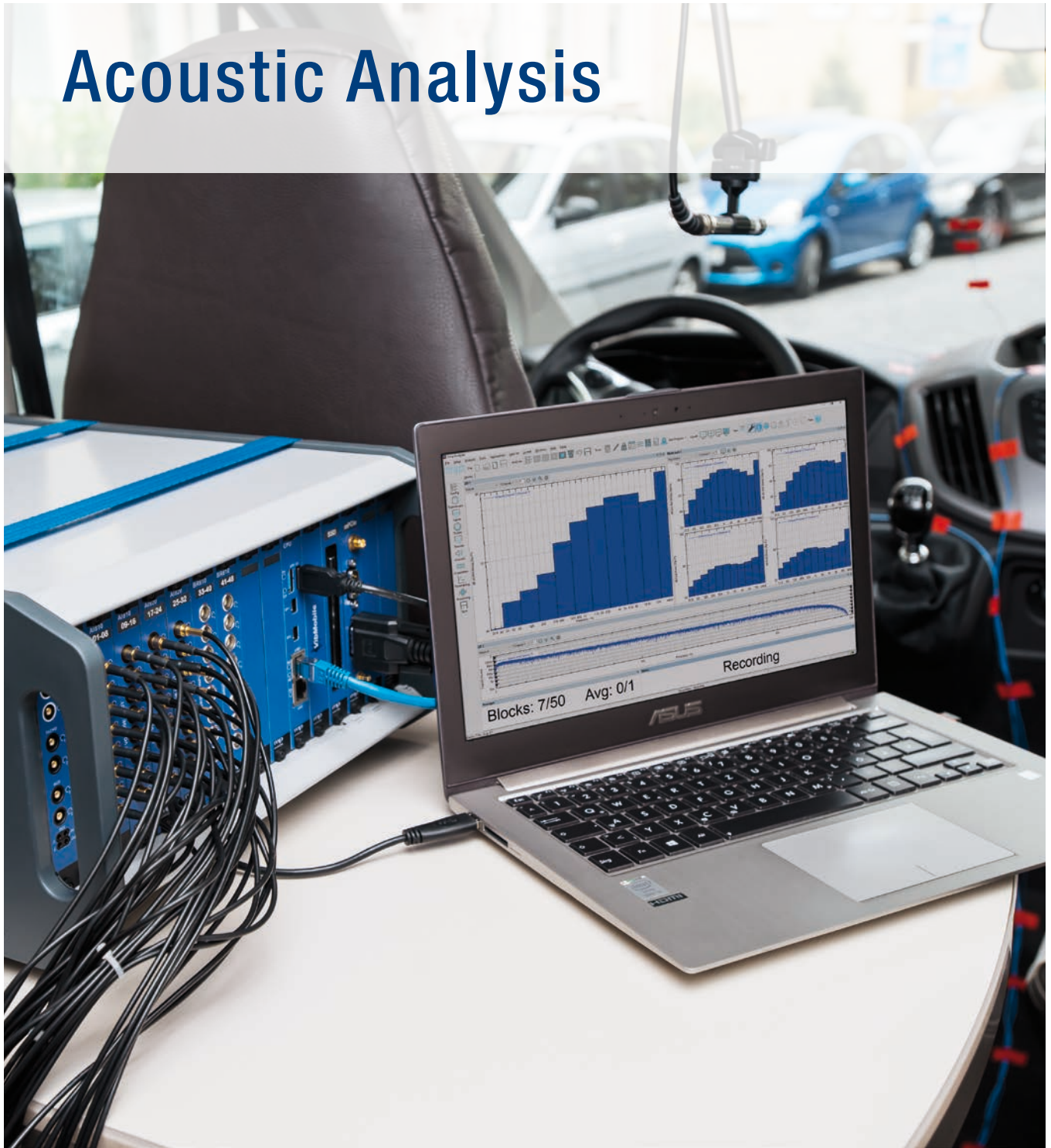


Envelope analysis of rolling-element bearings: detection of cracks in race and ball/roller defects





# Acoustic Analysis



Noise is increasingly the subject of new regulations for the protection of human health and safety as well as for improving the environment in general. As well as sound levels, the perceived sound quality of products from washing machines to vehicles is often an important part of the customer purchasing decision and must be considered during product development.

m+p Analyzer provides a full range of capability for these applications. Real-time fractional octave filters satisfy all acoustic applications from simple sound pressure, sound power for equipment legislative requirements, intensity mapping to isolate sources to sound quality metrics for

product refinement. All this in parallel with narrowband analysis and time history throughput to disc for fully detailed analysis online and offline post-processing of any data source.

## Octave Analysis

Fully compliant with ANSI S1.4 and IEC 61672 type 1 sound meter specifications including A/B/C weighting and 1/1 to 1/24 octave spacing from 1 Hz to 100 kHz even with high channel counts. Response types include fast, slow, impulse, custom, linear average and LEQ.



## YOUR BENEFITS

- Traditional 1/3 octave sound meter features plus fractional octaves to cover all needs
- Traditional microphones and intensity probe measurements for flexibility
- Sound power procedures for all popular measurement methods with full validity analysis
- Sound power using intensity probe for use within noisy backgrounds
- Sound intensity mapping to identify and visualize noise sources
- Sound quality evaluation to refine your products
- Transmission loss, pitch, warble and tonality to develop your own quality metrics
- LOFAR and DEMON analysis for sonar applications

### Sound Meter Functions

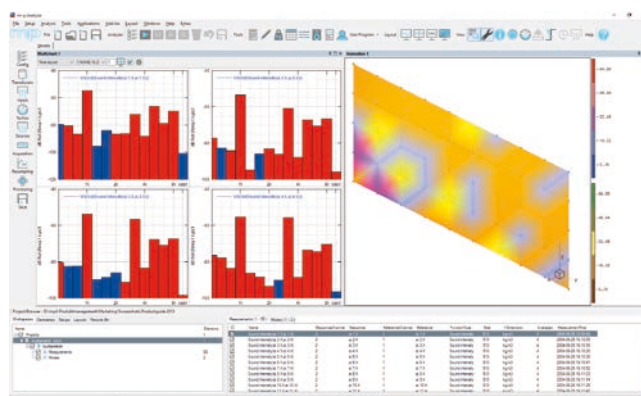
With m+p Analyzer there is no need for a separate sound level meter as these functions are already built-in with fast, slow and impulse settings, LEQ, peak hold by band or OASPL. Sound pressure histories and trends over long periods can be captured continuously or sampled.

### Sound Intensity

Sound (or acoustic) intensity can be measured in any sound field. Real-time sound intensity measurements use a standard dual microphone intensity probe calculating real-time pressure, intensity and pressure residual intensity index. This technique is directionally sensitive making it ideal for source localization or background noise cancellation. It enables accurate measurements directly in the field without the need for expensive acoustic laboratories.

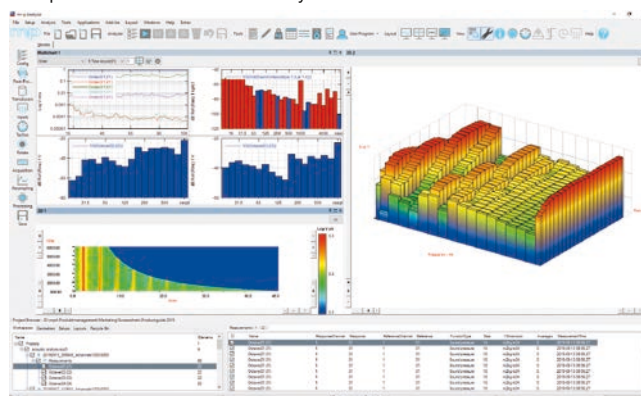
### Sound Intensity Mapping

A wire frame 3D model of your equipment under test is used to guide an operator around a sequence of sound intensity measurements. These results are then mapped to the colour coded 3D image for identification of the principal sound sources and their levels.



Sound intensity measurements

Comprehensive acoustic data analysis



*Using m+p's system, we were able quickly to identify the issues and the effect of component modifications, which saved us time and money. We are now looking to see how we can use the system to investigate other noise and vibration issues with a view to further improvements in design, including forthcoming electric vehicles.*

Amit Satav, Mechanical Design Engineer at The London Taxi Company, Coventry, UK





Identifying the root cause of sound issues helps making the right decisions at the design stage

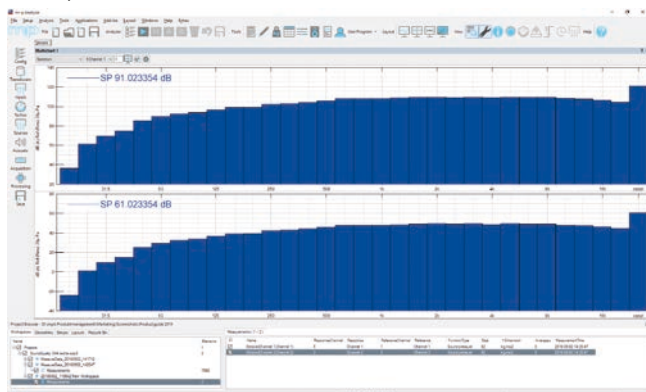
## Sound Power

Sound power is an absolute measure to determine the noise emissions of a product. All equipment from PC fans to heavy machinery must have published sound power emission levels for environmental regulation. m+p Analyzer wizards guide the operator through the maze of requirements in the ISO 374x standards and, using the intensity measurements, the ISO 9614 standards. The latter method has high tolerance to background or reverberation effects so is suitable for use in most on-site environments rather than needing expensive anechoic chambers or field sites. More specialized applications such as wind farm methods like IEC standard 61400-11 and tonality using ECMA-74 are also available.

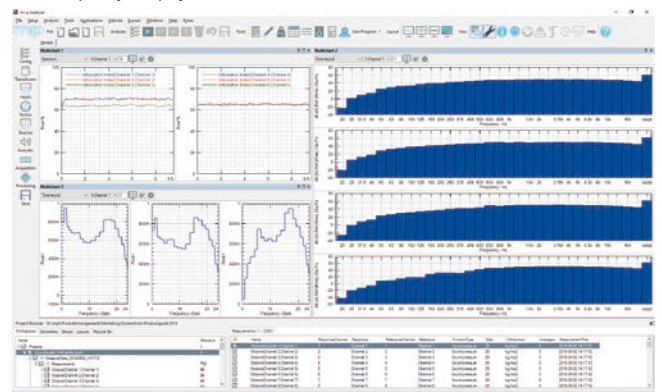
## Sound Quality

Human perception is critical in improving product competitiveness: Designers face a challenging task in that they not only have to reduce the product noise level, but also have to find the “right” sound that attracts the customer. Sound quality metrics can be used to rank and evaluate different product designs. The basis of the m+p Analyzer Sound Quality Analysis is Zwicker loudness according to ISO-532 and DIN-45631. The following metrics are available both online and for post-processing and can be computed from either narrowband or octave band spectra:

Sound power measurements



Sound quality for psychoacoustic noise evaluation





- Specific loudness and transient loudness (in terms of sones and bark)
- Loudness and percentile loudness time history
- Articulation index and extended articulation index time history
- Sharpness time history
- Pitch and warble analysis wizards for squeak and rattle analysis
- Statistical analysis of any function, e. g. LSF, L(10), L(50), L(90), L(n)

These functions can be viewed as 2D, 3D charts or as colour maps (spectrograms) for further detailed analysis. Other statistical tools are available for least-squares curve fitting and trend analysis which are useful, for example, in squeak and rattle evaluation.



Finding the best possible sound

### Human Vibration

Alongside environmental noise, evaluation of other human factors such as hand-arm vibration from the use of power tools or the evaluation of whole body vibration from riding in vehicles as per the various ISO and BS standards are available. These include C/D/H/K weighting and functions such as VDV (vibration dose value) calculations. In conjunction with sound quality algorithms, these vibration results can form a comprehensive set of metrics for vehicle comfort assessment and refinement engineering.

### Impedance Tube Testing

With its optional Impedance Tube Testing software package, m+p Analyzer allows the calculation of important acoustic characteristics of materials such as absorption coefficient, reflection coefficient, acoustic impedance and transmission loss coefficients based on impedance tube measurements. Measurements and calculations are possible in compliance with ISO 10534-2, ASTM E2611-12 and ASTM E2611-17. Depending on the test standard, measurements are taken in two different ways using either two or four microphones. The latter method allows calculation of the transmission loss as two microphones are placed on either side of the specimen. The software package uses pre-test



Measurement and evaluation of human vibrations with the aim of reducing the exposure to these vibrations

measurements to establish the signal-to-noise ratio, the appropriate volume of the speaker and the calibration coefficients for microphone mismatch correction. The measurement results are displayed online and the desired acoustic coefficients are calculated. Of course, all results can be gathered together into a report, including the setup, the results and specific information of the test.

Impedance tube testing using m+p Analyzer software and m+p VibPilot front-end





# Environmental Vibration Testing

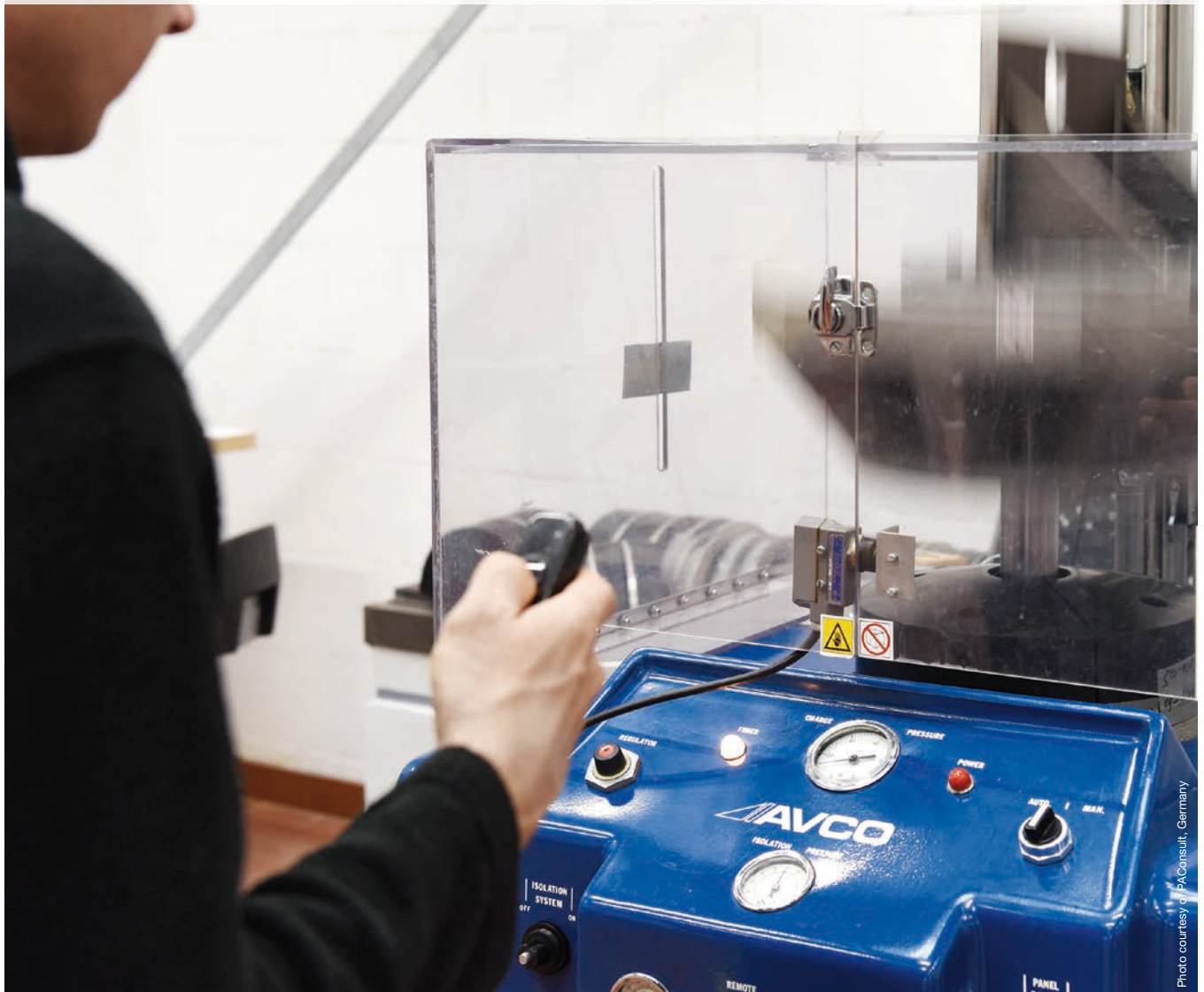


Photo courtesy of PACConsult, Germany

Whether for independent monitoring or just adding additional channels to an existing vibration controller, m+p Analyzer provides an ideal solution for measuring vibration and other responses during a shaker test or with shock machines:

## Random Vibration

Power Spectral Density (PSD) data with single or multiple average results can be computed during the vibration test run. m+p Analyzer's "scope mode" allows pre-monitoring of the test start-up before averaging starts and averages can be manually reset if required during the process. Transfer functions, coherence and many other functions

are easily included for a more thorough analysis of the test data. Sampling frequency and various measurement windowing can be selected for full compatibility with the vibration controller.

## Swept Sine Vibration

m+p's expertise in vibration control technology has been embedded into m+p Analyzer to give accurate and fully compatible swept sine tracking results using the COLA output reference. Sampling, bandwidth and result estimator filters can all be selected to match the controller or indeed used to provide alternative higher resolution results for example. As with all test modes, time history recording can



## YOUR BENEFITS

- Independent response channel monitoring for test data security
- Cost effective for addition of large number of monitoring channels
- Fully compatible results with vibration controller so easy to combine data
- Data reduction in all test modes for flexibility and integrity
- Throughput to disc recording at any sample frequency
- Powerful sequence of event analysis on largest of time history files
- Integrated modal analysis for on-the-spot mode shape animation
- Built-in m+p VibControl test report templates
- Utilize same hardware as m+p VibControl for improved hardware utilization
- Acceptance and qualification testing of shakers

be run in parallel for post-processing or detailed sequence of event analysis. Post-processing of both m+p VibControl and m+p Analyzer time history recordings provide the opportunity to re-analyze data runs with different settings such as filter bandwidth, etc. as well as doing sequence of event analysis of a premature test abort.

### Classical Shock

For use with shaker tests, drop tables, pneumatic hammers or any other shock machines, the classical shock capture wizard enables a full test specification to be entered and overlaid with the measurements. Control and response channels can be independently filtered in real time to avoid out-of-band noise and the result limit overlays are automatically adjusted to best fit the triggered shock waveform.

Calculations are also done of pulse duration, peak amplitude, velocity change and within limits so that these data and their pass/fail criteria are displayed for each pulse immediately on capture. Special report templates that handle control and triax response channels automatically make for rapid report generation.

### Shock Response Spectrum

Online and offline wizards are available to cover all aspects of capturing and reporting SRS data. These can be used with shaker or shock machine testing and include limit overlays for instant test assessment and report generation. As well as real-time low pass filters, the online wizard computes the standard maximax results whereas the offline wizard computes all intermediate SRS functions as well as displaying the actual time response waveforms at each frequency for the most detailed of analyses.

Shock Response Spectrum testing using an impact hammer



### Throughput to Disc Recording and Post-Processing

All test modes allow in-parallel throughput to disc recording so that the raw sample data is available for post-test analysis. This is particularly useful for sequence of event analysis if the vibration test should abort mid-test. Multi-gigabyte file sizes can be quickly reviewed and zoomed for detailed cross channel analysis. Peak time histories are computed and kurtosis time history provides a more sensitive identification of transient events in the data. Furthermore all data reduction test modes can be re-run on the recorded data for more detailed analysis using alternative settings.

### Shaker Qualification

m+p Analyzer provides an advanced software tool for acceptance tests and regular qualification tests of shakers. Total harmonic distortion, amplitude uniformity, table lateral vibration ratio and other relevant measures are evaluated to verify functionality and performance data and to minimize the risks of downtime and associated costs.





## **m+p international**

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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