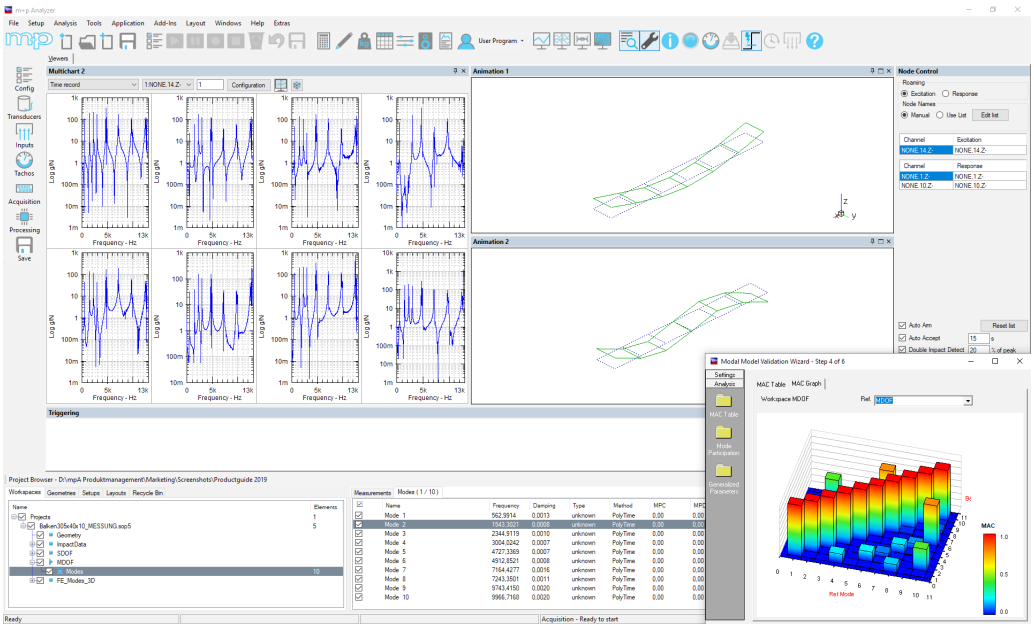
m+p Analyzer

Structural Acquisition and Analysis

The Structural Dynamics package is part of the m+p Analyzer for noise & vibration testing that provides a complete set of tools for observing, analysing and documenting the vibrational behavior of machines and mechanical structures. It includes modules for classical and operational modal analysis, impact and MIMO acquisition as well as for ODS, SDOF and MDOF analysis. A modal model validation module is also available.

The software makes it very simple to create the structure‘s geometry and calculate modal parameters including mode shape animation. The experimental modal data (frequency, damping and mode shape) are obtained by curve fitting a set of FRF (Frequency Response Function) measurements. FRFs can be directly measured or calculated from time records automatically. FRFs and time records can also be imported from other systems. Structural Dynamics Modifications and FE model correlation and updating are further optional tools.



Comprehensive structural data analysis tools

Key Features

Structural Acquisition and Analysis

- Data collection, analysis and reporting in one package
- Impact (modal hammer) data acquisition
- Creation of component based geometries
- ODS (Operating Deflection Shape) analysis
- SDOF (Single Degree of Freedom) analysis
- MDOF (Multiple Degree of Freedom) analysis
- OMA (Operating Modal Analysis)
- Modal model validation
- Polyreference Time Domain algorithm
- Polyreference Time Domain Plus algorithm
- Polyreference Least-Squares Complex Frequency Domain algorithm
- Interface to FEMtools for SDM analysis (optional)
- Correlation/updating between experimental and Finite Element Analysis data (optional)
- Intelligent wizards for easy and safe user guidance
- Copy & paste to ActiveX applications like MS Word and PowerPoint
- Free installation of the m+p Analyzer Viewer software to actively view/analyze data on any MS Windows PC

Structural Add-Ons

- MIMO (Multiple Input/Multiple Output) analysis including multi-source outputs
- Stepped sine online analysis
- Sine reduction analysis
- Ground vibration testing
- Advanced frequency domain curve fitter and optimized pLSCE

Applications

- Analysis of structural dynamics in the automotive, aerospace, defense, consumer and other industries
- Experimental modal analysis
- Operational modal analysis
- Fixture analysis for environmental vibration test (for MILSTD 810F)
- Vibrational troubleshooting
- Structural Dynamics Modifications
- FE Model Validation and Updating
- Ground vibration testing

Overview

The Windows-based Structural software uses intelligent wizards which, step by step, guide you through the process of performing a modal acquisition and analysis. Graphs and mode shapes can be directly copied and pasted into ActiveX compliant applications such as Microsoft Word or PowerPoint. Once imported into these applications, all m+p Analyzer Viewer properties such as data rescaling, reformatting, animating, etc. stay active. The m+p Analyzer Viewer software can be installed on any PC at no extra cost.

A data interface is available between the m+p Analyzer and the FEMtools software of DDS Corporation. FEMtools also interfaces to all popular FE analysis software packages. It has modules for pre-test analysis, SDM (structural dynamics modifications) analysis, correlation analysis and FE model validation and updating. More information is available at www.femtools.com.

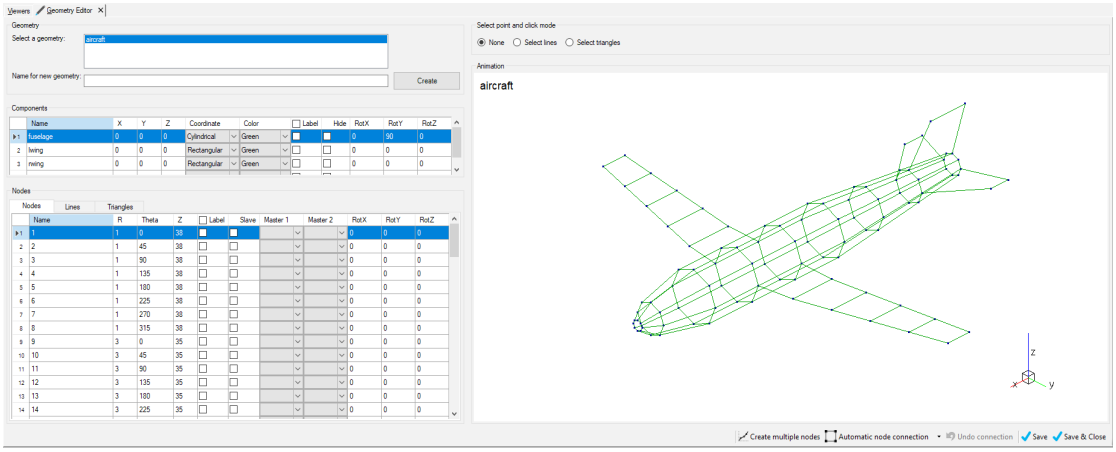
Impact Data Acquisition

Impact testing includes useful tools like the selection of a roving hammer or transducer, selection of data points/ nodes, double impact detection and rejection, definition of force and exponential window and a user-definable display configuration as a visual measurement feedback. The combination of automatic DOF/node scheduling, automatic rejection of invalid measurements and automatic saving of data after a user-defined interval virtually eliminates all keyboard interaction. This is helpful for impact testing on large structures or at locations that are difficult to access.

- Unlimited and freely definable list of user-specific header information (metadata) for annotation, data retrieval, sorting and reporting
- Simple parameter entry for the channels in tables including engineering units, transducer calibration data and inputs
- Channel type: excitation, response, inactive; DC or AC coupled; input range, offset, pregain, acoustical weighting; FIR weighting filters hand, arm, body, user defined
- Channel input: V, ICP, Charge
- Enter transducer calibration data or import from Excel
- Roving hammer or roving transducer mode
- Easy selection of measurement points (nodes) and directions
- Level trigger with selectable pretrigger
- Acquisition setup: sample rate or useful bandwidth, blocksize, arming
- Data processing/data storage: time record, spectrum, PSD, cross-PSD, cross-half-PSD, FRF, coherence; linear averaging
- Windows: uniform, force-exponential; force width and exponential end in %
- Automatic detection and rejection of double impact measurements
- Automatic, hands-off stepping through measurement points (nodes) and storage of averaged results during acquisition
- User-definable displays for impact pulse, PSD, FRF/Coherence etc.
- Save and recall measurement and display setups

Geometry Creation

Component based geometries for ODS/modal analysis can be created in a simple step-by-step approach. The steps are to define the components, describe them with nodes and draw lines and surfaces. Geometries can also be imported as UNV/UFF files and from most CAD packages via STL format.



Geometry creation

- Rectangular, cylindrical or spherical coordinate systems
- Components can be displayed in different colors
- Rotate components around the X, Y and Z axis
- Arbitrary node names
- A node can be a slave to one or two other master nodes
- Enter sensor/node direction as a rotation around the X, Y and Z axis
- Draw lines and surfaces with the mouse, or by entering node data in a table
- Rotate, resize and move the geometry while drawing
- Geometry tables can easily be imported from and exported to Excel for enhanced processing capability

Operating Deflection Shape (ODS) Analysis

The Operating Deflection Shape (ODS) analysis is used to visualize how a structure vibrates under steady-state operating conditions. Unlike modal analysis, knowledge of the input forces is not required. The source of the data for the analysis can be time, spectra, crosspower or FRF measurements. A geometry and corresponding measurement data are the only prerequisites for an ODS analysis. Any measurement can easily be referenced to a node by a simple header entry. Measurement data and geometry are then displayed together allowing immediate animation of an ODS at any discrete frequency, or over a frequency sweep. While the structure is animated, there is access to tools for selecting the data being displayed, storing a mode, moving through the data or searching for the ”next“ peak in the data.

- ODS in frequency and time domain
- Automatic check for missing data
- Online display of ODS for cursor selected frequency
- Manual cursor placement or automatic sweep, adjustable sweep speed
- Automatic cursor peak finding for ODS storage

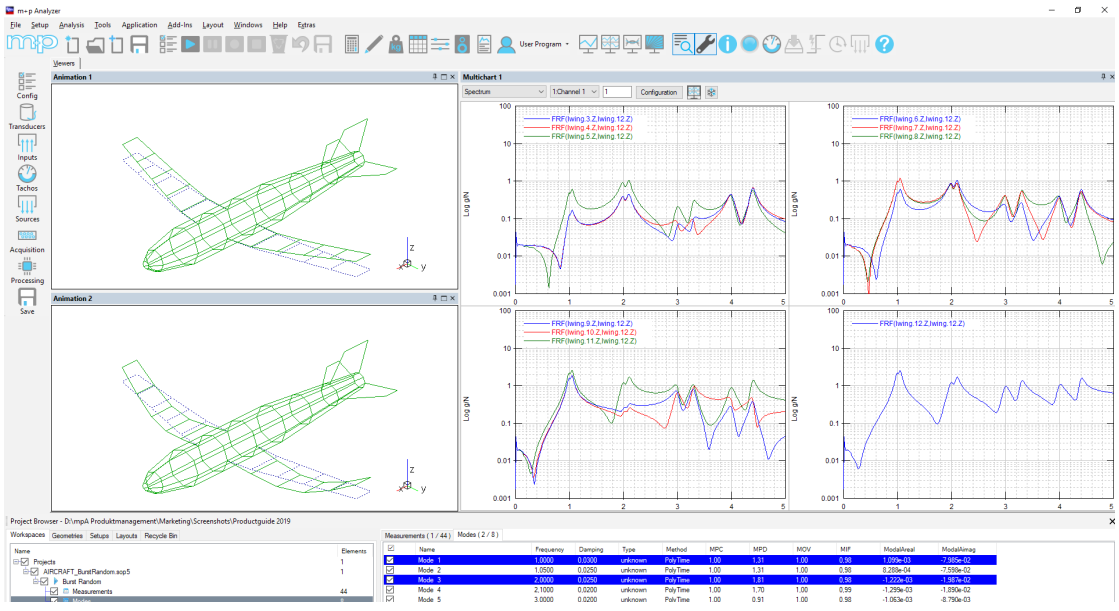
Modal Analysis[1)]

Both SDOF (Single Degree of Freedom) and MDOF (Multiple Degree of Freedom) analysis use FRFs to calculate the modal parameters (natural frequencies, damping and mode shapes) of the structure. The SDOF analysis steps are identical to those of the ODS analysis. However, the SDOF analysis uses least squares fit, peak picking and quadrature cut methods to estimate the modal parameters.

The MDOF analysis handles the most sophisticated modal analysis tasks like detecting repeated or closely spaced modes. It takes the user through a simple series of steps to complete the analysis and also makes intelligent estimates of all analysis options so even an inexperienced operator can produce a reliable result whereas the experienced user can easily fine tune his result for the most difficult analysis situations.

The SDOF and MDOF wizards include the option of processing operational modal data. This is for cases where a structure is self-excited or where input forces are not known. Applications include automotive testing using road loading, bridges using traffic passing, shakers using random or swept sine inputs etc. Typically, a set of cross power measurements replace the FRFs and are processed using accepted assumptions about the forcing function input. Compared to ODS which creates a modal shape animation this technique handles closely coupled modes and computes full frequency and damping results for FEM validation and tuning. In contrast to classical experimental modal analysis which relies on FRFs calculated from measured excitation forces and response signals, OMA (Operational Modal Analysis) only requires the structure's responses which are measured assuming an equally distributed excitation.

Industry-proven time and frequency curve fitting algorithms with wizard-guided operation offer ease of use and simplify result interpretation for non-experts. 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 high system orders (above 50) in more heavily damped structures. All methods include clear stabilization diagrams and synthesized FRFs for optimum analysis.



Advanced MDOF modal analysis

1) included in AN-MDOF add-on

- FRFs: acceleration/force, velocity/force, displacement/force
- SDOF: least squares fit, peak picking and quadrature cut
- MDOF: polyreference time domain method for extracting poles and modal participation factors; multi-reference least squares frequency domain method to estimate the modal vectors; multivariate and power spectrum summation mode indicators
- Select data, references and directions for the analysis process
- Automatic checking for missing data
- Select frequency range, data being displayed and mode indicator function
- Determine the modal order and the over-determination factor
- Stability diagram: set the tolerance of the stability parameters and select poles
- Synthesis and shape animation: view and save selected mode shapes
- Wizard guides through the analysis process and greatly facilitates it by limiting the choices to be made
- Modal model validation (MAC, MPD, MPC, MOV, MIF)
- OMA (Operational Modal Analysis)
- 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[2)]

The Multiple Input/Multiple Output (MIMO) module measures the crossfunctions of all responses versus all excitations and checks the correlation of multiple inputs by displaying the eigenvalues of the input crosspower. The results are the Principal Input Spectra indicating the number of uncorrelated physical inputs. Acquiring data with multiple inputs requires that the inputs are uncorrelated with one another.

- Unlimited and freely definable list of user-specific header information (metadata) for annotation, data retrieval, sorting and reporting
- Simple parameter entry for the channels in tables including engineering units, transducer calibration data and inputs
- Channel type: excitation, response, inactive; DC or AC coupled; input range, offset, pregain, acoustical weighting; FIR weighting filters hand, arm, body, user defined
- Channel input: V, ICP, Charge
- Enter transducer calibration data or import from Excel
- Source modes: random, burst random, periodic random, sine, stepped sine, burst sine, chirp, sine sweep, multiple level controlled fixed/swept sine and random
- Source parameters: level, bandwidth, burst %, sine frequency, sine phase, ramp time
- Acquisition setup: sample rate or useful bandwidth, blocksize, arming
- Trigger modes: free run, source, channel, pos./neg. slope, zone entry/exit; level, pretrigger up to 100%
- Data processing: principal input spectra, time record, spectrum, autopower, crosspower, PSD, cross-PSD, FRF, coherence, autocorrelation, crosscorrelation, histogram, probability distribution, probability density, impulse response
- Averaging: none, linear, exponential
- Windows: uniform, hanning, hamming, flattop, exponential; exponential end in %
- Auto-ranging: instant graphical feedback, automatic/manual ranging, range up only
- Overload handling: ignore, retry or break
- Save and recall measurement and display setups
- Calibration: calibrate transducers

2) included in AN-MM add-on

Swept and Stepped Sine Analysis[3)]

Both swept sine and stepped sine analysis modules are available. Compared to random excitation modes these single frequency excitation modes offer improved signal to noise analysis, the ability to analyse non-linear effects and user control over structural settling times for improved mode identification.

- Entry of start frequency, end frequency, frequency step or sweep rates
- User selection of step delay, averaging and tracking filter bandwidth
- Data processing/data storage: FFT spectra, auto-power spectra, crosspower spectra, FRF, coherence
- Modal analysis using the SDOF and MDOF functions

Viewers/Post-Processing

2D Viewer[4)]

Animation Viewer

- Unlimited number of displays, up to 4 views (x, y, z-axis, selectable) per display
- Rotate, resize, move the geometry
- Solid or wireframe view
- Undeformed or animated view
- Animation speed and amplitude selectable, or manual stepping
- Node measurement direction view
- Geometry component color selection

Post-Processing

- Data import/export[4)]
- All processing can be done from imported time domain signals
- Drag/drop data combining from different workspaces
- Advanced calculator for non-standard calculations

Operating System

- Microsoft Windows 10 Pro 64 bit

3) included in AN-SSO and AN-SINR add-ons
4) see the m+p Analyzer eReporter Product Information

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