ME'scopeVES 5.0™

Visual Engineering Series

Tools for Solving Noise & Vibration Problems

- ODS Analysis
- Acoustic Analysis
- Structural Modifications
- Modal Analysis
- MIMO Simulation
- Experimental FEA

Vibrant Technology



What is ME'scopeVES?

ME'scopeVES **(Visual Engineering Series)** is a series of software packages designed to make it easier for you to observe and analyze a variety of noise & vibration problems in machinery and structures. ME'scopeVES is used for operating deflection shape (ODS) analysis, modal analysis, acoustic analysis, MIMO modeling & simulation, and structural modifications.

ME'scopeVES is used to display and analyze experimental multi-channel time or frequency domain data, acquired during the operation of a machine, or forced vibration of a structure. With it, you can interactively display ODS's, mode shapes, acoustic shapes, or engineering data shapes directly from experimental data.

By animating the **spatial response** of a structure in slow motion, you can view a structure's overall motion, and the motion of one part relative to another. Locations of excessive vibration are easily identified. You can also view mode shapes, which give you a better understanding of troublesome resonant vibration problems, so that structural modifications can be made to control or isolate them.

With **interactive sweep** animation, you can animate a structure model by sweeping through a set of time histories, and observe its overall response; whether it be sinusoidal, random, transient, linear or non-linear, stationary or non-stationary. With **interactive dwell** animation, you can dwell at a specific time or frequency in a set of response data, and display shapes **statically** or with **sinusoidal** animation.

*In addition to its interactive animated display, ME'scopeVES contains state-of-the-art tools for Experimental Modal Analysis **(EMA)**, Multiple-input Multiple-output **(MIMO)** modeling & simulation, Structural Dynamics Modification **(SDM)** and experimental Finite Element Analysis **(FEA)**.*

Importing Measured Data

ME'scopeVES has file translators for importing data from a wide variety of disk data files. File formats used by all popular multi-channel data acquisition systems, analyzers, recorders, and data collectors are supported.

Direct Data Acquisition

The optional Acquisition window in **ME scopeVES** can directly control a broad range of multi-channel data acquisition hardware front-ends. The User Interface is the same, regardless of the acquisition hardware used.

The User Interface is designed specifically for structural testing. It consists of an **Acquisition** window connected to a **Structure** window, where the next measurement location is depicted, and a **Data Block** window where measurements are accumulated.

The Acquisition window acquires time domain data from the front-end hardware and performs signal processing on the data, including time domain windowing, spectrum averaging, and calculation of Auto & Cross Spectra, FRFs, Coherences, etc.

Interactive 3D Modeling

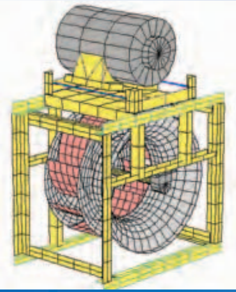
A 3D model of the test structure must be built or imported in order to display shapes in animation. ME'scopeVES contains a variety of drawing tools to assist you in building 3D models. Models can be drawn interactively by dragging objects on the screen, or by editing their properties in spreadsheets. Objects can also be cut, copied, and pasted between drawings.

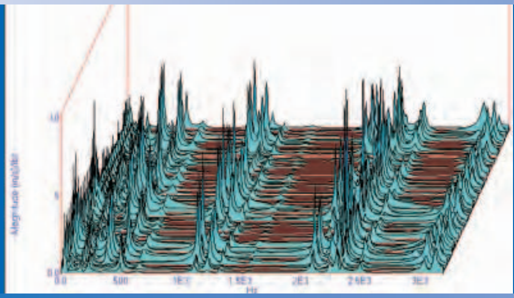
ME'scopeVES also contains a **Drawing Assistant** that rapidly generates 3D models using substructures. Complex structure models are created by merging together several substructures with simple geometries. The Drawing Assistant contains a substructure browser from which you can select pre-defined substructures for building the model.

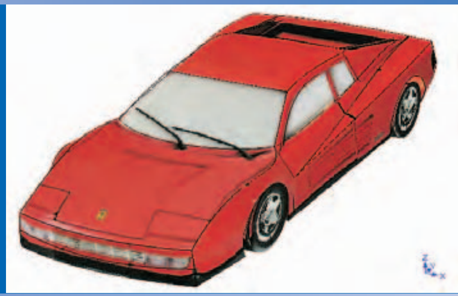
The Drawing Assistant also contains powerful **Revolve** and **Extrude** commands which can be used to create 3D models from 2D profiles. 2D profiles can be drawn freehand, or traced from digital pictures or drawings using the picture tracing capabilities in ME'scopeVES or third party software.

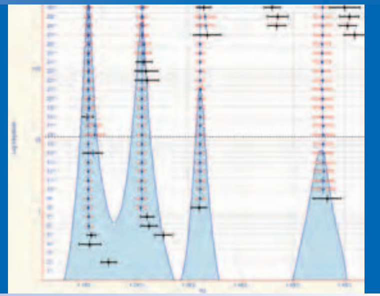
Measurements in Local Directions

When making vibration measurements, it is usually easiest to attach the transducers directly to the surface of the test structure. If the surface is curved, each transducer will sense motion in a different local direction.









In ME'scopeVES, each point on a 3D structure model has its own local measurement axes which can be graphically oriented to coincide with the transducer measurement directions. This feature gives you the freedom to mount transducers directly on curved surfaces. Tri-axial and radial measurements are easily defined on the 3D test model using this feature.

Interpolation for Unmeasured Points

Vibration measurements are usually made at relatively few points on a test article. On the other hand, the 3D model of the test article will typically require more points to give it a realistic appearance. ME'scopeVES contains a unique **spatial interpolation** feature which calculates shape values for all unmeasured points based on the shape values at neighboring measured points. With interpolation turned on, a more realistic animated shape is displayed from relatively few measurements.

Interactive Shape Animation

An Operating Deflection Shape (ODS) is the simplest way to see how a machine or structure moves during its operation; at a specific frequency or moment in time. An ODS contains the overall dynamic response of a structure due to forced and resonant excitation.

With **sweep** animation, **Time-Based ODS s** are displayed by sweeping through a set of time histories describing motions at multiple points and directions on a test article. You can stop the animation, back it up, and play it forward to observe in slow motion phenomena that may have taken place very quickly in real time. You can use sweep animation to analyze the run up, coast down, or other transient behavior of a machine.

With **dwell** animation, you can observe the **Frequency-Based ODS** of a structure at a single frequency. You simply move the cursor to a frequency of interest in your test data, and the animated display will display the ODS for that frequency. A frequency-based ODS can also help you determine whether or not a resonance is being excited, or whether the vibration is an order related forced vibration.

Interactive Shape Animation allows you to view shapes directly from your experimental data without curve fitting or any other processing.

Resonances and Mode Shapes

Modes of vibration are used to characterize all vibration in mechanical structures. All vibration can be characterized as a summation of contributions from **rigid body** modes and **elastic** modes. An elastic mode characterizes a structural resonance. If a structural resonance is excited, the structure will readily absorb energy and resonate at levels that can far exceed deflections due to static loading. These excessive vibration levels can also create excessive noise, and can cause material fatigue and premature failure.

Each resonance has a specific "natural" or **modal frequency**, a **modal damping** value, and a **mode shape.** These three properties of a mode will not change unless one of the physical properties or the boundary conditions (e.g. supports) of the structure changes.

Under the proper conditions, a structure will readily absorb energy and resonate if excited at or near one of its modal frequencies. Modal damping is a measure of how quickly the resonant vibration will decay when all forces are removed from the structure. The mode shape defines the spatial deformation of the structure due to the resonance.

If one of the resonances of a structure is excited, its deflection shape will often be ***dominated*** by the mode shape associated with the resonance. By observing ODS's in animation, ME'scopeVES helps you determine whether or not a resonance is being excited.

Documentation with Digital Movies™

With our unique Digital Movies™ feature, you can save any ME'scopeVES animation sequence in a *Microsoft* AVI file. The AVI file can be played back and the animation viewed just as it appeared when the movie was made.

Digital Movies can be embedded in Microsoft *PowerPoint* presentations, *Word* documents, or Web pages, and played by simply clicking on them. Digital Movies can also be played on Macintosh, Linux, or Unix computers.

Packages & Options

ME'scopeVES can be purchased in a variety of different packages. The basic ***Visual* ODS"** package contains all of the features for interactively drawing 3D models, importing multi-channel measurement data, and interactively displaying shapes in animation. All of the other advanced packages consist of the **Visual ODS"** package with options added to it. (See the back cover).



Acquisition Options

ME'scopeVES can be ordered with Acquisition options that allow you to setup, control, and directly acquire data. Most popular multi-channel data acquisition systems, analyzers, recorders and collectors are supported. The Acquisition window is particularly useful for Impact Testing, where user interaction with data acquisition and post-processing is essential.

This option adds an Acquisition window to ME'scopeVES that contains all of the controls necessary for acquiring, calculating, displaying, and saving multi-channel data. The Acquisition window calculates a variety of frequency domain measurements, including Auto & Cross Spectra, FRFs, Coherences, ODS FRFs, etc.

Impact testing (with force and exponential windowing), and tests using ambient, pure random, and sine excitation methods are supported. Shaker signal generation using random, burst random, chirp and burst chirp are also supported with hardware front-ends that have signal output capability.

Connected Windows

The Acquisition window is connected to a Structure window with a 3D test structure model in it, and a Data Block window where measurements are accumulated. Using these three connected windows, you can select measurement points & directions on a 3D model, acquire measurements, and view ODS's or mode shapes in animation, even before all measurements have been acquired.

With only a few measurements, you can begin to see how a structure is deforming. As more measurements are acquired, the shapes will gain more definition.

Measurement Sets

Measurement sets are used in the Acquisition window to designate each set of simultaneously acquired data. Each measurement set contains the measurement DOFs and all front end channel setup parameters for acquiring data. All measurement sets for an entire test are saved in an Acquisition file, so the test can be repeated using the same parameters.

Acoustics Option

This option post-processes and displays Acoustic Intensity, Sound Pressure Level (SPL), and Sound Power in addition to vibration data. It allows you to analyze vibro-acoustic problems, by displaying both vibration and acoustic data together in the same animated picture. Vibration data is displayed on the 3D test model, while acoustic data is displayed on an acoustic surface.

Acoustic Intensity is measured with a two or four channel acoustic probe and a multi-channel acquisition system. Each Intensity measurement is made in a direction at each point in a point grid. Intensity is usually measured either normal to the acoustic grid or surface, or in three directions (tri-axially) at each grid point.

Sound Power flow though an acoustic surface can be calculated from Intensity data. Sound power is calculated using the surface area surrounding each test point and the surface normal at each test point. Sound power is then displayed on the acoustic surface using a color map.

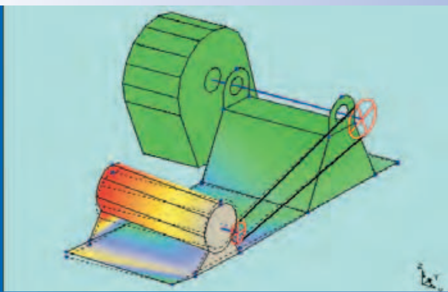
Interactive **Source Ranking** allows you to graphically document the breakdown of acoustic energy measured from various components of a test article. Acoustic sources can be ranked according to their percentage of the total power, in dB units or watts.

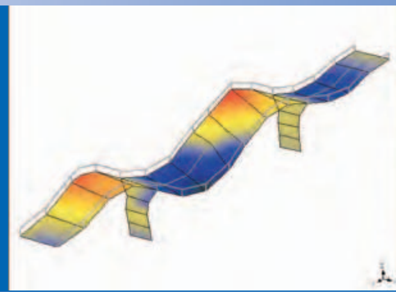
Signal Processing Option

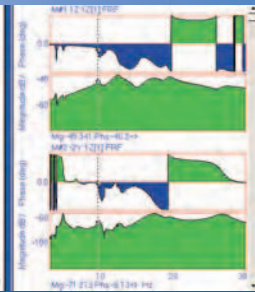
This option includes **FFT** commands that simultaneously transform all measurements in a Data Block window between the time and frequency domains. This allows you to conveniently analyze data and display shapes from either time or frequency data.

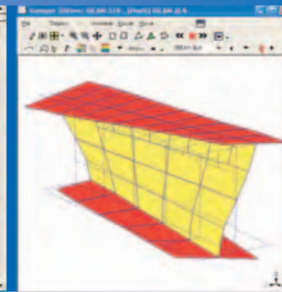
*The prime factor FFT transforms **any number** of samples, not just a powers-of-2, thus providing more flexibility for working with your data.*

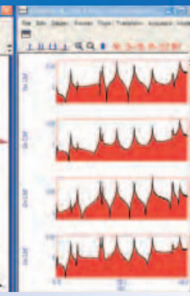
You can cut, copy, and paste data, or portions of data between one Data Block and another. When measurements with dissimilar time or frequency axes are pasted together, **interpolation** between samples is used so that the pasted data matches the time or frequency axis of the destination Data Block.This allows you to combine measure-ments acquired with different hardware front ends into a common Data Block.











Vibration data can be measured with a variety of transducers, including accelerometers, proximity probes, lasers, photonic sensors, etc. However, the question, ***How much is the machine or structure actually moving?*** is usually answered with displacement values.

With the signal processing option, you can **integrate** *or* **differentiate** *time or frequency waveforms or shapes between accelerations, velocities, and displacements.*

Notch or **band pass** windows can be used for removing unwanted portions of your data such as noise or DC offsets. The exponential window can also be used for removing noise. This window adds a specific amount of damping to each mode, which is automatically removed from the modal damping estimates obtained during curve fitting.

ODS FRFs

When the excitation forces cannot be measured, and therefore a set of FRFs cannot be calculated, a set of ODS FRFs is calculated instead. An ODS FRF measurement is calculated from operating (or response only) data.

ODS's can be displayed in animation directly from a set of ODS FRFs. ODS FRFs have peaks at resonant frequencies, thus making it easier to locate resonances. **Operating mode shapes** can also be obtained by curve fitting a set of ODS FRFs.

Order Tracked ODS's

An Order Tracked ODS provides a picture of a rotating machine's deformation as a function of one of its rotational orders. With the Signal Processing option, you can import and process multi-channel order tracked peak & phase response data. Order Tracked ODS's can then be displayed in animation directly from the ordered tracked operating data.

MIMO Modeling & Simulation Option

This option uses a Multiple Input Multiple Output **(MIMO)** FRF matrix model to calculate structural responses, FRFs, or excitation forces. Each part of the model can be calculated from the other two. Excitation force and response waveforms can either be obtained experimentally or synthesized in ME'scopeVES.

Elements of the FRF matrix can be measured or synthesized from modal parameters.

MIMO response waveforms caused by multiple forces are calculated using the MIMO model. FRFs defining the dynamics of the structure between the appropriate excitation and response DOFs are required, plus time or frequency waveforms of the excitation forces. MIMO modeling is also used to calculate and display ODS's due to multiple sinusoidal forces at a single frequency.

The **MIMO force** waveforms required to cause multiple structural responses are also calculated using the MIMO model. This capability is useful for **Force Path Analysis.** The FRFs and response waveforms required for this calculation can be measured or synthesized in ME'scopeVES.

MIMO FRFs

MIMO FRFs can be calculated from multiple excitation force and response time waveforms, or from Auto & Cross Spectra. If time waveforms are used, time domain windowing (Rectangular, Hanning, or Flat Top), linear or peak hold spectrum averaging, triggering, and overlap processing can be applied during the FRF calculations. Ordinary Coherences are calculated for single input forces, and **Multiple & Partial Coherences** are calculated for multiple input forces.

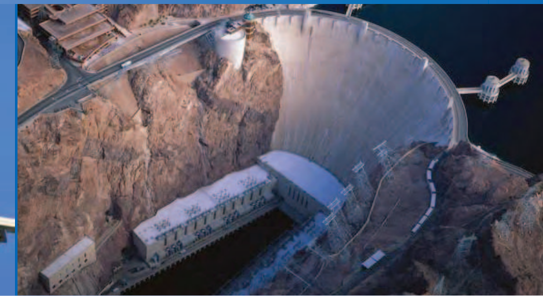
Modal Analysis Option

Modal analysis is used to analyze resonant vibration in a structure. **Modal parameter estimation** (or **curve fitting**) is used to estimate the modal parameters of a structure from a set of FRF data. Each mode is defined by its modal frequency, modal damping, and mode shape.

This option includes **SDOF** (one mode at a time), **MDOF** (multiple modes at a time), and **Global** (multiple measurements at a time) curve fitting methods for estimating modal parameters. **SDOF** curve fitting is fast and easy to use, and is useful for quickly obtaining mode shapes so that they can be displayed in animation.

MDOF curve fitting is more powerful, and simultaneously estimates modal parameters for two or more modes at a time. It is useful for curve fitting FRFs with high modal density (many modes in a small frequency band).





Global curve fitting is better for obtaining parameter estimates of **local modes**, that is modes that are confined to local regions of a structure.

*The Modal Analysis option also contains a **Quick Fit** command that performs curve fitting in one operation. All of the curve fitting methods can be used on* **selected** *measurements, and in user-controlled* **cursor bands.**

Mode Indicator

The first step of curve fitting is to determine ***how many modes*** are contained in a set of measurements. Resonances are indicated by **peaks** in FRF measurements. This option contains a **Count Peaks** command that calculates a Mode Indicator function from the FRFs, and counts its peaks above a user-defined threshold.

Polynomial Curve Fitting

The Polynomial method uses a least squared error curve fitting algorithm to estimate the numerator and denominator polynomial coefficients of an analytical FRF model from experimental data. The numerator and denominator coefficients are then processed to obtain modal parameters. This method also uses **extra numerator polynomial** terms to compensate for the residual effects of out-of-band modes in the curve fitting frequency band. With residual compensation, curve fitting can be done in narrow frequency bands without incurring errors due to out-of-band modes.

Advanced Modal Analysis Option

This option contains additional curve fitting methods that will assist you in estimating modal parameters under more difficult conditions. It contains the **Complex Exponential, Z-Polynomial**, and **ERA** curve fitting methods.

The **Complex Exponential** method curve fits a set of time domain Impulse Response Functions (inverse FFT's of FRFs) using a least squared error algorithm. The **ERA method**, developed by NASA for use with large scale modal tests on spacecraft structures, also curve fits a set of IRF data.

The **Z-Polynomial** method uses the Z-transform to significantly enhance the numerical stability of the Polynomial method, thus allowing it to also estimate the parameters of a large number of modes. Because all three of these methods can estimate the parameters of a large number of modes at a time, they are used with a **Stability** diagram for best results.

Stability Diagram

The Stability diagram is very useful for obtaining modal frequency & damping estimates from data with **closely coupled modes** (two or more modes represented by a single resonance peak), or **repeated roots** (two or more modes at the same frequency but with different mode shapes).

The Stability diagram displays frequency & damping estimates for a range of model sizes, from 1 to several hundred. Modal parameters are said to be "stable" when estimates from successive model sizes yield values within user-specified tolerances. Stable frequency & damping estimates are saved directly from the Stability diagram.

MIMO Curve Fitting

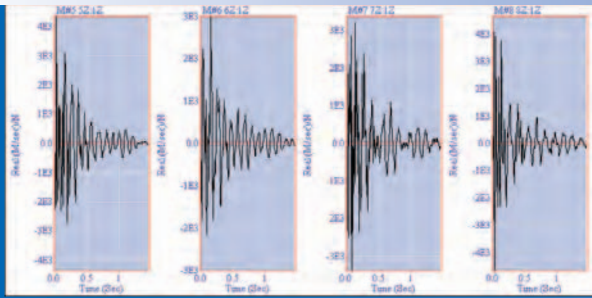
For structures that have **closely coupled** or **repeated roots**, a set of MIMO FRFs must be measured to insure that all modes are correctly identified. A set of MIMO FRFs is measured in a **MIMO** modal test.

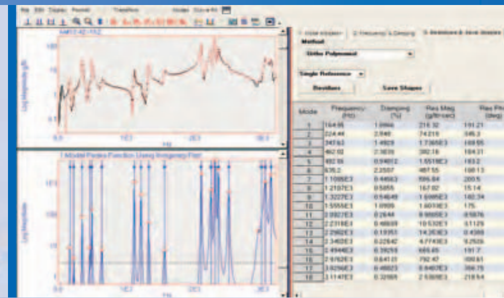
In a **MIMO** shaker test, the structure is simultaneously excited from two or more exciter locations. In a roving exciter **MIMO** test, two or more fixed response transducers are used. A set of MIMO FRFs corresponds to FRFs from two or more rows or columns of the MIMO matrix model.

The Advanced Modal Analysis option also contains two additional Mode Indicator functions, the Complex Mode Indicator Function **(CMIF)** and the Multivariate Mode Indicator Function **(MMIF)**, that are helpful for finding closely coupled modes and repeated roots from a set of MIMO FRFs.

Modal Assurance Criterion (MAC)

The MAC calculation is useful for numerically comparing two different ODS's or mode shapes. A MAC value of 1 means that the two shapes are identical. A MAC value greater than 0.9 means that the two shapes are similar, and a value less than 0.9 means that they are different. MAC values are displayed in either a spreadsheet or a 3D Bar chart.





Structural Modifications Option

If any of the physical properties of a structure (its geometry, density, elasticity, or boundary conditions) is changed, or if brackets, stiffeners, tuned absorbers, or other types of modifications are added to the structure, its modes will change and it will vibrate differently. If a noise or vibration problem is due to the excitation of a resonance, the structure must either be isolated from the excitation source or physically modified in order to reduce its vibration levels.

The Structural Dynamics Modification **(SDM)** algorithm allows you to calculate the effects of structural modifications on the modes of a structure. Structural modifications are modeled using industry standard **Finite Elements**. The Finite Element library includes **springs, masses**, and **dampers**, as well as higher order elements such as **rods** (with axial stiffness), **bars** (with axial, shear, and bending stiffness), triangular and quadrilateral **plate elements**, and **solid elements** such as tetrahedra, prisms and bricks.

All modification elements are displayed on the 3D structure model. Each element type has its own spreadsheet, where its properties (thickness, density, elasticity, etc.), can be edited.

SDM converts all structural modifications into mass, stiffness and damping changes. These changes, together with the modes of the unmodified structure, are used to calculate the new modes of the modified structure. The new mode shapes can be viewed in animation, compared with the modes of the unmodified structure, used to synthesize FRFs for comparison with measured FRFs, or used in MIMO simulations.

SDM can be used with either experimental or analytical mode shapes. Analytical mode shapes can be calculated with the Advanced Modifications option, or imported from most popular Finite Element Analysis (FEA) packages. Once an FEA model has been validated, its analytical modes can then be used with SDM to quickly investigate many modification possibilities.

Scaling Operating Modes

In order to be used for modeling purposes (SDM, MIMO or FRF Synthesis), mode shapes must be properly scaled in order to preserve the mass and elastic properties of the structure. A set of scaled mode shapes is called a **modal model.**

This option contains a unique mode shape scaling command so that any set of mode shapes, including operating mode shapes, can be properly scaled for use as a modal model.

Advanced Modifications Option

With this option, you can construct a **Finite Element** model of your test structure and solve for its analytical mode shapes. Experimental FEA allows you to investigate a much wider variety of structural modifications than with the SDM method alone.

This option includes both a **normal** mode "band" solver and a **complex** mode solver that includes modal damping. The normal mode solver can solve for the modes of FE models with up to 20,000 DOFs, and the complex mode solver can solve for the modes of models with up to 2000 DOFs.

FEA Assistant

The FEA Assistant allows you to easily populate a 3D geometric model with finite elements. You can start by populating your 3D test model with finite elements, or **mesh** it to add more elements for improved accuracy. The FEA Assistant uses built-in materials and properties lists from which you can select pre-specified physical properties for the finite elements before adding them to the model.

Modal Test Planning

With the Advanced Modifications option, you can simulate an entire modal test using analytical modes and MIMO simulation. This is very helpful for planning transducer and excitation locations prior to the actual test. Following the test, you can conveniently compare experimental modes with analytical modes, thus validating both your finite element model and your experimental results.

The FE model can also be used to expand ODS's or mode shapes to include deflections for all unmeasured DOFs of the model. This unique **Shape Expansion** capability uses the FE model to calculate shapes with many DOFs in them using experimental data that was acquired at only a few DOFs.

ME'scopeVES Packages

ME'scopeVES can be purchased in one of the following packages. Each advanced package adds one or more options to the basic ***Visual ODS***™ package.

- ***Visual* ODS** ™ 3D model building, measurement data import and display, interactive shape animation
- ***Visual* ODS Pro**™ adds Signal Processing to ***Visual* ODS**™
- ***Visual* Modal**™ adds Modal Analysis to ***Visual* ODS Pro**™
- ***Visual* Modal Pro**™ adds Advanced Modal Analysis & MIMO Modeling & Simulation to ***Visual* Modal**™
- ***Visual* Acoustics**™ adds Acoustics to ***Visual* ODS**™
- ***Visual* Vibro-Acoustics**™ adds Acoustics to ***Visual* Modal Pro**™
- ***Visual* SDM**™ adds Structural Modifications to ***Visual* Modal Pro**™
- ***Visual* SDM Pro**™ adds Advanced Modifications to ***Visual* SDM**™
- ***Visual* STN**™ adds Acoustics to ***Visual* SDM**™
- ***Visual* STN Pro**™ adds Acoustics to ***Visual* SDM Pro**™

Data Capacities

ME'scopeVES can store thousands of measurements, with thousands of samples per measurement. Structure models can have thousands of points, lines, and surfaces. ME'scopeVES can also store hundreds of shapes with thousands of DOFs per shape.

User Support

Vibrant maintains an Internet site (www.vibetech.com) from which we provide fast and convenient support to all of our customers. The latest date code of the ME'scopeVES software is available for downloading and installation. In addition to a list of available training courses, users can find technical papers and application notes conveniently organized by category. Our dedicated support staff of engineering professionals is always available to respond to your needs via email or phone.

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ME'scopeVES 5.0™ Features

3D Modeling & Display

- Quad View (front/back, top/bottom, left/right, and 3D views).
- Interactive rotation & elevation in the 3D view.
- Auto rotation in the 3D View.
- Interactive zoom, pan, rotation, and perspective distance.
- Surfaces with color fill, transparency, and surface textures.
- Surface textures imported from digital photographs.
- Lighted surfaces.
- Drawing Assistant for rapidly building structure models using rectangular, cylindrical & spherical coordinates. Includes sizing, no. of points, positioning, revolve, extrude, and a substructure palette with pre-defined substructures.
- Interactive drawing tools. Select & drag objects on screen, resize, rotate, and stretch objects to rapidly build a structure model.
- Cut, Copy & Paste of drawing objects.
- Spreadsheets for editing properties of drawing objects.
- Measurement Axes (rectangular, cylindrical, spherical & machine), graphically oriented at each point.
- Interactive point numbering.
- Measurements displayed on the model.
- Imports structure models from UFF, AutoCAD (DXF), STL, FEMAP, NASTRAN & ANSYS files.

Shape Animation

- Interactive shape animation directly from time or frequency domain measurements, using a line, peak, or band cursor.
- Interactive shape animation directly from a Shape Table.
- Interpolation of shape data for unmeasured points using data from neighboring measured points.
- Animation in Quad view or a Single view.
- Display of two shapes (side-by-side & overlaid) from two sources (Data Blocks or Shape Tables).
- Shape contour colors (including nodal lines).
- Shape animation of scalars or vectors (translations & rotations).
- Deformed & un-deformed structure displayed together.
- Speed & amplitude controls.
- Display of maximum deflection points & shape values.
- Display of shape values at selected (monitored) points.
- Animation using arrows.
- Animation with persistence.
- Auto, relative & fixed shape scaling.
- Animation in selected directions.
- Animation from selected references in multiple reference data.
- Print & Copy to Clipboard.
- Digital Movies, documents animation as an AVI file.

Measurement Display

- Displays time or frequency domain measurements.
- Imports PC disk files saved by popular multi-channel data acquisition systems, analyzers, recorders & collectors.
- Imports & exports UFF, ASCII Spreadsheet, MATLAB, DADiSP & MS WAV file formats.
- Displays up to 100 measurements in Row/Column, 10 in Strip Chart, an unlimited number in Overlay, Cascade, & Color Map formats.
- Real, Imaginary, Magnitude (Linear, Log, dB), Phase, CoQuad (Real & Imaginary), Bode (Magnitude & Phase), Nyquist (Real vs. Imaginary).
- Horizontal & vertical zoom with scrolling.
- Line, Peak & Band Cursors.
- Grid lines, labels, DOFs, units & cursor values displayed on each measurement.
- Spreadsheet for editing measurement properties (select, show/hide, color, line types, DOFs, units, labels, etc.)
- Play button, plays the sound of each measurement.
- Measurement statistics.
- Auto, relative & fixed vertical axis scaling.
- Maximize vertical axis display.
- Linear & Log horizontal axis.
- Print & Copy to Clipboard.
- Text font, window, background, fill, text color & line type.

Direct Data Acquisition

- Connects to most popular multi-channel acquisition front ends.
- Front end sampling, triggering, sources & measurements selected from tabs.
- Front end channel parameters, windowing, etc. setup in a spreadsheet.
- Displays both acquired time domain and calculated frequency domain waveforms.
- Scope mode for looking at front end time domain waveforms.
- Displays un-windowed and windowed front end waveforms.
- Impact force & exponential windows.
- Accept/reject controls for impact testing.
- Outputs multiple shaker random (burst random), chirp (burst chirp) signals for selected front end hardware.
- Calculates MIMO FRFs, Multiple & Partial Coherences, Auto & Cross Spectra, ODS FRFs.
- Measurement points & directions graphically indicated on a connected structure model.
- Measurements accumulated into a connected Data Block.

Acoustics

- Animated display of vibro-acoustic (acoustic & vibration) data.
- Displays narrow band or 1/1, 1/3rd, 1/12th, 1/24th octave band measurements.

ME'scopeVES 5.0™ Features

- Displays measurements in Linear, Log, dB, dB Reference.
- Acoustic Intensity calculated from Cross Spectrum or time domain data.
- Sound Power through a surface calculated from Intensity data.
- Converts narrow band measurements to octave band.
- A, B & C weighting of narrow band or octave band measurements.
- Noise source ranking based on percentage, dB, or watts.
- Magnitude & phase tone calibration.

Signal Processing

- Simultaneous FFT & IFFT on all measurements in a Data Block. (Not restricted to powers-of-2 number of samples.)
- Integration & differentiation of time or frequency signals.
- Waveform Cut, Copy & Paste.
- Notch & Band windows for removing unwanted data.
- Exponential window for removing noise or sharpening resonance peaks.
- Calculates Fourier Spectra, Auto Spectra, PSDs & ODS FRFs from time domain operating data, using Hanning, Flat Top, or Rectangular windows, triggering, linear or peak spectrum averaging, overlap processing.
- Calculates ODS FRFs from Auto & Cross Spectra.
- Displays Order Tracked ODS's from multi-channel Order Tracked response data.
- Block Math functions (scale, add, multiply, conjugate, etc.)
- Linear (RMS) to Power (MS) units conversion.
- Peak, Peak to Peak, RMS scaling.

Modal Analysis

- SDOF Co-Quad & Peak curve fitting.
- MDOF Polynomial curve fitting, with compensation for out-of-band modes.
- Local or Global curve fitting.
- Quick Fit command, one step curve fitting with minimum user interaction.
- Interactive curve fitting using selected measurements and a band cursor.
- Mode Indicator functions with resonance peak counter.
- Frequency & damping estimates overlaid on Mode Indicator graph.
- FRFs synthesized from modal parameters.
- All curve fitting functions and modal parameters saved with each measurement.
- Imports & exports modal parameters in UFF format

Advanced Modal Analysis

- MDOF Z-Polynomial curve fitting.
- MDOF Complex Exponential curve fitting.
- MDOF ERA (Eigenvalue Realization Algorithm) curve fitting.
- Multiple Reference curve fitting.
- Stability diagram. Graphical display of frequencies & damping for a range of curve fitting model sizes.
- CMIF (Complex Mode Indicator Function), indicates closely coupled modes & repeated roots.
- MMIF (Multivariate Mode Indicator Function), indicates closely coupled modes & repeated roots.
- Modal Assurance Criterion (MAC), numerical shape comparison.
- Shape Complexity plot.
- Shape component Magnitude ranking.

MIMO Modeling & Simulation

- MIMO Forced Response. Calculates multiple response time or frequency waveforms from FRFs (or modes) and multiple excitation force waveforms.
- MIMO Sinusoidal Forced Response. Calculates and displays response shapes due to multiple sinusoidal excitation forces.
- MIMO Forces. Calculates multiple excitation force time or frequency waveforms from FRFs (or modes) and multiple response waveforms.
- Calculates MIMO FRFs or Transfer Functions, and Ordinary or Multiple & Partial Coherences from multiple excitation & response time waveforms, using Hanning, Flat Top, or Rectangular windows, triggering, linear or peak averaging, overlap processing.
- Calculates MIMO FRFs, Transfer Functions, and Coherences from Auto & Cross Spectra.

Structural Modifications

- Interactive graphical addition of modification elements to a structure model.
- Displays modification elements on the structure model.
- Point mass, linear spring & linear damper elements.
- Rod & beam elements.
- Triangular & quadrilateral plate elements.
- Tetrahedron, prism & brick solid elements.
- Spreadsheets for finite element properties.
- Modal sensitivity analysis.
- Substructuring (connecting together two or more structures using finite elements).
- Tuned absorber (mass, spring, damper element).
- Scaling of operating modes.

Advanced Modifications

- FEA Assistant. Populates a geometric model with finite elements. Includes material & geometric property lists.
- Calculates Normal Modes for up to 20,000 DOFs.
- Calculates Complex Modes (with damping) for up to 2000 DOFs.
- Shape Expansion. Calculates unmeasured shape DOFs using FE model and response measurements at a few DOFs.

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