

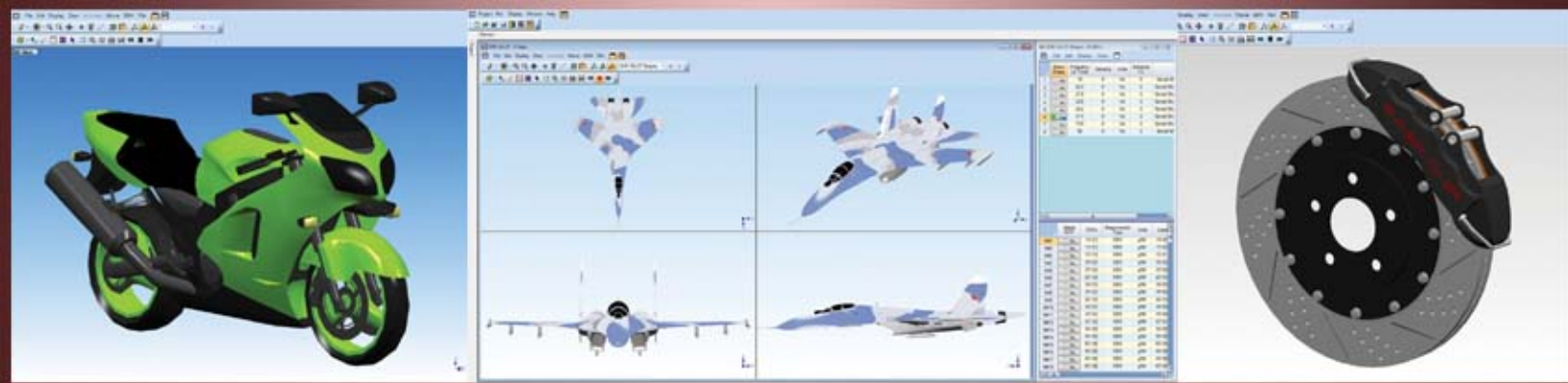
MIE'scopeVESTM

Visual Engineering Series

Tools for Solving Noise & Vibration Problems



- ODS Analysis
- FRF-Based Modal Analysis
- Operational Modal Analysis
- Vibro-Acoustic Analysis
- Dynamics Modeling & Simulation
- Experimental FEA
- Structural Dynamics Modification
- FEA Model Updating



What is ME'scopeVES?

The ME'scopeVES *Visual Engineering Series* of software packages and options makes it easier for you to observe and analyze noise & vibration problems in machinery and structures, using either experimental or analytical data.

ME'scopeVES can acquire and post-process multi channel time or frequency data from machinery and structures. Its industry leading interactive 3D animation allows you to observe operating deflection shapes from running machinery, resonances and mode shapes in structures and machinery, acoustic shapes and engineering shapes directly from acquired data. Structure models can range from simple wire frame (stick figure) models to photo-realistic models.

By animating **spatially acquired data** in slow motion, you can view a structure's overall motion, and the motion of one part relative to another. You can easily spot areas of excessive vibration, noise, temperature, pressure, or other measured parameters. With **interactive sweep** animation, you can sweep through a set of time histories, and observe overall responses, whether they 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 data, and display shapes **statically** or with **sinusoidal** animation.

In addition to its industry leading interactive animated display, ME'scopeVES contains *state of the art tools* for performing;

- FRF-Based Modal Analysis
- Operational Modal Analysis
- Vibro-Acoustic Analysis
- Dynamics Modeling & Simulation
- Structural Dynamics Modification
- Experimental FEA
- FEA Model Updating

Importing Data

ME'scopeVES has file translators for importing data from over **60 different** third-party data files. File formats used by all popular multi-channel data acquisition systems, analyzers, recorders, and data collectors are supported. In addition, structure models and mode shapes can be imported from many solid modeling and FEA program files.

Direct Data Acquisition

ME'scopeVES contains Data Acquisition options with which you can setup and control third-party multi-channel data acquisition systems. The Acquisition User Interface is the same, regardless of the acquisition hardware you use with it. This makes it easy for your engineers and technicians to change from one hardware platform to another without having to learn another user interface.

The User Interface consists of an **Acquisition** window connected to a **Structure** window, (where the next measurement location and direction is depicted on a 3D model), and a **Data Block** window (where measurement data is accumulated during acquisition).

Interactive 3D Modeling

A 3D model of the test structure is required in order to display its 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. Drawing objects can also be cut, copied, and pasted between drawings.

ME'scopeVES also contains a Drawing Assistant that rapidly generates 3D models with very little user interaction. Complex structure models are easily created by assembling together several substructures with simpler geometries. The Drawing Assistant also contains a substructure Library from which you can select pre-defined 3D models.



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 free-hand, or traced from digital photographs or drawings.

Photo-Realistic 3D Models

ME'scopeVES can import 3D models that were created from digital photographs using the third party Photo Modeler™ program. These unique **photo-realistic models** make the test machine or structure *come alive* when animated with shape data.

Internet Model Store

Vibrant maintains an Internet model store where a large selection of 3D models are available for downloading in ME'scopeVES format. Many models are free of charge. Using the built-in **Interpolation** capabilities in ME'scopeVES, a photo-realistic model is easily animated by superimposing it on a **stick model** that has already been setup and animated with your shape data. Using a photo-realistic model, your results are more easily understood by your customers, clients, and management.

Measurement Directions

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

In ME'scopeVES, each point on a 3D structure model has its own measurement axes which can be **graphically oriented** to coincide with transducer directions. This feature gives you the freedom to mount transducers in the most convenient manner.

Interpolation For Unmeasured Points

Measurements are usually made at relatively few points on a test article. On the other hand, a 3D model typically has many more points in order 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. Using interpolation, a more realistic animated shape is displayed from relatively few measurements. **Spatial interpolation** also makes it convenient to animate a photo-realistic model with many points in it, by superimposing it on a **stick model** containing only a few points.

ODS Animation

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

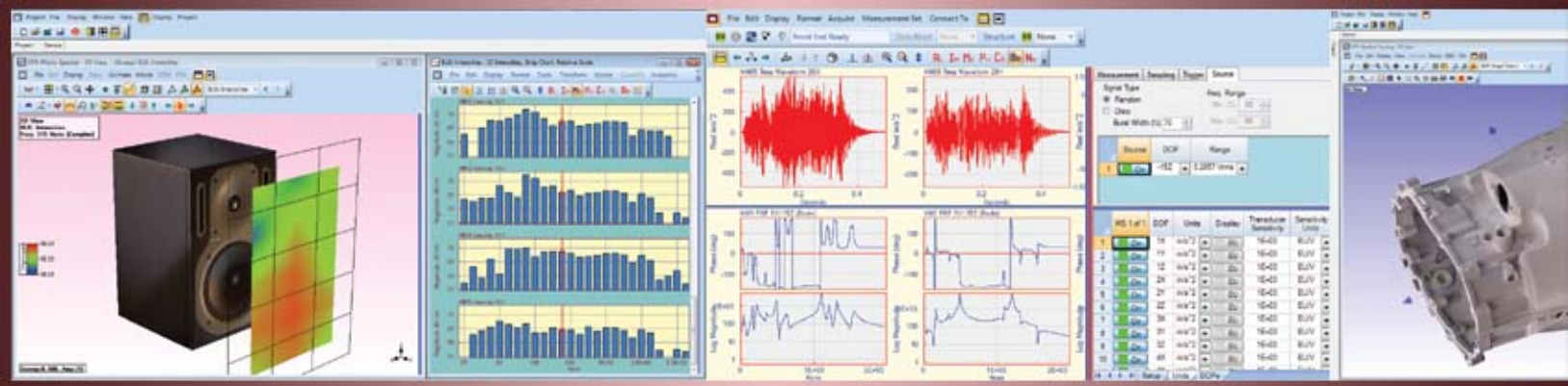
Time-based ODS animation sweeps a cursor through a set of time histories describing motions at multiple points and directions on a test article. You can stop the animation, back it up, and play it forward to observe in slow motion phenomena that may have taken place very quickly in real time.

With **frequency-based ODS** animation, you simply move the cursor to a frequency of interest in your data, and the ODS for that frequency is displayed. With this animation, you can observe resonant vibration as well as order-related forced vibration.

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

Documentation with Digital Movies™

With Digital Movies™, you can record any ME'scope animation in an AVI or WMV file. Digital Movies can be embedded in **PowerPoint** presentations, **Word** documents, or Internet pages, and played by simply clicking on them.



ME'scope Packages & Options

ME'scopeVES can be purchased in a variety of different packages. The basic package, **Visual ODS™**, contains all of the features needed to interactively draw 3D models, import measurement data, and interactively display shapes in animation. All of the other packages add extra capability options to **Visual ODS™**. Any option can also be added to any package.

Acquisition Options

With one of these options, you can directly acquire and post-process data from a third party data acquisition front end. An Acquisition window is added to ME'scopeVES, which is used to setup the front end hardware, acquire data, and calculate, display, and save both single-channel and cross-channel measurements.

The Acquisition window calculates a variety of time and frequency domain measurements, including Auto & Cross Spectra, Auto & Cross Correlations, FRFs, Coherences, and ODS FRFs. It is particularly useful for impact testing, where user interaction with data acquisition and post-processing is essential.

The Acquisition window is *connected* to a Structure window and a Data Block window. The Structure window is used to graphically indicate the location and direction of the next measurement. The Data Block window is used to accumulate measurements. Using these three windows, an entire test can be pre-defined, and ODS's and mode shapes viewed in animation, even before all measurements have been acquired.

Modal Analysis Options

Modal analysis is used to characterize resonant vibration in mechanical structures. 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 create excessive noise, and cause material fatigue and premature failure.

Each resonance has a specific "natural" or modal **frequency**, a modal **damping** value, and a **mode shape**. FRF-Based Modal **parameter estimation** (or **curve fitting**)

is used to estimate the modal parameters of a structure from a set of FRFs. ME'scopeVES has three Modal Analysis options; Basic Modal Analysis, Multi-Reference Modal Analysis, and Operational Modal Analysis.

Basic Modal Analysis

At the heart of this option is the ME'scope Polynomial method, a easy to use **Global MDOF** curve fitter. Global methods use multiple measurements to obtain the best estimate of modal frequency and damping. This curve fitter can be used extract modal parameters for multiple modes at the same time, even in regions of *high modal density* (many modes in a small frequency band). It can also extract *local modes* where the resonant vibration is confined to a local region of a structure.

The Polynomial method can also be used as a **Local** fitter, helping to overcome problems within the data such as transducer *mass loading* and other *non-stationary effects*. This option also includes **SDOF** methods, which are fast and easy to use for obtaining quick estimates of mode shapes.

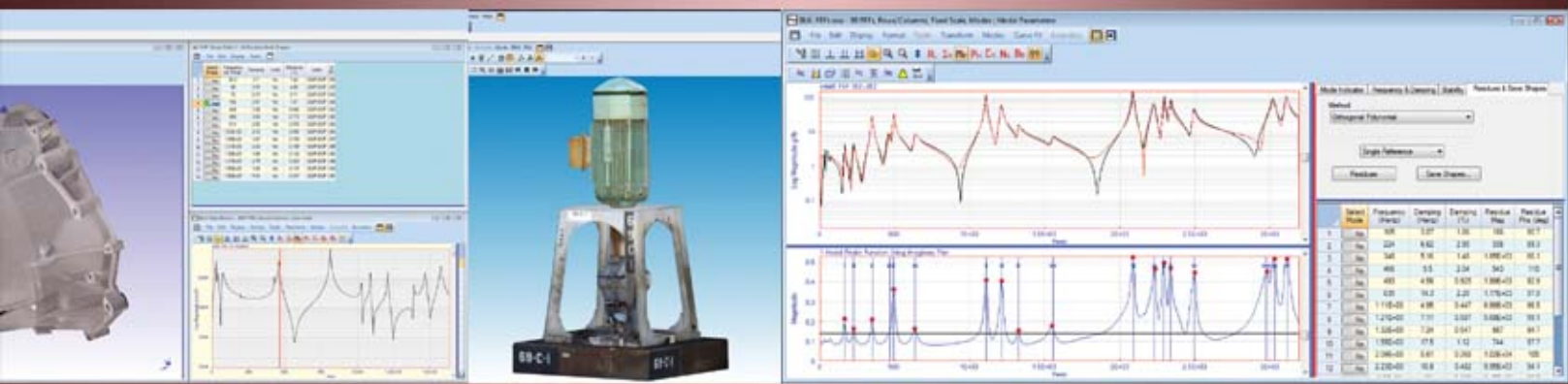
*ME'scopeVES contains a **Quick Fit** command that performs curve fitting in one simple operation. All curve fitting methods can be applied to **selected measurements**, and in user-controlled **cursor bands**.*

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 and counts its peaks. The number of peaks counted is used to define the model size for succeeding curve fitting steps.

Polynomial Curve Fitting

The Polynomial method estimates the polynomial coefficients of an analytical FRF model by curve fitting experimental data. The polynomial coefficients are then processed to obtain modal parameters. This method uses *extra numerator polynomial* terms to compensate for the residual effects of out-of-band modes. Curve fitting can then be done in frequency bands without incurring errors due to out-of-band modes.



Multi-Reference Modal Analysis

This option contains all of the features of the Basic Modal Analysis option, plus additional methods for curve fitting a multiple reference set of FRFs. Multi-reference curve fitting is useful for obtaining the modal parameters of *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).

This option contains a multi-reference version of the Polynomial method, plus three additional curve fitting methods; **Complex Exponential**, **Z-Polynomial**, and the patented **AF Polynomial** method. These three methods are designed to use a high order curve fitting model, so they can be used with a Stability diagram.

Stability Diagram

A Stability diagram is used when counting peaks on a Mode Indicator function cannot be done reliably. 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 then averaged and saved directly from the Stability diagram into a modal parameters spreadsheet.

Operational Modal Analysis (OMA) Option

When the excitation forces causing a structure to vibrate are not measured, then FRFs cannot be calculated, and modal parameters can only be extracted for **output only or operational measurements**. Nevertheless, a key advantage of OMA is that data is acquired under real world operating conditions.

This option contains all of the features of the Multi-Reference Modal Analysis option, plus special tools for curve fitting measurements obtained from **output only or operating data**. A common OMA measurement is a Cross spectrum which is calculated between two

acceleration signals, a roving and a reference (fixed) accelerometer. After a set of Cross spectra has been specially windowed, they can be curve fit using FRF-based curve fitting methods to obtain operating modal parameters.

Modal Assurance Criterion (MAC)

All of the Modal Analysis options contain the MAC calculation, which is used for numerically comparing a pair of shapes. 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. A value of 1.0 means that the two shapes are identical. MAC values are displayed in either a spreadsheet or a 3D Bar chart.

Signal Processing Option

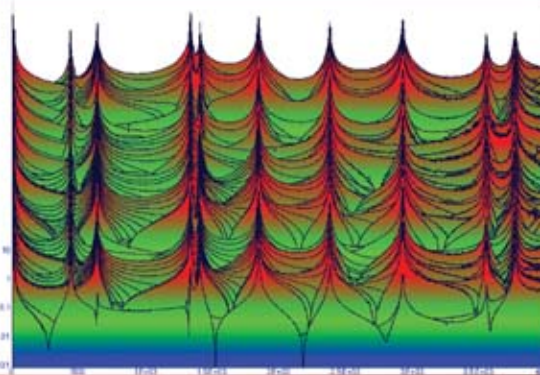
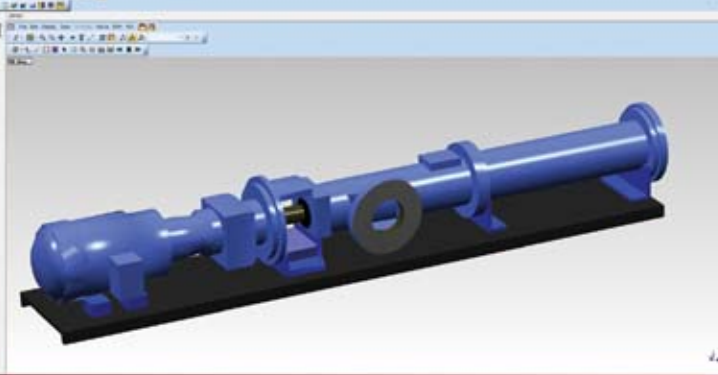
This option includes **FFT** commands that simultaneously transform all measurements in a Data Block window between the time and frequency domains. This makes it convenient to analyze data in either domain, and also display shapes from either domain.

The prime factor FFT in ME'scopeVES 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** measurement data between one Data Block and another. Measurements with dissimilar time or frequency axes are **interpolated** so that all data in a Data Block has the same time or frequency span.

Vibration data is acquired using different types of transducers; accelerometers which measure acceleration, lasers which measure velocity, and proximity probes which measure displacement. With this option, you can **integrate** or **differentiate** time or frequency waveforms or shapes between acceleration, velocity, and displacement units.

Various types of windows (**Notch, Band Pass, Force, Exponential, Interpolation, De-Convolution, Hanning, Flat Top**) can be applied to your data. Each of these windows is used for a different purpose, including removing noise or DC offsets, and reducing waveform leakage.



Modeling & Simulation Option

This option uses a Multiple Input Multiple Output (MIMO) dynamics model to calculate Inputs, Outputs, and Transfer functions. Each part of the model can be calculated from the other two.

Transfer functions can be calculated from multiple Input and Output time waveforms. Time domain windowing (Rectangular, Hanning, or Flat Top), linear or peak hold spectrum averaging, triggering, and overlap processing can be applied during Transfer function calculations. Ordinary Coherences are calculated for single Inputs, and **Multiple & Partial Coherences** are calculated for multiple Inputs.

Multiple Output time waveforms or frequency spectra can be calculated from multiple Input time waveforms or frequency spectra and Transfer functions. This option can also be used to calculate and display ODS's due to multiple sinusoidal Inputs at a single frequency.

Multiple Input time waveforms or frequency spectra can be calculated from multiple Output time waveforms or frequency spectra and Transfer functions. This capability can be used for **Force Path Analysis**.

Structural Dynamics Modification (SDM) Option

If a noise or vibration problem is due to the excitation of a resonance, the structure must either be isolated from the excitation sources or physically modified to reduce its vibration response levels. With this option, the effect of adding modifications to a structure on its modes, and hence its vibration levels, can be investigated.

SDM models structural modifications using **industry-standard FEA elements**. The FEA element library includes **springs, masses, dampers, 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 properties can be viewed and edited.

SDM uses the modification elements on the structural model together with the modes of the unmodified structure, to calculate the new modes of the modified structure. SDM can be used with either experimental or analytical modal data. Because it solves for the new modes so quickly, SDM can be used for **Modal Sensitivity** studies, where *thousands* of solutions are calculated and ranked for comparison.

Acoustics Option

This option post-processes and displays Acoustic Intensity, Sound Pressure Level (SPL), and Sound Power. It allows you to analyze vibro-acoustic problems by displaying both vibration and acoustic data together in the same animated picture.

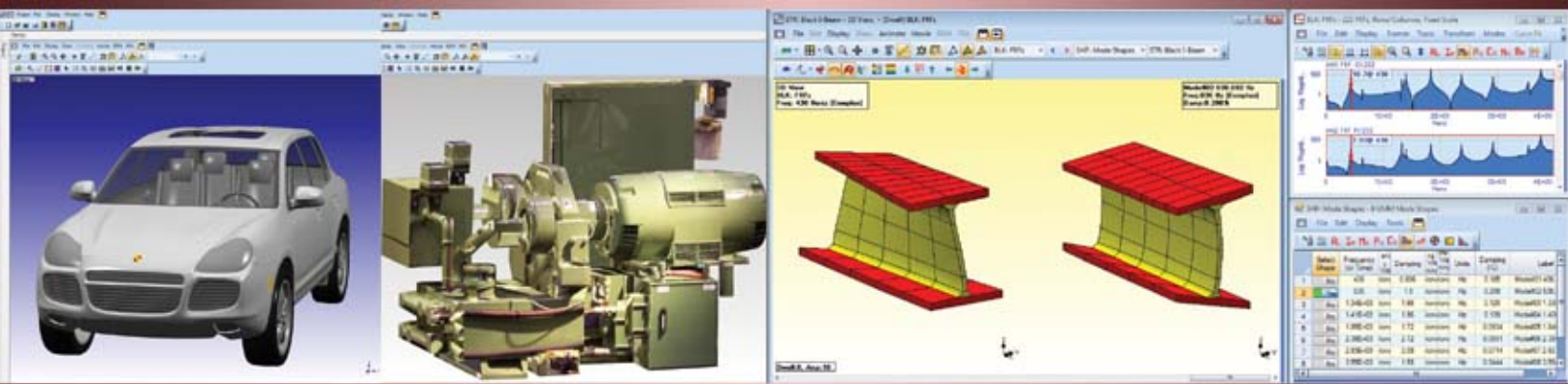
Acoustic Intensity is measured with a two or four channel acoustic probe and a multi-channel acquisition system. Each Intensity measurement is made either normal to an acoustic grid or surface, or in three directions (tri-axially) at each grid point.

Sound Power flow through an acoustic surface is calculated from Intensity data. Sound power is 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.

Rotating Machine Option

With this option, you can setup the rotating parts of a machine so that they rotate during animation. The speed of each rotating part is specified (in RPM), and its rotational speed is scaled to match the frequency of the shape being animated. The option is very useful for observing the effects of order related forces on the operating shapes of a machine.



Experimental FEA Option

This option allows you to construct an FEA model of your test structure and solve for its analytical mode shapes. The FEA model is constructed by adding **industry standard FEA elements** to the same 3D model that is used for displaying experimental shape data. The FEA element library includes the same elements used by the SDM option. Both a normal mode solver and a complex mode solver that includes modal damping are included.

By constructing an FEA model and solving for its analytical modes prior to a modal test, this option helps you determine proper transducer and exciter locations for the test. Following the test, you can compare experimental and analytical mode shapes (both graphically and numerically), which further validates your results.

The FEA model can also be used for **shape expansion**, where deflection shapes with many DOFs are calculated from experimental shapes containing only a few DOFs.

FEA Assistant

The FEA Assistant allows you to easily populate a 3D test model with FEA elements. You can start by populating the 3D model with only a few FEA elements, and then **mesh** it to add more elements for improved accuracy. The FEA Assistant contains both **materials** and **properties** libraries from which you can select pre-specified physical properties for the FEA elements.

FEA Model Updating Option

This option is used to update the physical properties of an FEA model so that its modes more closely match experimentally derived modal frequencies and mode shapes. The following FEA properties can be updated;

- Spring **stiffnesses**
- point **masses**
- **cross sectional** and **material** properties of rods, bars, and plate elements
- **material properties** of solid elements.

Since an FEA model usually has more points and different mode shape coordinates than an experimental model, this

option includes **point matching**, which matches points and mode shape coordinates on the FEA model with those on the experimental model.

This option uses the **SDM** method to evaluate all solutions within a user-defined solution space. This **exhaustive search** insures that the optimal solution will always be found. All solutions are ranked according to the error between the analytical and experimental modal parameters, and are easily examined by scrolling through both graphical and numerical displays of the results.

Programming Option

This option allows you to write programs which automatically execute a sequence of ME'scopeVES commands. Each program step executes a command in one of the windows in an open Project. If a command requires parameters which are normally entered into a dialog box, those parameters can be entered into a Parameters spreadsheet so that the command will be executed without user intervention.

Programming makes it easy to repeatedly process different sets of data using the same sequence of steps. This makes all of the processing power in ME'scopeVES available for production line qualification testing, and continuous structural and machinery monitoring applications.

Data Capacities

ME'scopeVES can store **thousands** of measurements, with **millions** of samples per measurement. 3D structure models can have **thousands** of points, lines, and surfaces. ME'scopeVES can also store **thousands** of shapes with thousands of DOFs per shape.

Internet User Support

Vibrant maintains a Internet site from which we provide fast and convenient support to all of our customers. The latest date code of ME'scopeVES software is available for downloading directly from our Internet site. Technical papers, application notes, and training videos are also available for downloading.

ME'scopeVES Packages

Visual ODS™

Interactive animated display of Operating Deflection Shapes, Mode Shapes, Acoustic Shapes, Engineering Data Shapes from time or frequency domain data

Visual ODS Pro™

Visual ODS™ plus the **Signal Processing** option

Visual Modal™

Visual ODS Pro™ plus the **Basic Modal Analysis** option

Visual Modal Pro™

Visual Modal™ plus the **Multi-Reference Modal Analysis and Dynamics Modeling & Simulation** options

Visual OMA™

Visual Modal Pro™ plus the **Operational Modal Analysis** option

Visual SDM™

Visual Modal™ plus the **Structural Dynamics Modification** option

Visual SDM Pro™

Visual Modal Pro™ plus the **Structural Dynamics Modification** option

Visual Acoustics™

Visual ODS™ plus the **Acoustics** option

Visual Vibro-Acoustics™

Visual Modal™ plus the **Acoustics** option

Visual Vibro-Acoustics Pro™

Visual Modal Pro™ plus the **Acoustics** option

Visual Experimental FEA™

Visual Modal Pro™ plus the **Experimental FEA** option

Visual FEA Model Updating™

Visual SDM Pro™ plus the **FEA Model Updating** option

Visual STN™

Visual ODS™ plus **all ME'scopeVES options** (except Local Language & Acquisition options)



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ME'scopeVES is compatible with Windows XP SP2, Windows Vista and Windows 7, either x86 (32 bit) or x64 (64 bit) systems.

ME'scopeVES 5.0TM Features

3D Structure Model

- 3D wire frame, surface, solid or photo-realistic model used for animating shapes.
- Drawing objects include points, lines, surfaces, and substructures.
- Surfaces with color fill, transparency, and surface textures.
- Photo-realistic surface textures.
- Lighted surfaces.
- Quad View (front/back, top/bottom, left/right, and 3D view).
- Interactive zoom, pan, rotation, and perspective distance.
- Interactive drawing tools. (select, drag, resize, rotate, and stretch objects)
- Drawing Assistant for rapidly building models using rectangular, cylindrical & spherical substructures. (includes re-size, number of points, position, revolve, extrude, library of pre-defined substructures)
- Cut, Copy & Paste of drawing objects.
- Measurement coordinate axes (rectangular, cylindrical, spherical & machine), graphically oriented at each point.
- Interactive point numbering.
- Spreadsheets for editing drawing object properties.
- Print & Copy to Clipboard.

Measurement Data

- Imports disk files from over 60 multi-channel data acquisition systems, analyzers, recorders & collectors.
- Imports & exports UFF, ASCII Spreadsheet, MATLAB, DADiSP & MS WAV file formats.
- Displays a Data Block of time or frequency domain measurements.
 - Auto Correlation, Cross Correlation,
 - Impulse Response Function (IRF)
 - Fourier Spectrum (FFT of time waveform),
 - Auto & Cross Spectrum, Power Spectral Density (PSD)
 - Frequency Response Function (Response / Force),
 - Transfer Function (Output / Input)
 - Transmissibility (Roving response / Reference response)
 - Coherence (Ordinary, Multiple & Partial)
 - ODS FRF (Roving Auto Spectrum & phase relative to a Reference)
 - Acoustic Intensity, Sound Pressure Level
- Measurements in Rows & Columns (up to 10 by 10 with scrolling)
- Measurements in Strip Chart (up to 10 with scrolling)
- Measurements in Overlay, Cascade & Color Map (unlimited number)
- Real part, Imaginary part.
- Magnitude (Linear, Log, dB), Phase.
- CoQuad (Real & Imaginary), Bode (Magnitude & Phase),
- Nyquist (Real vs. Imaginary).
- Horizontal & vertical axis zoom with scrolling.
- Auto, relative & fixed vertical axis scaling.
- Maximize vertical axis display.
- Linear & Log horizontal axis.
- Play the sound of each measurement.

- Line, Peak & Band Cursors.
- Grid lines, DOFs, units & cursor values displayed on graph.
- Spreadsheets for editing measurement properties.
- Print & Copy to Clipboard.
- Window background, fill under graph & text colors.

Shape Animation

- Animation in Quad View or Single View.
- Interactive animation from a time or frequency domain Data Block, using line, peak, or band cursor.
- Interactive animation from a Shape Table.
- Comparison animation of shapes from two sources (Data Blocks or Shape Tables).
- Modal Assurance Criterion (MAC), numerical shape comparison.
- Interpolation of shape data for un-measured DOFs using data from nearby measured points.
- Speed & amplitude controls.
- Animation of scalars (temperatures, pressures, sound power, etc.).
- Animation of vectors (translations, rotations, acoustic intensity).
- Deformed & un-deformed structure display.
- Shape contour color map (including nodal lines).
- Display of shape values at selected points.
- Animation with arrows.
- Animation with persistence.
- Animation with orbits.
- Animation in selected (X,Y,Z) directions.
- Auto, relative & fixed shape scaling.
- Animation from a selected reference in multiple reference data.
- Measured, interpolated & fixed DOFs indicated on the model.
- Digital Movies record animation in an AVI or WMV file.

Signal Processing

- Simultaneous FFT & IFFT on all measurements in a Data Block.
- Integration, differentiation & remove DC.
- Cut, Copy & Paste of measurements between Data Blocks.
- Notch & Band windows for removing unwanted data.
- Force & Exponential windows for removing noise & leakage.
- Interpolation window for smoothing data.
- Fourier Spectra, Auto Spectra, PSDs from time waveforms. Spectrum averaging includes windowing (Rectangular, Hanning, Flat Top), triggering, linear or peak hold averaging, overlap processing.
- ODS FRFs from time waveforms, or Auto & Cross Spectra.
- Order Tracked ODS's from Order Tracked data.
- Block Math functions (scale, add, multiply, conjugate, invert, etc.)
- Linear (RMS) to Power (MS) units conversion.
- Peak, Peak to Peak, RMS scaling.
- Measurement statistics (min., max., mean, RMS, power).

ME'scopeVES 5.0TM Features

Basic Modal Analysis

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

Multi-Reference Modal Analysis

- Basic Modal Analysis features plus curve fitting of Multiple Reference measurements.
- CMIF (Complex Mode Indicator Function) & MMIF (Multivariate Mode Indicator Function). Both indicate closely coupled modes & repeated roots.
- MDOF AF Polynomial curve fitting.
- MDOF Complex Exponential curve fitting.
- MDOF Z-Polynomial curve fitting.
- Stability diagram. Graphical display of poles (frequency & damping) for a range of model sizes.
- Shape Complexity plot (including shape normalization).
- Shape DOF Magnitude ranking.

Operational Modal Analysis

- Multi-Reference Modal Analysis features plus curve fitting of Output Only measurements.
- DeConvolution windowing.
- Interpolation to increase time or frequency resolution.
- Unit modal mass scaling of operating mode shapes.

Modeling & Simulation

- Multiple Outputs (time or frequency waveforms) from multiple Inputs.
- Multiple Inputs (time or frequency waveforms) from multiple Outputs.
- Sinusoidal ODS (from multiple sinusoidal Inputs.)
- Multiple Reference Transfer Functions (including Ordinary or Multiple & Partial Coherences) from multiple Input & Output time waveforms, or Auto & Cross spectra.

Direct Data Acquisition

- Connects to third party multi-channel acquisition front ends.
- Displays acquired time domain and calculated frequency domain waveforms.
- All front end channel parameters setup in a spreadsheet.
- Scope mode for real time display of acquired time domain waveforms.
- Next measurement location indicated on a connected structure model.
- Measurements accumulated into a connected Data Block.
- Triggering & accept/reject controls for impact testing.
- Force & exponential windows for impact testing.

- Outputs burst random & burst chirp shaker signals (up to 6 signals).
- Multiple Reference FRFs, Ordinary or Multiple & Partial Coherences.
- Auto & Cross Spectra, ODS FRFs.
- Spectrum Averaging, including windowing (Rectangular, Hanning, Flat Top, Force, Exponential) triggering, linear or peak hold averaging, overlap processing.

Structural Dynamics Modification

- Interactive addition of modification FEA elements to a structure model.
- Point masses, translational or rotational springs & dampers.
- Rod & beam elements.
- Triangular & quadrilateral plate elements.
- Tetrahedron, prism & brick solid elements.
- FEA material & geometric property libraries.
- Spreadsheets for editing FEA element properties.
- Modal sensitivity. Scrolling of numerical & graphical solutions from user-defined solution space.
- Substructuring (couple two or more structures using FEA elements).
- Tuned absorber (attach a mass, spring, damper absorber to a structure).

Acoustics

- Animated display of acoustic & vibration data.
- Narrow band or 1/1, 1/3rd, 1/12th, 1/24th octave band measurements.
- Measurements in Linear, Log, dB, dB Reference.
- Acoustic Intensity (calculated from Cross Spectra or time domain data).
- Sound Power calculated from Intensity data.
- Convert 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.

Experimental FEA

- FEA Assistant. Adds FEA elements to a geometric model.
- FEA material & geometric property libraries.
- Calculates Normal Modes (up to 20,000 DOFs).
- Calculates Complex Modes with damping (up to 2000 DOFs)
- Shape Expansion. Calculates un-measured shape DOFs using experimental shape data.

FEA Model Updating

- Point matching between FEA & EMA models.
- DOF matching between FEA & EMA mode shapes.
- FEA properties updated so FEA frequencies & mode shapes match EMA modal data.
- Stiffness, mass, cross sectional area, inertia, plate thickness, material properties can be updated.
- Scrolling of numerical & graphical solutions from user-defined solution space.
- Calculates mode shapes for the updated FEA model.
- Imports & exports FEA models in NASTRAN, ANSYS, FEMAP, I-DEAS, formats.