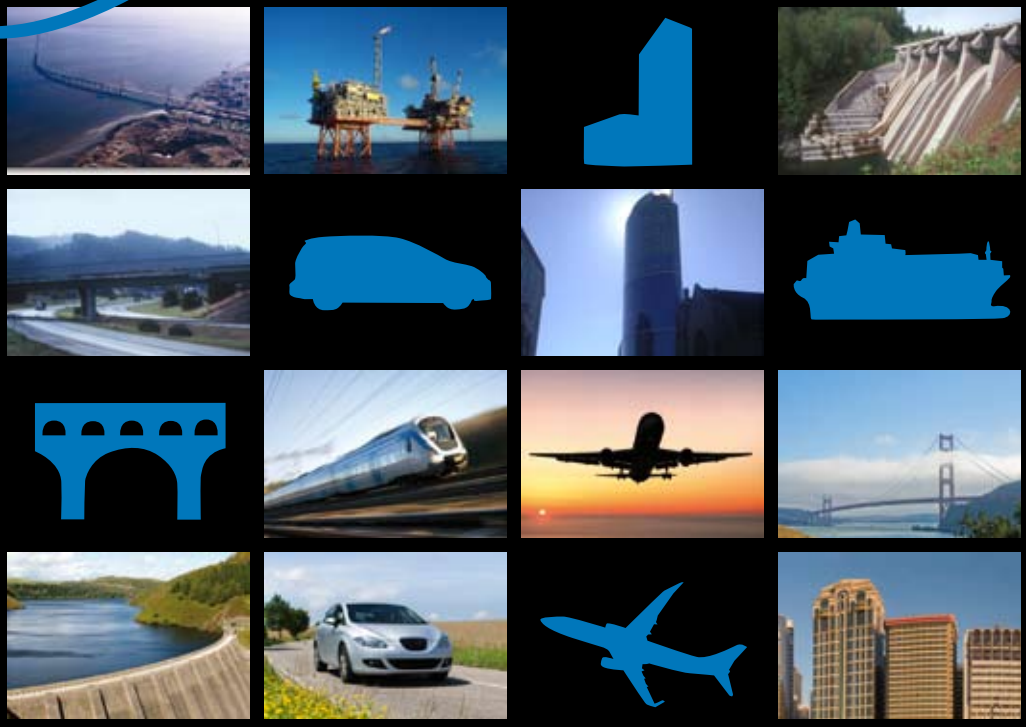
Structural Vibration Solutions A/S

# SVS



# Structural Vibration Solutions A/S

Structural Vibration Solutions A/S is a supplier and developer of software for Operational Modal Analysis.

It is our mission to be the worlds leading provider of Operational Modal Analysis solutions and to follow our vision to develop Structural Vibration Solutions that every engineer can use.
Structural Vibration Solutions A/S was founded on the 1st of March 1999 as a spinoff company from Aalborg University in Denmark.

In 2009 we celebrate our 10 years anniversary with clients and users all around the globe. Our software is today used by mechanical engineers for modal analysis of operating machinery and components and by civil engineers for ambient modal analysis of large structures like bridges and buildings.

Our patented software products are unsurpassed in the world. Our customers include United Launch Alliance, Siemens AG ,Wölfel Beratende Ingenieure GmbH & Co. KG, Fraunhofer LBF, Weidlinger Associates Ltd. , Bureau Veritas, MARIN and Ramboll Oil & Gas among others.

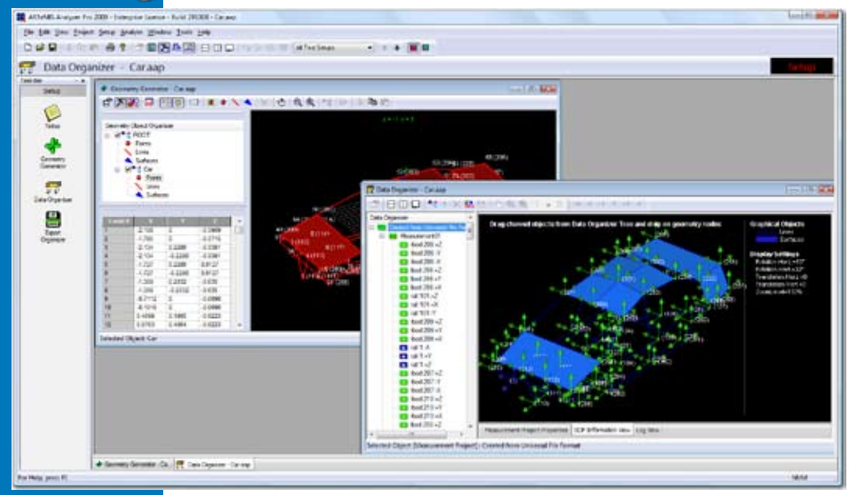
Since the beginning, we have collaborated with some of the leading companies and research and development institutes within our field. Some of theese are Brüel & Kjær Sound & Vibration Measurement A/S in Denmark, University of British Columbia Earthquake Engineering Research Facility in Canada, Dynamic Design Solutions NV in Belgium and TEAC corporation in Japan.

We are confident that by understanding our customers and partners challenges and needs, and by responding with innovative solutions, we will continue to be the leading provider of Operational Modal Analysis solutions in the world.

# ARTeMIS Analyzer Pro

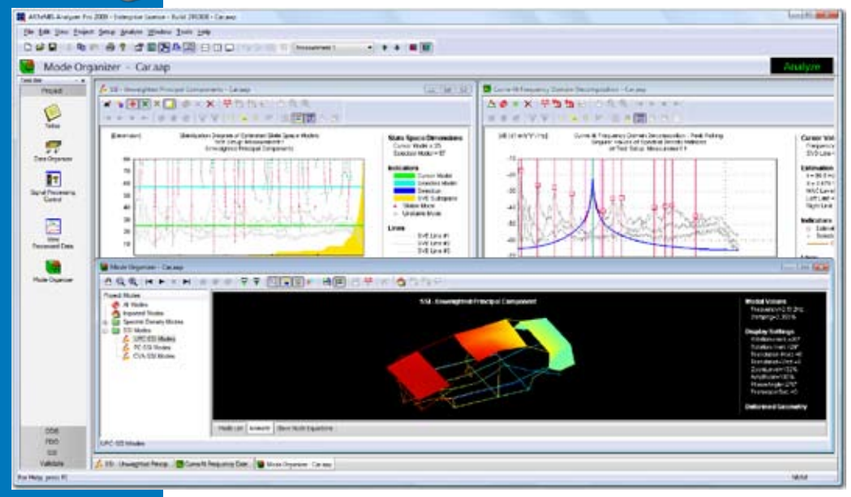
The Complete Software Package for Operational Modal Analysis and Operating Deflection Shapes


...and manage your tests





...your data and validate the results




## Features

### Test Notes

Keep your important notes from the field tests together with the measured data and results. Write them here and embed your digital photos or other relevant information here as well.

### Geometry Generator

Create your test geometry graphically or import, and optionally modify, an existing geometry.

### Data Organizer

Organize your measurements in logical test setups using graphical drag and drop. Upload your measurements through one of the many data file formats supported.

### Export Organizer

Save the test geometry, measured data and the sensor locations and directions to e.g. Universal File Format.

### Operating Deflection Shapes

Use the frequency and time domain Operating Deflection Shapes (ODS) editors to study the overall vibration pattern either at a certain frequency or over a specific interval of time.

### Frequency Domain Decomposition Techniques

Use the patented Frequency Domain Decomposition (FDD) technique for fast and extremely user-friendly modal analysis. With a single click on a button, it instantly gives you mode shapes and natural frequency estimates of even very large and complex systems.

The Enhanced Frequency Domain Decomposition (EFDD) takes the FDD technique one step further, allowing accurate estimation of mode shapes, natural frequencies and damping ratios based on the estimation of the Single-Degree-Of-Freedom, correlation function.

The Curve-fit Frequency Domain Decomposition (CFDD) simplifies operations even more via utilization of a frequency domain single-degree-of-freedom curve fitter.

**ARTeMIS Analyzer Pro makes testing easier and more productive.**

ARTeMIS Analyzer Pro is a result of combining all the well known and reliable features from the ARTeMIS software. With this all-in-one software package for Operational Modal Analysis (OMA) and Operating Deflection Shapes (ODS) Analysis, you obtain validated modal parameters directly from the raw measurements without the use of other tools.

The task of Operational Modal Analysis has never had a more simple and reliable solution.

### Stochastic Subspace Identification Techniques

Choose between three data-driven Stochastic Subspace Identification (SSI) techniques that estimate the modal parameters directly from the measured time history measurements. These are the Unweighted Principal Component, Principal Component and Canonical Variate Analysis techniques. The SSI techniques incorporate effective ways of dealing with noise. As a result, modal parameter estimation is the most accurate commercially available today.

### Modal Validation

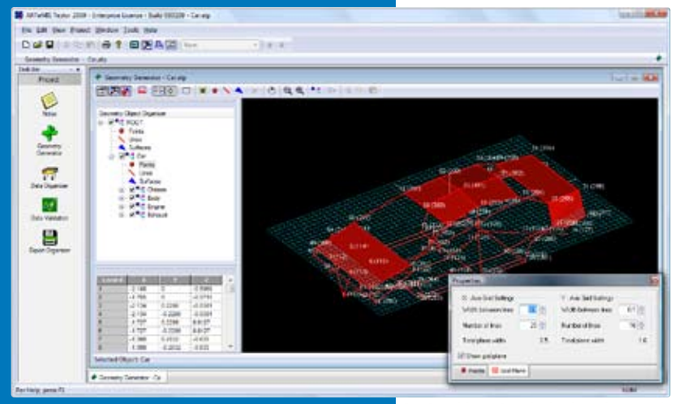
Use the extensive collection of powerful graphical modal validation tools. 3D and Quad View animations, overlaid or difference animations of multiple modes, Modal Assurance Criterion (MAC) diagrams and document it all using copy/paste or graphical files such as JPEG or AVI. Finally, you can export the modal results using e.g. the Universal File Format.

# ARTeMIS Testor

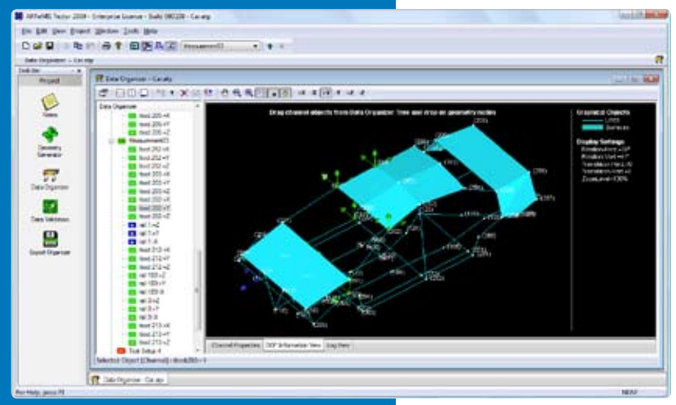
Software for Test Planning and Data Management

## The versatile tool for test planning and data management

ARTeMIS Testor is the natural support tool for any person doing Operational Modal Analysis. No matter if you are using the ARTeMIS Extractor for modal analysis or any other software, the ARTeMIS Testor is the natural choice that provides you with the possibilities that you need. If you need a user friendly, powerful test management package to handle your test data in a simple, but very effective and flawless way, the ARTeMIS Testor is the right solution and the right choice.



Drawing can be done using the mouse or by entering information in tables using the keyboard or copy/paste operations.



Assign DOF information (measurement nodes and directions) for imported measurement channels using drag-and-drop on the test geometry or keyboard. Moving sensors are indicated with green arrows and reference channels with blue arrows.

## Major Features

### Geometry Generator

The Operational Modal Analysis made with ARTeMIS is geometry driven. Measurement channels in use have to be tied to a geometry node, and mode shapes and operating deflection shapes need a realistic test geometry for proper animation.

The Geometry Generator is designed to help you produce a realistic test geometry in a simple manner. Draw it from scratch or import an existing geometry using e.g. Universal File Format. The drawing is object orientated, enabling the design of complex structures using more basic sub-elements, each with its own grid plane and coordinate system. Drawing options are: Points, lines and triangular surfaces. Elements can be drawn using the mouse or by entering information in tables using the keyboard or copy/paste operations.

### Data Organizer

ARTeMIS is an open platform supporting many data file formats for input of the measured time series. If the file format includes DOF information about the sensor positions and directions, this will be used. If no DOF information is available, use the drag-and-drop features of the data organizer for easy DOF assignment.

The data organizer is capable of administrating multiple test setups where the sensors are moved over the structure from measurement to measurement, keeping a few sensors in fixed positions as references. If multiple test setups are used, the data organizer will automatically identify the reference sensors.

### Other Features

Notes: Keep your important test notes from the field tests together with the measured data and results and embed your digital photos or other relevant information.

Data Validation: Inspect the raw time series measurements or their spectral densities.

Export Organizer: Export the geometry, measurements and DOF information in either SVS Configuration File format, Universal File Format (ASCII and Binary), or directly to ARTeMIS Extractor by clicking on a button using OLE Automation.



# ARTeMIS Extractor

The State-of-the-Art Software for Operational Modal Analysis

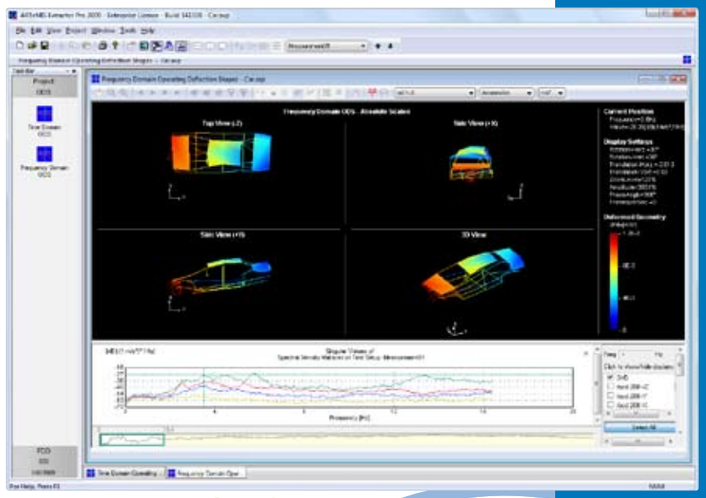
## Major Features

- In-situ testing of a structure – True boundaries and excitation forces even harmonics
- Test during normal service state – No interruption needed - increased productivity
- Use operational forces - No artificial excitation needed
- Modal parameter results describe the true service state of the structure
- Can be used on extremely small or large structures – Size does not matter
- Scalable software – Unlimited amount of sensors and data points
- Handles multiple test setups (rowing sensors) and multiple reference points – Increased mode shape accuracy
- Fast and automatic results – Saves time
- User friendly – Have your first modal parameters estimated in a matter of minutes
- Versatile – If you can measure the vibration, ARTeMIS will always give you the answer
- Open - Major data input file formats supported
- Outstanding results – Validated output based on several parallel modal analysis – Accuracy
- Results can be used directly by e.g. FE updating software solutions.

### Pro, Handy and Light Versions

ARTeMIS Extractor is available in three versions. The difference between the three versions is the number of available modal analysis techniques. All versions have the Operating Deflection Shapes features available. ARTeMIS Extractor Pro is the full version containing all six modal analysis techniques. ARTeMIS Extractor Handy contains all the frequency domain modal analysis techniques, and ARTeMIS Extractor Light contains the Frequency Domain Decomposition (FDD) technique.

They all use the same software platform, which means that there is no difference in what data formats that are supported, or the amount of channels and data points that can be used. Projects generated are also the same, so it is always possible to upgrade from e.g. the Light version to the Pro.



Frequency Domain Operating Deflection Shapes

## The preferred software for the last decade

As the state-of-the-art software platform, used as the reference in Operational Modal Analysis for the last decade, ARTeMIS Extractor is still the most powerful and versatile tool for Operational Modal Analysis on the market today. Its ability to produce validated modal parameter estimates, based on parallel analysis of up to six different analysis techniques, makes it the natural choice in mission critical applications.

## Operating Deflection Shapes

ARTeMIS Extractor includes both Time Domain ODS and Frequency Domain ODS allowing the determination and visualization of deflection shapes as a function of time or for specific frequencies. ODS analysis is very beneficial in combination with Operational Modal Analysis as it determines and visualizes the combination of the actual forcing functions acting on the structure and the dynamic behavior of the structure.

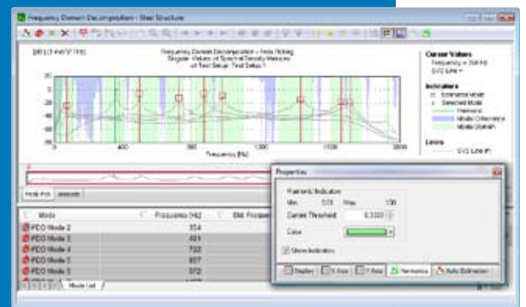
Results can be shown as displacement, velocity or acceleration in SI, Imperial or user-defined units (Time Domain ODS). Decimation and various filters (low-pass, band-pass, band-stop and high-pass) can be applied, in Time Domain ODS, to frequency limit the analysis.

# ARTeMIS Extractor

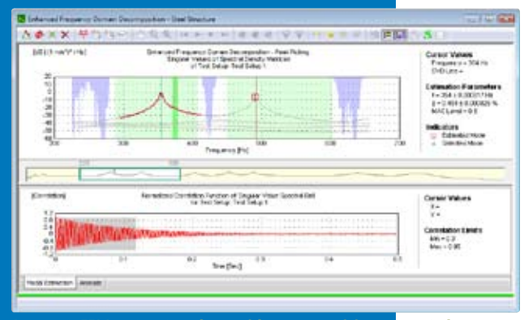
Operational Modal Analysis Techniques

### Frequency Domain Modal Analysis

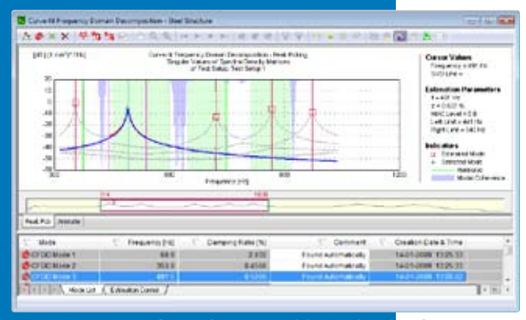
ARTeMIS Extractor includes up to three frequency domain modal analysis techniques derived from the patented Frequency Domain Decomposition technology utilizing the singular value decomposition of the esti-mated spectral densities of the measured response.



Frequency Domain Decomposition with automatic peak-picking and harmonic detection enabled.



Automatic EFDD estimation of natural frequency and damping ratio from SDOF correlation function presence of harmonics.



Automatic CFDD curve-fitting of auto spectral density directly in frequency domain.

## Frequency Domain Modal Analysis

### The techniques available are:

- Frequency Domain Decomposition – FDD
- Enhanced Frequency Domain Decomposition – EFDD
- Curve-fit Frequency Domain Decomposition – CFDD.

All three techniques are based on peak-picking in frequency domain, using either automatic picking or manual picking using the mouse. Once picked, the mode shapes are ready for immediate anima-tion. The techniques are all specially designed to account for the presence of harmonics in case of rotating structural parts or other sinusoidal excitation.

### Frequency Domain Decomposition - FDD

The FDD technique is the most user-friendly and intuitively easiest method available on the market. Pick out the resonance peaks of the modes by a click of the mouse, and FDD return robust natural frequency estimates as well as high quality mode shapes, no matter how complicated the tested structure is.

Available in all versions of ARTeMIS Extractor.

### Enhanced Frequency Domain Decomposition – EFDD

From a user point of view the EFDD works just like the simple and efficient peak-picking FDD. How-ever, based on a Modal Assurance Criterion (MAC), EFDD identifies the top part of the auto-spectral density of the Single-Degree-Of-Freedom (SDOF) system of the picked mode. By transforming the auto-spectral density SDOF function to a time domain correlation function by inverse FFT, the natural frequency and damping ratio are obtained by accurate least squares estimation in time domain. Mode shapes are obtained by averaging directly in frequency domain using the identified part of the auto-spectral function and the corresponding singular value decomposition of the spectral matrices.

Available in ARTeMIS Extractor Handy and ARTeMIS Extractor Pro.

### Curve-fit Frequency Domain Decomposition – CFDD

CFDD utilizes the MAC criterion in the same way as EFDD to find the top part of the auto spectral density function of the SDOF system of a mode. The auto-spectral function is then the curve-fitted directly in the frequency domain using an SDOF curve-fitter to produce high-quality estimates of the natural frequency and damping ratio. This makes the CFDD an extremely easy technique, as no time domain displays are needed. The mode shape is estimated in the same way as in EFDD.

Available in ARTeMIS Extractor Handy and ARTeMIS Extractor Pro.

## Time Domain Modal Analysis

### The techniques available are:

- Unweighted Principal Component – UPC
- Principal Component – PC
- Canonical Variate Analysis – CVA.

The SSI techniques estimate the parameters of a range of models – so-called stochastic state space realizations. From these estimated parameters, the modal parameters are extracted directly using a modal decomposition. The model that gives the best estimates of the modal parameters is selected from a stabilization diagram, making it an easy task to identify all physical modes.

The SSI techniques can work with closely spaced and repeated modes with light or heavy damping. Since they are working in time domain there are no leakage bias or lack of frequency resolution. As a result, the modal parameter estimates are asymptotically unbiased. Further, as the SSI techniques are low model order estimators relying on linear least squares estimation, the statistical errors of the modal parameter estimates are extremely small.

The performance of the estimated models can be validated by displaying the synthesized spectra together with the spectra of the measurements, or by displaying the spectra of the prediction errors between measurements and models.

Available in all versions of ARTeMIS Extractor.

### Modal Validation

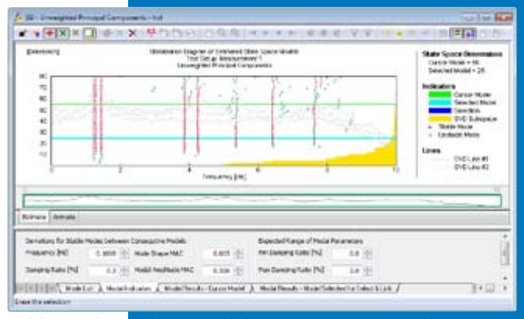
The Operational Modal Analysis can be validated by comparing modal results from the different estimation techniques, used for the same project. Results of different projects can also be compared, allowing an older analysis of a structure to be compared with a new analysis. External results may also be imported using Universal File Format, allowing e.g. numerical modes of a Finite Element model to be compared with experimentally obtained modes.

### Major validation features are:

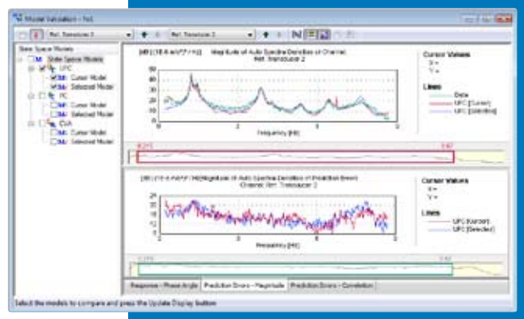
- Overlaid animation of mode shapes
- Difference animation of mode shapes
- Side-by-side and top-bottom animation of mode shapes
- 3D and table read-out of the Modal Assurance Criterion (MAC).

### Time Domain Modal Analysis

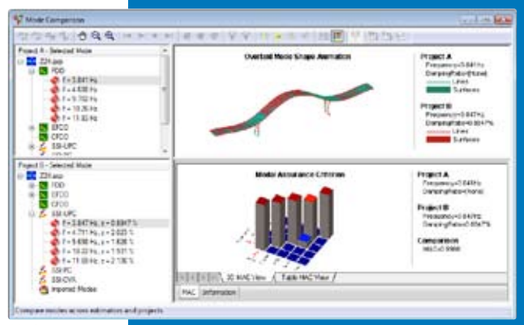
ARTeMIS Extractor Pro includes three different types of the data-driven Stochastic Subspace Identification (SSI) time domain techniques. These techniques estimate the modal parameters directly from the raw measured time series. The SSI techniques incorporate effective ways of dealing with noise. As a result, the modal parameter estimations are the most accurate commercially avail-able today.



Stabilization diagram showing stabilized modes in red. Even closely spaced modes are estimated with a high accuracy.



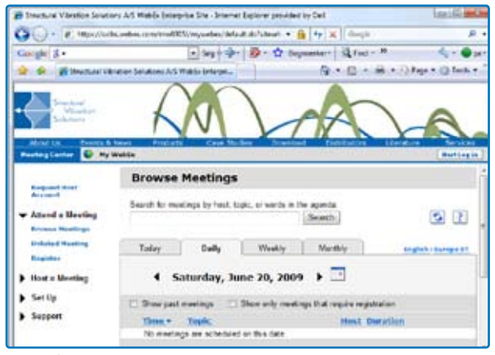
Validation of two SSI models



Mode comparison between a set of FDD modes and a set of SSI-UPC modes. Overlaid mode animation and Modal Assurance Criterion.

# Artemis Services

SVS Website www.svibs.com




Free Webinars

## ARTeMIS Demo Download

Structural Vibration Solutions A/S offer all to download a fully functional 30-day evaluation version of the ARTeMIS software from our website www.svibs.com for free. This allows you to experience the fantastic world of ARTeMIS software yourself.

## ARTeMIS Customer Service

Structural Vibration Solutions A/S offer all our customers and end-users the possibility to sign up for a Service Agreement. You subscribe to this service agreement for one year at a time, starting from product delivery date or the date of expiration of a previous service agreement. The service agreement covers:

- A major software update at least once a year, covering new features as well as keeping up to date with current operating systems
- Regular software maintenance
- Day to day technical support either by email or phone
- Internet support site with Frequently Asked Questions
- Service can be signed up for one year or more
- Notification of service expiration date one month before
- Free seats at SVS Webinar User Training Course which will be held minimum 5-6 times per year.

## ARTeMIS Update

It's not too late. Our customers always have the possibility to get an upgrade to the latest version of an existing software program or to "exchange" a smaller version to a bigger version. Please contact us for further information.

## SVS Webinars

On www.svibs.com you can sign up for our Webinars. Our software is presented and broadcasted via the web to potential users. The webinars are scheduled and presented about 5-6 times per year. They have a duration of 1-1½ hour, and participation is free of charge. All you need is a PC with a compatible internet browser.

We are also pleased to offer you a 1-on-1 webinar for a private assessment of how the ARTeMIS software works and will be able to add value to your company. Please contact us for more details.

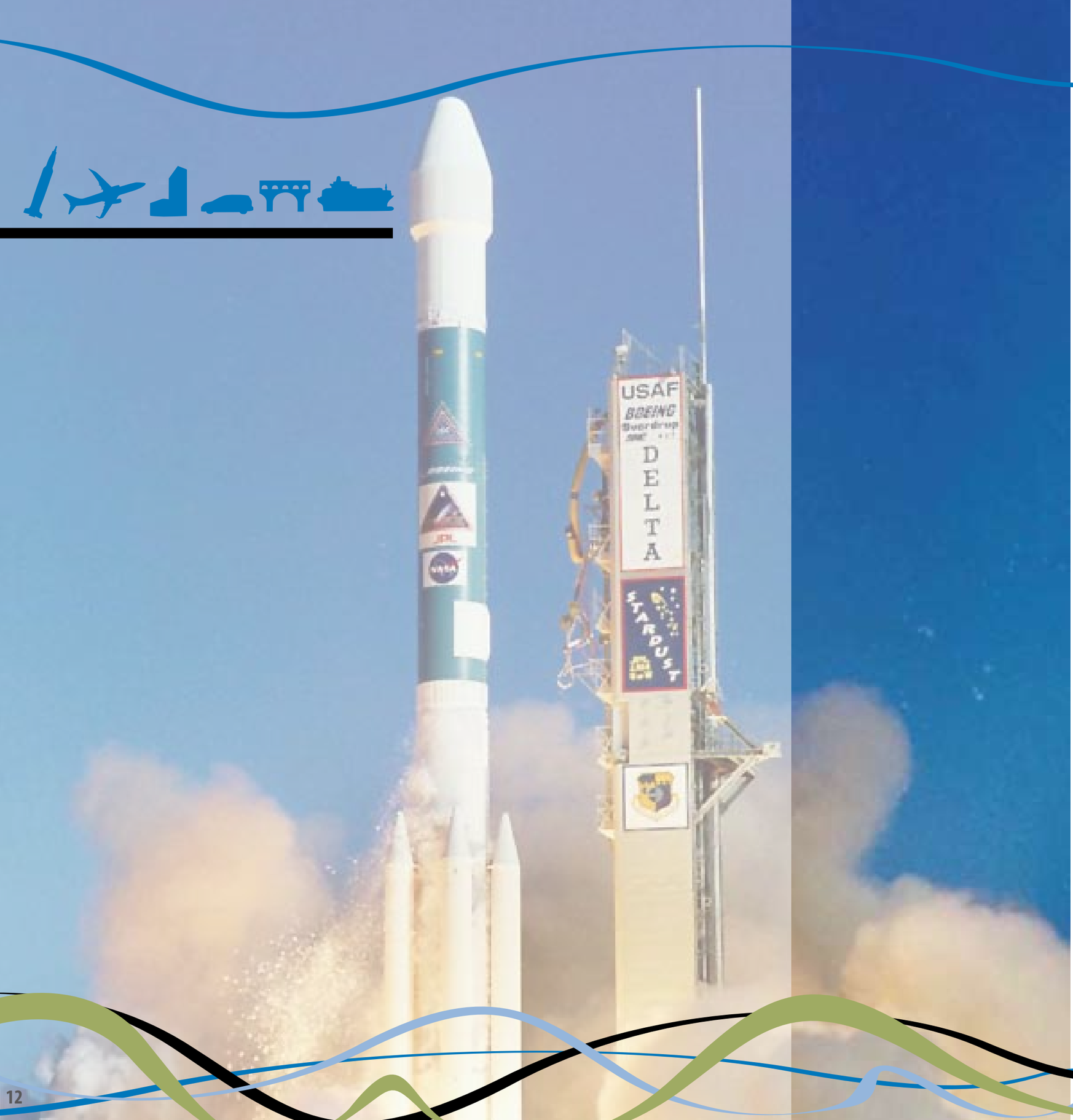


# ARTeMIS Family Overview

## Why ARTeMIS?

- In-situ testing - True boundaries
- Natural enviroment - Trie excitation forves, even harmonics
- Test during normal service state - No interruption needed
- Use operational forces - No artificial excitation needed
- Can be used on extremely small or large structures - Size does not matter
- Unlimited numbers of sensors and data points
- Fast and automatic results
- Versatile - If you can measure the vibration - ARTeMIS will always give you the answer
- Major data input file formats supported
- Outstanding results - Validated output based on several parallel analysis
- Results can be used directly by FE updating software solutions
- State-of-the-Art software - Used many places world-wide as reference in Operational Modal Analysis
- User friendly, simple & accurate.

| The ARTeMIS Product Family | ARTeMIS Testor | ARTeMIS Extractor Light | ARTeMIS Extractor Handy | ARTeMIS Extractor Pro | ARTeMIS Analyzer Pro |
|---|---|---|---|---|---|
| Test Notes | o | o | o | o | o |
| Geometry Generator | o | | | | o |
| **Data Input / Output** | | | | | |
| - Organizer - Test Planning and DOF Assignment | o | | | | o |
| - Organizer - Measurements File Upload | o | | | | o |
| - Organizer - View DOF information | o | o | o | o | o |
| - Export Organizer | o | | | | o |
| | | | | | |
| **Operating Deflection Shapes** | | | | | |
| - Frequency Domain - ODS (FODS) | | o | o | o | o |
| - Time Domain - ODS (TODS) | | o | o | o | o |
| | | | | | |
| **Frequency Domain Modal Analysis** | | | | | |
| - Frequency Domain Modal Analysis - FDD | | o | o | o | o |
| - Enhanced Frequency Domain Decomposition - EFDD | | | o | o | o |
| - Curve-fit Frequency Domain Decomposition - CFDD | | | o | o | o |
| | | | | | |
| **Time Domain Modal Analysis** | | | | | |
| - Stohastic Subspace Identification - SSI-UPC | | | | o | o |
| - Stohastic Subspace Identification - SSI-PC | | | | o | o |
| - Stohastic Subspace Identification SSI-CVA | | | | o | o |
| | | | | | |
| Modal Validation | | o | o | o | o |
| Mode Organizer | | o | o | o | o |
| Seamless Switch Between Setup and Analyze modes | | | | | o |




# The Idea of Modal Analysis

Modal analysis is the process of estimating modal parameters from vibration measurements obtained from a structure. Modal parameters of a structure include mode shapes, natural frequencies and damping ratios of each mode that influence the response of the structure in a frequency range of interest.

## An Old and Well-Proven Idea

Traditionally, experimental modal analysis has been carried out by curve-fitting a model to the Frequency Response Function relating measured excitation forces to the measured vibration response. The technique has been applied successfully for several decades.

## Why Operational Modal Analysis

Traditional experimental modal analysis techniques fail to give accurate results if some or all of the excitation, giving rise to the measured vibration response, cannot be measured. In this case, the Frequency Response Function includes information not solely related to the structure tested, causing the curve-fitting algorithms to fail. A well-known problem of this type is rotating machinery, where the harmonic excitation has to be shut down before carrying out a traditional modal analysis. Another problem is large civil engineering structures subjected to various ambient excitation forces.

## The Idea of Operational Modal Analysis

Operational Modal Analysis is capable of providing the modal parameters in a frequency range of interest and purely on the basis of measured vibration response. All modes being excited by the operating excitation forces can be determined.

## Benefits of Operational Modal Analysis

Operational Modal Analysis can be performed without applying artificially measureable excitation forces and on measured vibration response obtained while rotating parts of a structure is running. This means that vibration testing becomes less time consuming and does not interfere with the normal operation of the structure. Further, the modal parameters determined are representative of the structures behavior under real operating conditions and boundaries.

## Operational Modal Analysis and Operating Deflection Shapes

Operational Modal Analysis is related to Operating Deflection Shapes in the fact that only vibration response measurements are required, and the measurement technique used is exactly the same. However, with Operational Modal Analysis, the actual modal parameters of the modes being excited by the operating excitation forces are determined, whereas Operating Deflection Shapes only reveal the mixture of modes at a given frequency or time.

# Technical Specifications

## System Requirements

ARTeMIS is a software platform designed for Microsoft Windows. To increase speed it makes use of mathematical libraries from Intel. The help system is based on the Microsoft Internet Explorer.

- Intel® 32-bit processor architecture
- Microsoft® 32-bit Windows XP or Windows Vista
- Microsoft Internet Explorer 7
- 128MB of RAM (256MB recommended)
- 500MB of available hard-disk space. Since the space requirement is heavily dependent on the ARTeMIS Extractor projects stored, 1 GB is recommended
- 1,024x768 screen resolution
- CD-ROM drive or internet connection required for installation
- Internet connection or email system required for first time activation.

## Geometry Generator – Analyzer and Testor

- Universal File Format (UFF or UNV extension)
  UFF data sets 15 (nodes), 2411 (nodes), 82 (trace lines) and 2412 (triangular plate elements)
- SVS Configuration File Format (CFG extension)
- Object orientated drawing enabling drawing of complex structures using more basic sub-elements, each with its own grid plane and coordinate system
- Drawing options are: Points, lines and triangular surfaces. Elements can be drawn using the mouse or by entering information in tables using the keyboard or copy/paste operations.

## Data Input– Analyzer, Testor and Extractor

- Universal File Format (UFF) ASCII as well as binary import of measured time series
- SVS Configuration File format and data files: Text (ASCI), SVS binary format, Header File Formats (TEAC HDR, GeoSIG GHF, Diadem, Kyowa), Kinemetrics Altus, MS Wave file format. In text file format data is stored as a matrix with measurement channels stored column by column
- OLE Automation, geometry, and measurement data transfer from all other software with OLE Automation support
- Factory implemented OLE Automation support for direct input from ARTeMIS Testor, Brüel & Kjær Modal Test Consultant and MATLAB
- Unlimited number of channels (tested with 300 simultaneously measured channels)
- Unlimited number of data points in each record
- Unlimited number of test setups
- Assign DOF information (measurement nodes and directions) for imported measurement channels using drag-and-drop (Testor and Analyzer only) on the test geometry or using the keyboard
- Automatic identification of reference channels when using multiple test setups
- Automatic updating of test geometry and DOF information when modifying geometry in the Geometry Generator (Testor and Analyzer only).

## Data Output– Analyzer and Extractor

- Copy/paste and print functions for all graphics and tables
- Modal results: Universal File Format (ASCII) including geometry, one or more modes in each file
- Modal results: SVS output files, one or more modes in each file (ASCII)
- Modal results: Interface to FEMtools updating software through UFF
- Animations: Export of AVI movie files to e.g.Windows Media Player or Microsoft Power Point.

## Data Output– Analyzer and Testor

- SVS Configuration File Format (CFG extension)
  Geometry and DOF information is written directly in this file along with references to the required measurment files. The measurement files can be saved in text file format (ASC extension), SVS binary format (BIN extension)
- Universal File Format (UFF extension)
  Geometry saved in UFF data sets 15 (nodes), 82 (trace lines) and 2412 (triangular plate elements)
- DOF information and measurements are saved in UFF data sets 58 (ASCII) or 58b (binary) time series format
- Geometry, DOF information and measurements can be transferred directly to ARTeMIS Extractor using OLE Automation by clicking a single button.

## Signal Processing – Analyzer and Extractor

- Decimation, 1-1000 times, digital anti-aliasing filter, cut-off at 0.8 times Nyquist frequency of decimated signals
- Filtering: low-pass, high-pass, band-pass, bandstop Butterworth, filter order 1-50 poles, arbitrary cut-off frequencies, test for filter stability
- Projection Channels. Specify if all cross information of the measurement channels should be used or only between fewer number of channels
- Spectral estimation using FFT and Welch's averaged periodogram method. Data segment length: radix-2 only limited by the amount of data, overlap: 66.7 %, window: Hanning. Estimates the full spectral matrix if the Projection Channel option is disabled
- Operating Deflection Shapes. Specify the type of data imported to ARTeMIS Extractor (displacement, velocity, acceleration, other) and specify the unit of the imported data to ensure correct units of the operating deflection shapes
- Common SSI input matrix estimation to be used in all stochastic subspace identification algorithms. Maximum state space dimension: Only limited by the available amount of data. Noise mode suppression through the use of the Projection Channel option
- Option for reloading original uploaded data
- Data Presentation of Test Setups: Spectral magnitude and phase, singular value decomposition of spectral matrix, average of full spectral matrix, average of diagonal elements of spectral matrix, coherence of spectral matrix, time / frequency contour diagram. Cursor read out on all curves
- Data Presentation of Reference Data: Spectral magnitude and phase, average of full spectral matrix, average of diagonal elements of spectral matrix, coherence of spectral matrix. Cursor read out on all curves.

## Operating Deflection Shapes– Analyzer and Extractor

- Time domain animation test setup by test setup of all frequency content
- Frequency domain animation of all test setups using multiple references shape estimation
- Unscaled or scaled animation using phased assigned spectrum with a specific reference
- Units (displacement, velocity, acceleration) and scaling specified by the user
- Graphical information on deflections of selected channels
- AVI movie creation of animations.

## Frequency Domain Modal Analysis – Analyzer and Extractor

- Method: Frequency Domain Decomposition
- User choices: Peak picking
- Frequency resolution: Defined by number of frequency lines in spectral density function
- Mode shape estimation: Immediate animation
- Damping: None
- Patent protected.

## Method: Enhanced Frequency Domain Decomposition

- User choices: Peak picking, MAC level for identification of spectral peak, time interval for identification of frequency and damping
- Mode shape estimation: Immediate animation, mode shape estimate improved by frequency domain averaging
- Frequency and damping estimation: Estimated from the correlation functions corresponding to identified spectral peak
- Detection of harmonics and removal of their influence from estimated modal parameters
- Patent protected.

## Method: Curve-fit Frequency Domain Decomposition

- User choices: Peak picking, MAC level for identification of spectral peak, frequency interval for identification of frequency and damping
- Mode shape estimation: Immediate animation, mode shape estimate improved by frequency domain averaging
- Frequency and damping estimation: Estimated directly from identified spectral peak
- Detection of harmonics and removal of their influence from estimated modal parameters
- Patent protected.

## Time Domain Modal Analysis – Analyzer and Extractor

- Basic Method: Data driven Stochastic Subspace Identification.
  User choices: Implementation: Unweighted Principal components, Principal Components and Canonical Variate Analysis
- Model orders: From one mode to the size defined by the common SSI input matrix
- Stabilization criteria: Natural frequency deviation, damping ratio deviation, mode shape MAC deviation, initial modal amplitude MAC deviation, all limits user defined
- Physical mode separation: Damping ratio limits are user defined
- Select and link: Modes from the models chosen from each test setup are selected and linked using snap functions and editing facilities
- Uncertainty estimation: In case of several test setups, the empirical standard deviation is calculated for natural frequencies and damping ratios
- Comparison: Estimated model vs. FFT based auto and cross-spectra of measurements
- Spectra and correlation functions of prediction errors between estimated model and measurements.

## Validation– Analyzer and Extractor

- Modal Assurance Criterion, (MAC) diagrams for comparison of mode shapes between same or different estimation techniques as well as between same or different projects
- Simultaneous animation of different mode shapes, side-by-side and overlapped
- Animation of differences between mode shapes
- Mode import facility using Universal File Format for comparison with e.g. FE modes.






# Product Family

| The ARTeMIS Product Family | ARTeMIS Testor | ARTeMIS Extractor Light | ARTeMIS Extractor Handy | ARTeMIS Extractor Pro | ARTeMIS Analyzer Pro |
|---|---|---|---|---|---|
| Test Notes | o | o | o | o | o |
| Geometry Generator | o | | | | o |
| **Data Input / Output** | | | | | |
| - Organizer - Test Planning and DOF Assignment | o | | | | o |
| - Organizer - Measurements File Upload | o | | | | o |
| - Organizer - View DOF information | o | o | o | o | o |
| - Export Organizer | o | | | | o |
| | | | | | |
| **Operating Deflection Shapes** | | | | | |
| - Frequency Domain - ODS (FODS) | | o | o | o | o |
| - Time Domain - ODS (TODS) | | o | o | o | o |
| | | | | | |
| **Frequency Domain Modal Analysis** | | | | | |
| - Frequency Domain Modal Analysis - FDD | | o | o | o | o |
| - Enhanced Frequency Domain Decomposition - EFDD | | | o | o | o |
| - Curve-fit Frequency Domain Decomposition - CFDD | | | o | o | o |
| | | | | | |
| **Time Domain Modal Analysis** | | | | | |
| - Stochastic Subspace Identification - SSI-UPC | | | | o | o |
| - Stochastic Subspace Identification - SSI-PC | | | | o | o |
| - Stochastic Subspace Identification SSI-CVA | | | | o | o |
| | | | | | |
| Modal Validation | | o | o | o | o |
| Mode Organizer | | o | o | o | o |
| Seamless Switch Between Setup and Analyze modes | | | | | o |

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