MEscope Application Note 36

ODS & Mode Shape Animation

Requirements for Animation

The following steps are required in order to display shapes in animation on a structure model,

1. Create a Structure Model

1. Draw the model in a Structure window
2. Or import a structure model

2. Import or Acquire Measurements

1. Import time or frequency data into a **Data Block**, or shape data into a **Shape Table**
2. Or acquire data directly from an acquisition front end using an **Acquisition** window

3. Link M#s to the Model

1. Execute **M# Links | Create M# Links** in the Structure window in which shapes will be displayed
2. Or execute **Animate | Create M# Links** in the Animation Source window (Data Block, Shape Table, or Acquisition) from which shapes will be displayed

4. Start Animation

1. Execute **Draw | Animate Shapes** in the Structure window
2. Or execute **Animate | Animate Shapes** in the Animation Source window

Linking M#s

During shape animation in a Structure window, the structure model is animated by evaluating the M# links to each direction at each Point on the model.

- An **M# Link** is a ***weighted summation*** of measurements (or **M#s**)
- If the ***current*** Animation Source has an **M#** that is contained in an **M# Link,** data from that **M#** is used to animate a **DOF** of the model
- Each measurement function in a Data Block or Acquisition window has a ***unique*** **M#**
- Each shape component in a Shape Table also has a ***unique*** **M#**

Measured, Interpolated, and Fixed DOFs

Each Point & direction (DOF) of a structure model can have a **Measured M# Link**, an **Interpolated M# Link**, or it can be a **Fixed** DOF.

Measured M# Links

- A Measured M# Link is created when each **M#** in an Animation Source (Data Block, Shape Table, or Acquisition window) is **linked** to a DOF of the structure model
- Measured M# Links are created by executing either **M# Links | Create M# Links** in a Structure window, or **Animation | Create M# Links** in an Animation Source window

Interpolated M# Links

- An Interpolated M# Link is created for each ***un-measured*** DOF using the **Measured M# Links** of ***nearby*** **Points**, and also taking into account the Fixed DOFs of ***nearby*** **Points**

- Interpolated M# Links are created by executing **M# Links | Interpolate between Measured M# Links** in a Structure window

Fixed DOFs

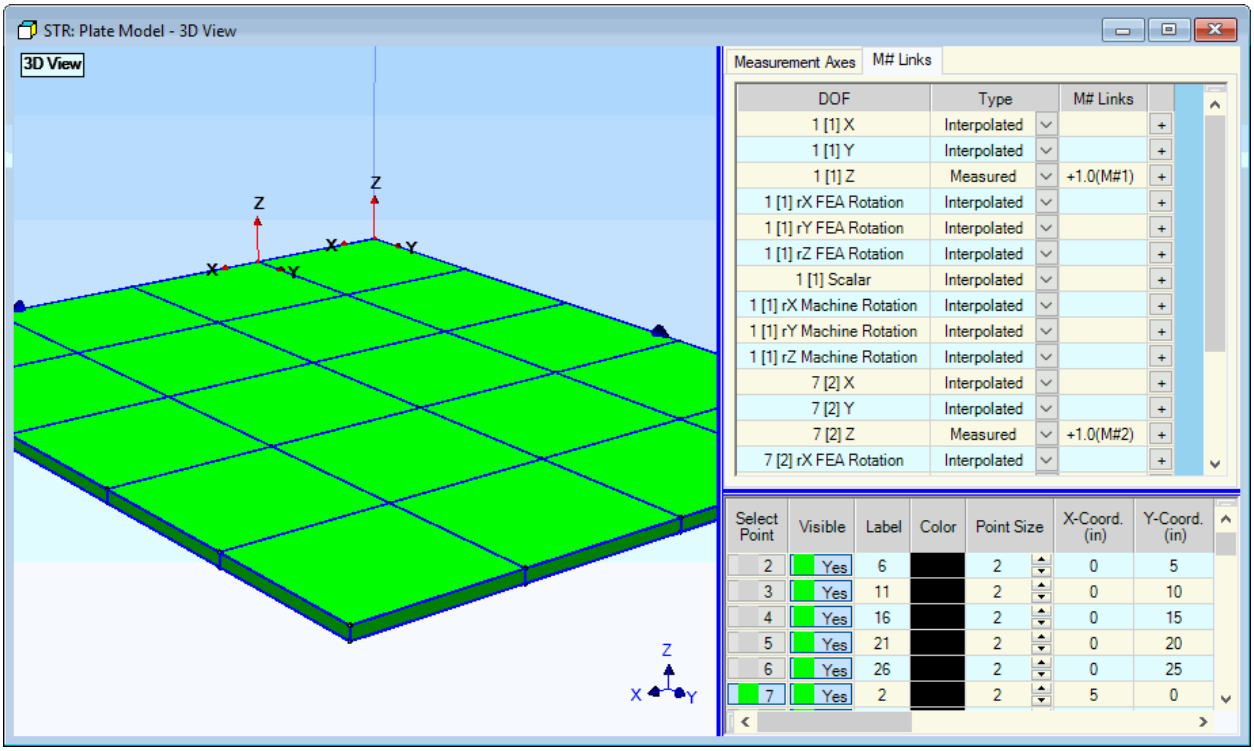
- A Fixed DOF has ***no motion*** during animation.
- Fixed DOFs are created on a model by executing **M# Links | Fix Directions** in its Structure window.

Editing the Links

To view the M# Links at ***selected*** Points on a structure model,

- Execute **M# Links | Links Editor**
- ***Click near*** a Point to select it

The M# Links for the ***selected*** Point will be displayed in the **M# Links** tab on the right side of the Structure window.

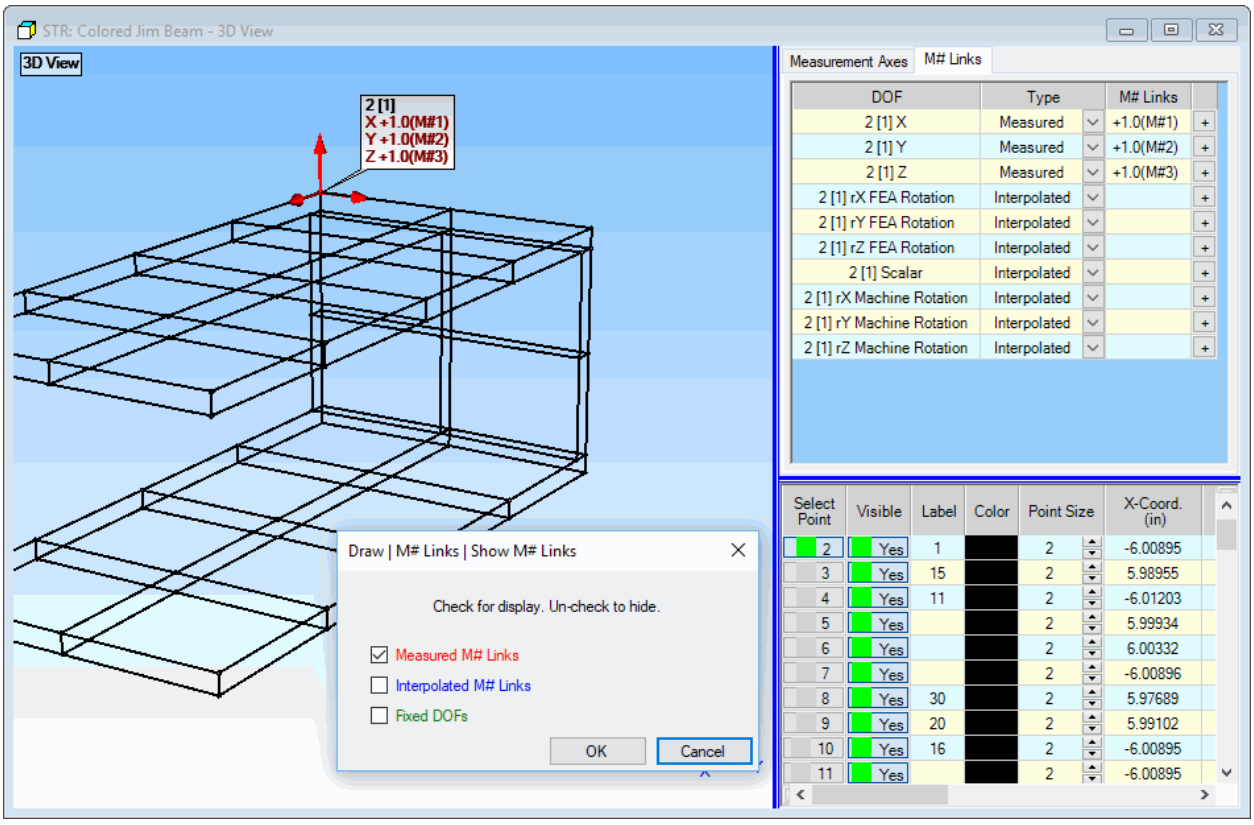


Structure Model Showing M# Links Tab.

Another way to view the **M# Links** is to display them next to each ***selected*** Point on the model.

- Execute **M# Links | Show M# Links**
- In the dialog box that opens, ***check*** **Assigned DOFs** and ***click*** on **OK**

The Assigned M#s are displayed in a ***balloon*** near each ***selected*** Point.



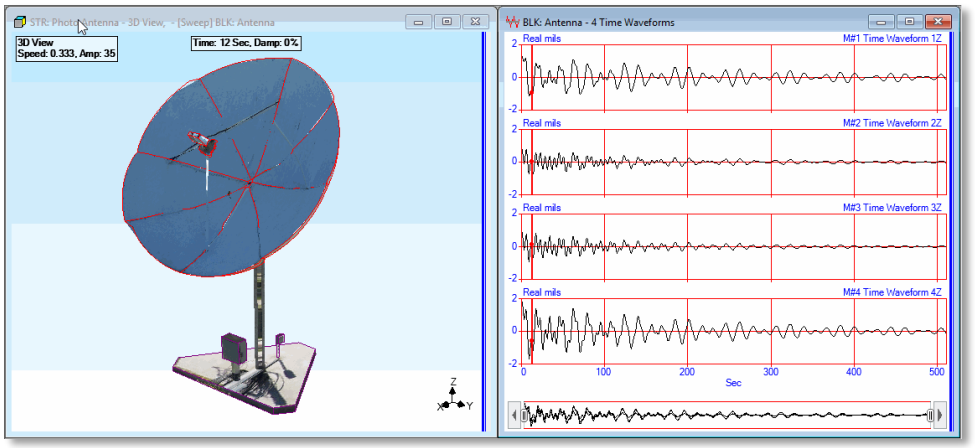
Structure Model Showing M# Links for a Selected Point.

Time-Based ODS Animation

With MEscope, you can animate time-based **Operating Deflection Shapes (ODS's)** directly from multi-channel data that was acquired spatially from a machine or structure.

- Time-domain Sweep Animation is done by sweeping a cursor through a set of time histories.

You can stop the animation, back it up, and play it forward to observe in slow motion vibration phenomena that may have taken place very quickly in real time. For example, you can observe in slow motion the run up, coast down, or other transient behavior of a machine. During this transition period, the machine may pass through a variety of vibrational states, due to resonances, unbalances, varying loads, fluid flow, etc.



Sweep Animation from Multi-Channel Time Responses.

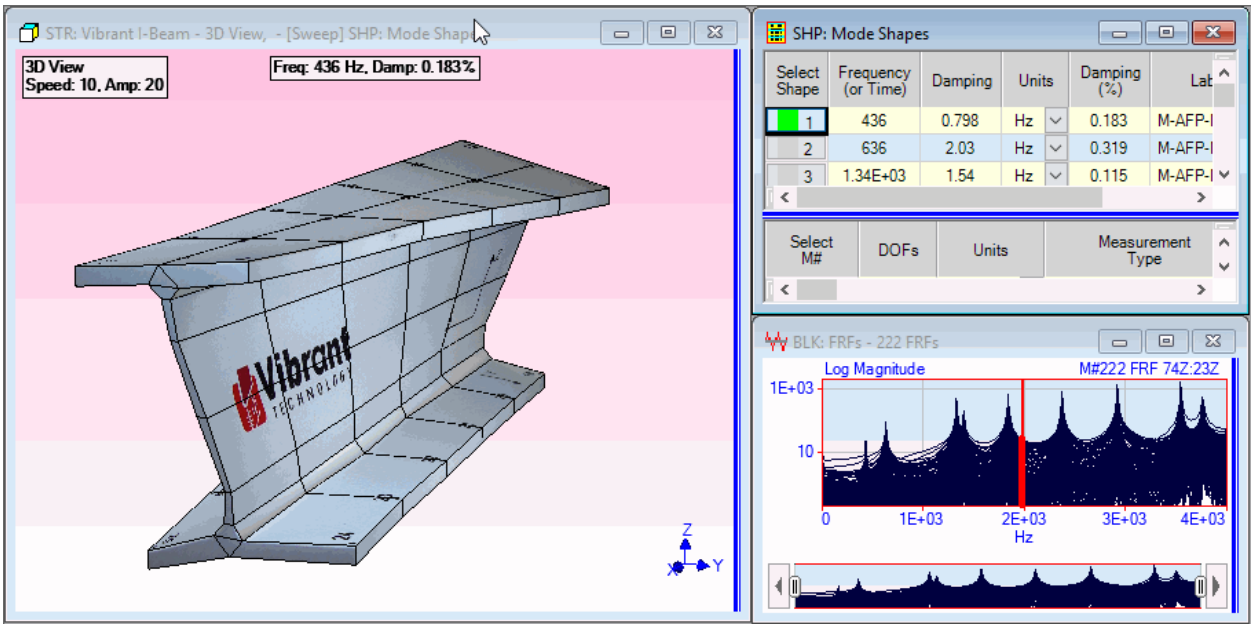
Animation from a Data Block

When a Data Block is chosen as the ***current*** Animation Source, shapes are displayed on a structure model by using data from the ***cursor position***.

- If the **Line** cursor is displayed, the values at the cursor ***position*** for each assigned **M#** are displayed as the ODS
- If the **Peak** cursor is displayed, the values at the cursor ***peak location*** for each assigned **M#** are displayed as the ODS.
- If the **Band** cursor is displayed, the ***RMS of the values in the band*** for each assigned **M#** are displayed as the ODS

Animation Methods

- ***Double click*** on the **Vibrant I-Beam** on the **Demos** tab to open its Project
- Execute **Draw | Animate Shapes** in the **STR** window
- ***Click*** in either the **BLK** window or the **SHP** window to animation shapes from that window
- Execute each of commands in the **Animate | Method** list to observe the ***three*** different types of animation



Vibrant I-Beam Project

Sweep Animation

During sweep animation, the Data Block cursor is swept through the M#s from **left to right**. When the cursor reaches the ***right*** end of the samples, it starts over at the ***left*** end.

- ***Drag*** the cursor in the **BLK** window to begin the sweep animation from any position
- Execute **Display | Zoom** in the Data Block window, and draw a Zoom box to confine the sweep animation to the ***visible*** samples of Trace data.

Sine or Stationary Dwell

During sine dwell or stationary dwell animation, the cursor position ***is fixed*** and the shape is displayed from the ***current cursor position***.

- During **sine dwell** animation, each shape component is ***multiplied*** by sine wave values that range between **–1** & **+1**
- During **stationary dwell**, the shape values are displayed on the structure without any sinusoidal modulation
- ***Click & drag*** the cursor in the Data Block window to display the shape at the cursor position

Animation Speed

- ***Click*** on the ***turtle*** of the ***rabbit***  on the Toolbar to ***decrease*** or ***increase*** the animation speed

Data Block Sweep Speed

During sweep animation, the animation speed is controlled by how many samples of data are ***skipped*** or ***interpolated*** between

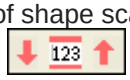
- For a speed of **1**, ***every*** sample of data is displayed during a sweep
- For a speed of **2**, ***every other*** sample is displayed, for a speed of **3**, ***every third*** sample is displayed, and so on
- For a speed ***less than* 1,** shape values are calculated using ***linear interpolation*** between adjacent samples of data
- For a speed of **0.5**, ***one interpolated value*** is calculated using ***half of the values*** at adjacent samples, for a speed of **0.33**, ***two interpolated values*** are calculated, and so on.

Sine Dwell Speeds

During sine dwell animation, the animation speed is controlled by using a different number of sine values per cycle of animation.

- For a speed of **4**, ***four*** sine values per cycle is used
- For a speed of **(N>4), N** sine values per cycle are used

Animation Amplitude

The amplitude of shape animation is influenced by the type of shape scaling you choose (*see* Shape Scaling), and by using the **Animate | Amplitude** commands  .

- Execute **Animate | Amplitude | Increase Amplitude**  or **Animate | Amplitude | Decrease Amplitude**  to change the animation amplitude.
- Execute **Animate | Amplitude | Amplitude**  to enter an amplitude value into the dialog box that opens.

The current animation amplitude can be displayed in the **Animation Legend** box, which is displayed in each View.

- Execute **File | Structure Options** in the Structure window
- On the **Animation** tab***, check* Amplitude and Speed** to display these values in the **Animation Legend** box in each View during animation.

Shape Scaling

During animation, shapes are scaled in one of ***three*** different ways.

- Execute **Animate | Shape Scaling | Auto Scale** to enable **Auto** scaling
- Or execute **Animate | Shape Scaling | Relative Scale** to enable **Relative** scaling
- Or execute **Animate | Shape Scaling | Fixed Scale** to enable **Fixed** scaling

Auto Scaling

- When **Auto** scaling is enabled, each shape component is ***divided*** by the ***maximum*** component of the shape
- When d**well** animation is initiated, **Auto** Scaling is ***automatically*** enabled, unless **Fixed** Scaling has been enabled

Relative Scaling

- When **Relative** scaling is enabled, each shape is ***divided*** by the ***maximum*** shape component of ***all*** data in the ***current*** Animation Source.
- When **sweep** animation is initiated, **Relative** scaling is ***automatically*** enabled, unless **Fixed** scaling has been enabled.

Fixed Scaling

- When **Fixed** scaling is enabled, each shape is scaled using a ***user-defined*** fixed scale factor.

Assume that an animating structure model has the following values;

The largest structure coordinate = **100** Length Units.

The Animation Amplitude = **1**.

The largest shape component (**M#** value) = **10**.

To fix the maximum amplitude of an animated shape so that it is **20%** of the *largest* structure coordinate.

Maximum Amplitude = 0.20 x 100 = (Fixed Scale Factor) x (1) x (10)

Therefore:

Fixed Scale Factor = 20/10 = 2.

Deformation, Arrows, and Contours

Shapes can be displayed in animation using one of the following methods,

1. Deformed
2. Arrows
3. Contour Colors
4. Contour Node Lines

Deformed Animation

Deformed animation displays shapes as a deformation at each Point. This is normally used only with ***vibration*** or ***acoustic intensity*** data.

- If **Animate | Deformation | Deformed**  is ***checked***, shapes are displayed using deformation at each Point
- If **Deformation** or **Both** is selected in the **Deformation** column of the **SubStructure** spreadsheet, those SubStructures will display deformed animation.
- If **Deformation** or **Both** is selected in the **Deformation** column of the **Points** spreadsheet, those Points will display deformed animation.

Animation with Arrows

Animation with Arrows displays shapes using an ***arrow*** at each Point. This is normally used only with ***vibration*** or ***acoustic intensity*** data.

- If **Animate | Deformation | Arrows**  is ***checked***, shapes are displayed using an ***arrow*** at each Point.
- If **Arrows** or **Both** is selected in the **Deformation** column of the **SubStructure** spreadsheet, those Substructures will display deformed animation using arrows.

- If **Arrows** or **Both** is selected in the **Deformation** column of the **Points** spreadsheet, those Points will display deformed animation using arrows.

Contour Colors

Contour Colors are used from the ***current*** Animation Source to display shape ***magnitudes*** on structure surfaces. Color contours are the ***primary means*** of displaying **Scalar** data on a model. All shape magnitudes within a ***band of values*** are displayed using the same color.

- Contour colors are user-specified on the **Contour Colors** tab in the **File | Options** box of the ***current*** Animation source.
- Contour Colors are displayed on each Substructure for the **Measurement Type (Translation, Scalar, Machine Rotation, FEA Rotations)** chosen in the **Contours Data Type** column of the **SubStructure** spreadsheet.
- Contour Colors are displayed on each Surface for the **Measurement Type (Translation, Scalar, Machine Rotation, FEA Rotations)** chosen in the **Contours Data Type** column of the **Surface Triangles** or **Surface Quads** spreadsheet.
- Execute **Animate | Contours** | **Contour Colors**  to display shapes using contour colors on the model Surfaces.
- Execute **Animate | Contours** | **Color Key** to display the **color key** for the contour colors.

Contour Node Lines

Contour Node Lines are lines where the shape magnitude is ***zero***. Contour Node Lines are displayed on Surfaces just like Contour Colors.

- Execute **Animate | Contours** | **Node Lines**  to display shape contour node lines.

Terminating Shape Animation

1. Execute **Animate | Draw Structure**  in the Structure window.
2. Or execute **Tools | Animate Shapes** in the Animation Source window.

Animation is also terminated,

1. If the ***current*** Animation Source window is closed.
2. Or a command is executed that modifies data in the ***current*** **Animation Source** window.