An Integrated
Finite Element Analysis Software
for MS Windows and Mac OS

VisualFEA

User's Manual

© 2001 Intuition Software
All Rights Reserved

Contents

Chapter 1 Overview 1-1

Finite Element Analysis and VisualFEA 1-2

Procedure of finite element analysis using VisualFEA 1-2

Stages of finite element analysis / Finite element analysis using VisualFEA / Mixed use of VisualFEA and external solvers

Creating a finite element model using VisualFEA 1-4

Node and element data / Other data assignment

Visualizing analysis results using VisualFEA 1-5

Visualization of scalar data / Visualization of vector data / Visualization of truss and frame data

Framework of VisualFEA 1-7

Basic User Interface 1-7

Project and file / View control / 3-D geometric data input system / Model selection and control / Model rendering

Preprocessing 1-8

Curve and surface primitive modeling / Mesh generation / Data Assignment / Others

Processing 1-11

Structural analysis / Heat conduction / Seepage

Postprocessing 1-12

Data visualization / Visualization aids / Image handling / Printing / Others

Educational Aids 1-14

Element stiffness computation / Assembly and solution process / Shape function and interpolation / Eigen mode / Stress recovery and smoothing / Adaptive analysis process / Structural behavior

Chapter 2 Basic User Interface 2-1

Basic Elements of User Interface 2-2

Mac OS and Windows versions 2-3

Menu and tool button 2-4

Menu / Tool button

Window and dialog 2-6

Window / Dialog

Project and File 2-9

Working with a project 2-9

Launching VisualFEA / Starting a new project / Opening a project file / Importing an external file / Closing the project file / Saving the project file / Saving the file with a new name / Creating a text ile with

the list of modeling and analysis data / Setting the project's analysis subject / Updating the file status / Setting up page for printing / Printing / Quitting VisualFEA

Setting preferences 2-15

Grid settings / Tolerance settings / Shading settings / Light source settings / View settings / Solver settings

Grid and 3-D Cursor 2-21

Grid 2-22

Setting grid / Turning grid planes on and off / Moving grid planes / Resizing grid planes / Subdividing grid

User Defined Grid 2-26

Constructing user defined grid planes / Retrieving user defined grid planes / Retrieving XYZ grid planes / Deleting grid planes / Renaming grid planes

3-D Cursor 2-29

Turning 3-D cursor on and off / Moving the 3-D cursor point

Viewing Control 2-31

Rotating view 2-31

Rotating view using virtual track ball / Rotating view using bounding box / Rotating view using key board / Getting the preset viewing rotations / Setting view direction

Zooming in and out 2-36

Zooming in and out using zoom dial / Zooming in and out using rubber-band rectangle / Instant zooming by zoom button / Fitting the display to the window / Entering the zoom factor by key board

Panning 2-39

Panning by scroll bar / Panning by option-drag / Centering the display

Setting and getting custom views 2-40

Setting custom views / Getting custom views / Removing custom views

Getting the initial view and the last saved view 2-41

Getting the initial view of the project / Getting the last saved view of the file

Saving ,importing and exporting views 2-42

Updating view data in the workting file / Exporting views / Importing views

Hiding objects 2-43

Hiding selected meshes / Hiding unselected meshes / Reversing visibility / Reversing visibility of all objects / Hiding primitive surfaces / Hiding unselected curves / Hiding line elements / Disabling or Enabling the hiding of the selected objects

Object numbers 2-46

Displaying numbers / Changing numbers / selecting an object by its number

Other functions related with view control 2-48

Displaying control points of curves / Making invisible nodes unselectable / Making attribute assignment displayed / Controlling the view using aerial view

Model Rendering 2-50

Setting rendering style 2-50

Rendering by wireframe with or without hidden line removal / Rendering by outline / Rendering by shading and transparency shading / Rendering by broken mesh

Setting projection mode 2-53

Perspective mode / Stereo mode / Depth cued mode

Inputting Coordinates of Points 2-54

Inputting coordinates using mouse 2-54

Entering coordinates using grid planes / Entering coordinates using grid points / Entering coordinates using control points / Entering coordinates using nodes / Entering coordinates using 3-D cursor

Inputting coordinates using keyboard 2-60

Inputting the coordinates by offset distance / Keyboad input with combined use of the grid points / Repeating the last input

Undoing coordinates input 2-61

Selection 2-62

Tools for object selection 2-63

Node selection tool / Curve selection tool / Surface primitive selection tool / Element selection tool / Surface mesh selection tool / Volume mesh selection tool

Method of selection 2-65

Selecting a single object by a mouse click / Selecting objects using keyboard / Selecting an object in the rear side by command(Windows:Alt) click / Adding selected objects using shift click / Selecting multiple objects by rubber banding / Selecting all / Unselecting objects

Chapter 3 Curves and Surface Primitives 3-1

Creating Curves and Surface Primitives 3-2

Creating straight lines 3-2

Creating circles or circular arcs 3-3

Arc / Clockwise Arc / Counter-CW Arc / Three Point Arc / Center & Angle Arc / Clockwise Circle / Counter-CW Circle / Three Point Circle / Center & Radius Circle

Creating ellipses or elliptical arcs 3-7

Quarter / Half / Full

Creating parametric curves 3-9

Cubic Spline / B-Spline / Bezier / Polynomial / Polyline

Creating rectangles 3-11

Creating single points 3-11

Creating parametric surfaces 3-12

Flat Plane / B-spline Surface / Bezier Surface / Lagrangian Surface

Creating spheres 3-15

Sphere by Radius / Sphere by 2 Points
Creating cylinders, cones or truncated cones 3-17
Creating tori 3-18
Handling Curves and Surface Primitives 3-19
General editing commands 3-19
Deleting curves and surface primitives / Copying curves and surface primitives / Cuttng curves and surface primitives / Pasting curves and surface primitives
Reshaping and moving 3-19
Activating modification mode / Moving control points by mouse / Moving control points by keyboard input / Moving an entire curve or surface primitive
Duplicating curves and surface primitives 3-22
Duplicating curves and surface primitives, and moving / Duplicating curves and surface primitives, and revolving / Mirroring curves and surface primitives / Modifying a curve or a primitive with its duplicate / Modifying attributes of a primitive surface
Processing curves and surface primitives 3-27
Linking curves / Separating curves / Filleting two straight lines / Splitting curves by their intersection points / Obtaining intersection curves between surface primitives / Projecting curves / Building boundary curves of a surface primitive
Curve Division 3-32
Dividing curves 3-33
Dividing curves individually / Dividing curves as a whole / Setting the number of divisions / Setting the weight of division density / Removing divisions from divided curves / Dividing curves using F keys
Changing **Divide** Menu Items 3-37
Modifying the menu items for number of divisions / Changing the menu items for weight of division density
Chapter 4 Mesh Generation 4-1
General procedure of mesh generation 4-1
Surface Mesh Generation 4-3
Automatic triangulation 4-4
Generating mesh on a plane by automatic triangulation / Setting a compatible region for automatic triangulation / Handling the incompatibility due to mismatching curve ends / Generating mesh on a surface primitive by automatic triangulation
Surface mesh generation by mapping 4-12
Generating mesh using 2 edges / Setting 2 edges compatible for mesh generation / Shifting alignment of node pairing on 2 edges /Generating mesh using 3 edges / Generating mesh using 4 edges / Setting 4 edges compatible for mesh generation
Surface mesh generation by sweeping operations 4-21

Generating mesh by extrusion / Generating mesh by extrusion up to bounding curves / Generating mesh by translation / Generating mesh by revolution / Generating mesh by twisting

Duplicating surface meshes 4-36

Projecting surface meshes 4-37

Volume Mesh Generation 4-38

Volume mesh generation by automatic tetrahedronization 4-39

Generating mesh by automatic tetrahedronization / Forming boundary meshes for automatic tetrahedronization

Volume mesh generation by mapping 4-42

Generating mesh using box edges / Setting box edges compatible for mesh generation / Generating mesh using prism edges / Setting prism edges compatible for mesh generation / Generating mesh using tetrahedron edges / Setting tetra edges compatible for mesh generation

Volume mesh generation by sweeping operations 4-49

Generating mesh by extrusion / Generating mesh by extrusion up to bounding surface primitives / Generating mesh by extrusion up to surface meshes / Generating volume mesh by translation / Generating volume mesh by revolution / Generating volume mesh by twisting

Duplicating volume meshes 4-62

Frame Element Generation 4-63

Creating frame elements using straight lines or curves 4-64

Creating a frame element by inputting a straight line / Generating frame elements by dividing curves

Creating frame elements using mesh generation functions 4-66

Duplicating frame elements 4-67

Mesh Editing 4-68

General mesh editing commands 4-68

Undoing mesh generation / Deleting meshes / Copying meshes / Cutting meshes / Pasting meshes / Merging meshes

Modifying nodal coordinates 4-70

Dragging nodes using mouse / Modifying nodal coordinates by keyboard input / Changing node number / Absorbing nodes

Transforming meshes 4-73

Moving meshes / Rotating meshes / Resizing meshes

Other mesh treatments 4-77

Remeshing / Making cracktip elements

Surface normal direction 4-79

Displaying surface normal direction / Displaying surface tangent directions / Reversing surface normal direction

Chapter 5 Data Assignment 5-1

Overview of Data Assignment 5-2

Basic composition of data 5-2

Data for structural analysis / Data for analysis of heat conduction / Data for seepage analysis

General procedure of data assignment 5-3

Functions common to all types of data assignment 5-4

Functions handling data sets / Entering values of data items / Modifying values of data items / Assigning data sets / Checking data assignment / Clearing data assignment / Condensing data sets / Ending data assignment

Structural Element Properties 5-8

Defining element properties 5-8

Analysis class of element / Constitutive model / Isotropy o f the properties / Data items of element properties

Defining element properties of truss and frame elements 5-11

Defining cross section of a truss or a frame member

Assigning element properties 5-15

Selecting objects to assign element properties / Overriding previous assignment of element properties / Representation of element property assignment

Mixing different structural types in one analysis 5-16

Changing the analysis class of element / Applicable analysis classes of element

Using interface elements 5-18

Characteristics of interface elements / Creating interface elements / Deleting interface elements

Using slip bars 5-20

Characteristics of slip bar elements / Creating slip bar elements / Deleting slip bar elements

Using embedded bars 5-22

Characteristics of embedded bar elements / Creating embedded bar elements / Deleting embedded bar elements

Color coding of property sets 5-25

Turning on the property color mode / Changing or setting the property color

Heat Conduction and Seepage Properties 5-26

Heat conduction properties 5-26

Defining heat conduction properties / Assigning heat conduction properties

Seepage properties 5-27

Defining seepage properties / Defining hydraulic conductivity functions / Assigning seepage properties

Structural Boundary Conditions 5-30

Defining structural boundary conditions 5-30

Nodal degrees of freedom / Data items of structural boundary condition / Entering data items of

boundary conditions / Defining boundary conditions in local coordinates
Assigning structural boundary conditions 5-35
Selecting objects to assign structural boundary conditions / Replacing or adding previous assignment / Representation of boundary condition assignment
Heat Conduction and Seepage Boundary conditions 5-38
Defining heat conduction boundary conditions 5-38
Types of heat conduction boundary condition / Editable text items
Assigning heat conduction boundary conditions 5-39
Selecting objects to assign heat conduction boundary conditions / Replacing previous assignment / Representation of heat conduction boundary condition assignment
Seepage boundary conditions 5-41
Types of seepage boundary condition / Assigning open head boundary condition / Assigning confined head boundary condition / Assigning flux / Assigning point source / Deining the initial water table
Load Conditions 5-45
Defining load condition sets 5-45
Data items of a load condition / Load types / Load direction / Editable text items
Defining load condition sets for dynamic analysis 5-54
Setting the time dependency / Defining static load for dynamic analysis / Defining harmonic load for dynamic analysis / Defining transient load for dynamic analysis
Assigning load condition sets 5-57
Selecting objects to assign load conditions / Assigning a load condition set to multiple objects / Assigning multiple load condition sets to a single object / Representation of load assignment
Other functions related with assigning load conditions 5-58
Reversing the force direction / Exchanging the reference end of the curve / Suppressing load selection / Changing the placement of force simbol / Limiting the size of force simbol / Resetting the size of force symbol
Load Combination 5-61
Difiing load combinations / Handling load condition sets in "Load combination" dialog / Combining analysis results of multiple load conditions
Dynamic Motions 5-63
Defining and assigning dynamic motion sets 5-63
Setting the time dependency of dynamic motion / Defining harmonic motions / Defining transient motions / Defining initial motions / Assign dynamic motions
Defining and assigning nodal dynamic properties 5-66
Nodal dashpot / Nodal mass
Frame Member Joint Conditions 5-68
Defining frame member joint conditions 5-68

Assigning frame member joint conditions 5-68

Sequentially Staged Modeling 5-69

Concept of sequentially staged modeling 5-69

The base model and the stage models / Data sharing and inheriting / Solution process of stage models / Procedure o sequentially staged modeling

Creating stage models 5-74

Creating a new stage / Deleting a stage / Moving to the desired stage

Building the geometry of stage models 5-74

Including the selected objectes to the current stage / Excluding the selected objects from the current stage / Hanling objects created after creation or some stages / "Model Display" options

Property assignment in sequentially staged moedling 5-75

Assigning properties to the base model / Assigning properties to stage models

Load assignment in sequentially staged modeling 5-77

Assigning loads to the base model / Assigning loads to stage models

Control in processing of a sequentially staged model 5-79

Assumed stress field of a stage model / Prescribing the staged stress relaxation rate / Clearitn displacements

Chapter 6 Finite Element Processing 6-1

Getting Finite Element Solution 6-2

Solver of finite element analysis 6-2

Processing of structural ananalysis 6-3

Setting Analysis Options for linear static analysis / Setting Analysis Options for adaptive analysis / Setting Analysis Options for dynamic analysis /Setting Analysis Options for nonlinear analysis / Setting analysis options for sequentially staged modeling

Processing of heat conduction and seepage analysis 6-14

Setting analysis options for heat conduction analysis / Setting analysis options for seepage analysis

Processing stages 6-16

Progress of processing / Inturrupting the processing / Abnormal termination of the processing

Interactive real time processing 6-20

Other Functions Related with the Processing 6-22

Optimizing node numbering 6-22

Optimizing element numbering 6-23

Setting output items 6-23

Specifying integration scheme 6-24

Displaying analysis information 6-25

Chapter 7 Postprocessing of Continuum Analysis 7-1

Visualizing Scalar Data by Contours 7-3

Setting contouring options 7-4

Selecting the data item / Designating the contouring object / Setting the number of contour bands / Selecting the contouring method / Selecting the style of boundary surface rendering / Turning the shading effect on or off / Displaying the boundary of cut or cross planes / Displaying the cube surrounding the entire model / Limiting the range of the contour scale by actually displayed values

Setting the contour scale 7-10

Editing the scale values / Setting the format of the contour scale / Aligning a contour to the specified value / Truncating the scale values at the specified decimal point / Getting symmetrically arranged scale values / Spacing the scale values with weight / Possible combination of contour scale options / Saving contour scale values / Reading contour scale values

Setting a cut plane for contouring 7-16

Activating the cut plane setting mode / Setting a cut plane / Contouring on a cut plane / Splitting objects using the cut plane

Setting parallel planes for contouring 7-20

Activating the parallel plane setting mode / Setting parallel planes interactively / Setting parallel planes by custom input / Contouring on parallel planes

Setting cross planes for contouring 7-25

Activating the cross plane setting mode / Setting cross planes / Contouring on cross planes

Other functions related with contouring 7-28

Contour marking over a contour image / Sampling contour value by specifying the coordinates / Turning on and off the contour scale bar

Visualizing Scalar Data by Iso-surface and others 7-32

Visualizing scalar data using iso-surfaces 7-32

Setting the iso-surface display options / Selecting the data item to be represented by iso-surfaces / Selecting the data item to be represented by contours / Setting the number of iso-surfaces / Setting the number of contour bands / Selecting the type of boundary surface rendering / Designating the iso-surfaces as the boundary of truncated model / Limiting the range of iso-surface scale by actually displayed values / Setting the iso-surface level / Setting the contour scale

Curve plotting of scalar data 7-39

Initiating curve plotting / Modifying curve plotting / Displaying the numerical value at the sampling point / Resizing the graph / Setting the options for curve plotting / Terminating curve plotting

Surface plotting of scalar data 7-42

Setting the surface plotting options / Selecting the data item / Selecting the type of rendering for the plotted surface / Selecting the type of rendering for the source plane / Setting the scale of height / Setting the datum of the plotted surface

Visualizing Vector Data 7-45

Visualizing vector data by arrows 7-45

Setting the arrow display options / Selecting the data item / Selecting the type of arrow rendering / Selecting the style of surface or boundary surface rendering / Setting the placement focus of arrows / Setting the position of arrow heads / Setting the length of arrows / Setting the thickness of arrows / Displaying selectively sampled arrows / Overlaying vector images

Visualizing displacements by deformed shape 7-52

Setting the display options / Selecting the style of the deformed shape rendering / Overlaying the deformed shape image over the screen image / Retainint the deformed shape in future rendering / Excluding the rigid body displacements from deformed shape / Setting the deformation scale / Visualizing the displacements by animation / Restoring undeformed shape

Getting numerical values of nodal data 7-56

Visualization of Multi-step Analysis Data 7-57

Stepwiae rendering of multi-step analysis results 7-57

Stepwise rendering of multi-step analysis results / Selecting the method of stepwise rendering / Ending stepwise rendering

Stepwise rendering of sequentially staged analysis results 7-59

Visualization of Dynamic Analysis Data 7-60

Visualizing dynamic response

Visualizing dynamic analysis results using multi-step view / Visualizing dynamic analysis results in time history form / Plotting time history records of nodal value in spatial coordinates / Plotting time history records in modal coordinates / Animation of dynamic motion / Displaying the trace of nodal movement / Changing the time step / Dragging the time step / Adjusting the animation speed and the deformation scale / Resizing "Dynamic Responce" window / Ending tie history display

Visualizing dynamic mode shape 7-67

Starting and controlling mode shape display / Selecting the mode to display /Scale of display / Speed of animation / Ending dynamic mode display

Visualization of combined Load Case Results 7-69

Characteristics of the analysis results with multiple load cases / Starting multi-loading view / Visualizing the analysis results of each load case / Visualizing the synthesized analysis results

Visualization of Seepage Analysis Data 7-71

Visualization of scalar and vector data 7-71

Contouring of scalar data / Representing vector data

Vesualization of phreatic surface 7-73

Rendering of phreatic surface in 2-D seepage analysis / Rendering of the phreatic surface in 3-D seepage analysis

Visualization of flow path 7-76

Interactively desplaying a flow path / Clearing flow paths / Getting flow velocity

Image and Animation 7-83

Image handling 7-83

Retrieving an image saved in a file / Saving the screen image in a file

Animation 7-86

Creating an animation / Writing the animation script / Playing an animation

Chapter 8 Diagrams for Frame Analysis 8-1

Diagrams for Truss and Rigid Frame 8-2

Visualizing analysis data of 2-D and 3-D trusses 8-2

Displaying axial force diagram / Displaying axial force value / Displaying reactions at supported nodes / Displaying displacements

Visualizing analysis data of 2-D and 3-D rigid frames 8-4

Displaying axial force diagram / Displaying shear force diagram for 2-D rigid frame / Displaying bending moment diagram for 2-D rigid frame / Displaying deformed shape of rigid frame / Displaying support reactions of rigid frame / Displaying shear force diagram for 3-D rigid frame / Displaying bending or torsional moment diagram for 3-D frame

Diagram Related Functions 8-9

Manipulating the diagrams / Displaying more than one diagrams / Clearing diagram / Redrawing diagram / Reversing diagram directions as a whole / Reversing diagram directions of selected element(s) / Adjusting the scale of diagrams

Setting display options 8-12

Instant redrawing mode / Curve normal mode / Turning on - off text of diagram values / Temporarily turning off text of diagram values / Popping up the hidden texts / Selectively turning on text of diagram values / Displaying part of the diagram for selected members only

Chapter 9 Data Interface with External Softwares 9-1

Overview of File Contents 9-2

File position 9-3

Input data for external solver 9-3

Output from external solver 9-4

Other data for user interface, graphical modeling and rendering 9-5

Contents of Data Items 9-6

Modeling data 9-6

Modeling data master record / Modeling data position record / Header record / Node data / Element data / Boundary condition data / Element property data / Temperature data / Member joint data / Equivalent nodal force data / Equivalent nodal heat data / Nodal dynamic data / Integration scheme record / Solver

option record / Analysis output item record / Dynamic analysis setting record / Curve end point data / Curve data / Primitive surface data / Surface mesh data / Volume mesh data / Load condition data-header record / Load condition data-attribute record / Heat boundary condition data / View transformation data / Construction plane data / Symbol size record

Analysis data 9-44

Analysis data master record / Adaptive analysis data position record / Nonlinear analysis data position record / Dynamic analysis data position record / Custom contour menu data / Custom vector menu data / Analysis data items