# FEMtools™ Model Updating

**An Integrated Solution for Structural Dynamics Simulation, Finite Element Model Verification, Validation and Updating**

## Overview

FEMtools Model Updating contains modules for

- **Sensitivity Analysis** – Analyses how changes of parameters influence the structural responses. This information can be used for different applications including model updating.

- **Model Updating** – Iteratively changes updating parameters to make the structure better match the target responses.

- **Harmonic Force Identification** – Identifies harmonic loads from operational shapes.

- **Probabilistic Analysis** – Applies uncertainty to parameters to obtain probability distribution on output responses.

- **Design of Experiments** – Efficient sampling of the design space.

## Applications

- What-If analysis
- Variational and sensitivity analysis
- Finite element model validation and refinement
- Probabilistic model updating
- Design improvement and robust design
- Finite element model reduction
- Structural damage detection
- Material identification
- Identification of structural parameters (e.g. joint stiffness, damping,…)

## Benefits

- **All-In-One** - A single dedicated program with all capabilities required for productive test-analysis correlation and FE model updating.

- **Open Environment -** Using FEMtools Script, end-users, partners or subcontractors can customize existing tools, develop new proprietary tools or integrate in-house tools. Data translators to use test data and FEA data coming from other programs are available. External solvers can easily be integrated. Updated FE models are exported in ready-to-run data decks.

- **Practical** - FEMtools has been designed to update structural FE models as used in industrial applications. There are no limitations in model size. FEMtools fits into existing CAE environments.

- **Availability -** Native versions of FEMtools are on all hardware platforms available that are popular for CAE or testing applications.

- **Easy-to-Use** - FEMtools offers an intuitive graphical user interface and a powerful, free-formatted command language. Online documentation and context-sensitive help support the user.

- **Proven Technology** – FEMtools is the result of continuous research and development by a dedicated team of engineers and programmers.

## Supporting Tools (Included)

- Direct data interfaces and drivers for external solvers
- Database management
- Integrated element library and solvers
- Pretest analysis
- Test-analysis correlation

For more information, see the datasheets for FEMtools Framework, FEMtools Dynamics and FEMtools Pretest and Correlation.

## Sensitivity Analysis

Sensitivity analysis provides gradient information on the relation between parameters and responses.

- Selection of all element material properties, geometrical properties, boundary conditions, lumped masses, and damping factors as parameters
- Selection of mass, static displacements, strain, stress, resonance frequencies, modal displacements, MAC, POC, FRFs, FRF correlation functions and ODS as responses
- Sensitivity for local and global parameters
- Internal sensitivity analysis to computer absolute or normalized sensitivities, finite difference and differential sensitivities
- Internally or externally computed sensitivities
- Pre- and postprocessing of external sensitivity analysis (e.g. Nastran SOL 200)
- Sensitivity and gain matrix analysis

## Model Updating

Model updating is used to minimize the 'distance' between FEA and reference test data.

- Automated iterative updating method
- Possibility to combine different parameter types and response residues in a single run

**FEMtools**

simulate › validate › update › optimize

- Weighting of updating parameters and targets
- Constraints on updating parameters
- Linking of updating parameters
- Simultaneous updating of multiple models (MMU).
- Superelement-based model updating
- Probabilistic correlation and model updating
- Automated scaling of sensitivity matrix
- Automated support of internal and external solvers for static and dynamic re-analysis
- Tracking of updating parameters and responses during updating
- Undo functions and database restoration
- Regrouping of local model updating results
- Export of updated FE models

## Design of Experiments

- Sample parameters using factorial, central composite, Latin hypercube or D-optimal designs
- Find optimal starting values for parameters in case of poor initial correlation

## Harmonic Force Identification

- Force identification from dynamic response measurements
- Definition of masks for location of forces
- Identification of harmonic nodal and element pressure loads
- Export of identified forces

## Probabilistic Analysis

- Apply a statistical probability distribution and randomly sample thousands of physical properties using only a few commands
- Re-analysis using FEMtools or external solvers
- For dynamic responses, a fast approximate modal solver can be used to significantly reduce the time required to run hundreds of simulations
- Use all parameter and response choices available for Sensitivity Analysis and Model Updating
- Postprocess simulations to obtain histogram, mean and standard deviation of output responses

## User Interface

- All definition, editing and analysis accessible via intuitive menus and dialog boxes or using free format commands for batch processing and process automation
- Complete digital documentation
- Dedicated graphics viewers for model inspection and results evaluation
- Point-and-click interactive selection
- Direct access to FEA and test data
- Unlimited customization with FEMtools Script language

## Prerequisites

- FEMtools Framework with FEA Solvers (included)
- FEMtools Dynamics (included)
- FEMtools Pretest and Correlation (included)

## Options

- Upgrade to FEMtools Model Updating and Optimization
- FE interfaces and drivers (Ansys, Abaqus, LS-DYNA, MSC.Nastran, Simcenter Nastran, OptiStruct, SAP2000, Universal File)
- Data Acquisition (Add-on)
- Modal Parameter Extractor (Add-on)
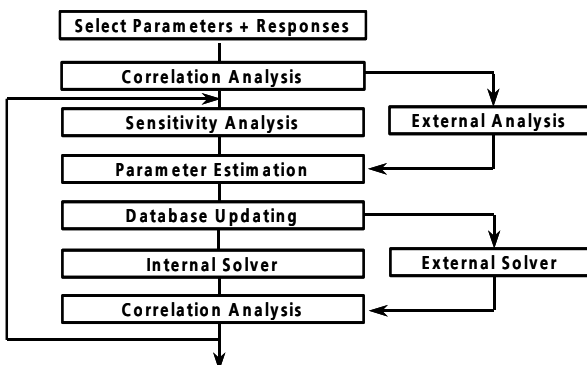- Rigid Body Properties Extractor (Add-on)

## Services

- Installation, training and customization
- Support by e-mail, phone and support site
- Custom software development
- Project research

## Supported Platforms

- Windows 10, 11 (64-bit)
- Linux 64-bit

For more information, contact us at



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