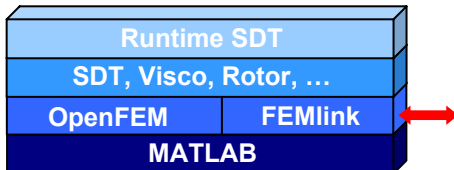# Structural Dynamics Toolbox

Multi-physics FEM, modal analysis and correlation

The Structural Dynamics Toolbox brings Finite Element Modeling and Experimental Modal Analysis capabilities to the MATLAB environment.

| Runtime SDT	
SDT, Visco, Rotor, …	
OpenFEM	FEMlink
MATLAB	

Easy adaptation to specific user needs is obtained by a complete integration in the MATLAB programming environment and the ability to perform modifications through both GUI and script. This capability is a major reason to choose SDT over competing programs that can't be customized or extended as easily. The SDT-Runtime license and MATLAB Compiler allow large scale deployment of custom applications.

State of the art performance in FEM analysis is obtained through compiled (mex) files for element level computations and sparse solvers.

The FEMLink interface is used to pre/post-process computations in other FEM software, import results for test/analysis correlation or state-space model building, run mixed software solutions through the use of superelements.
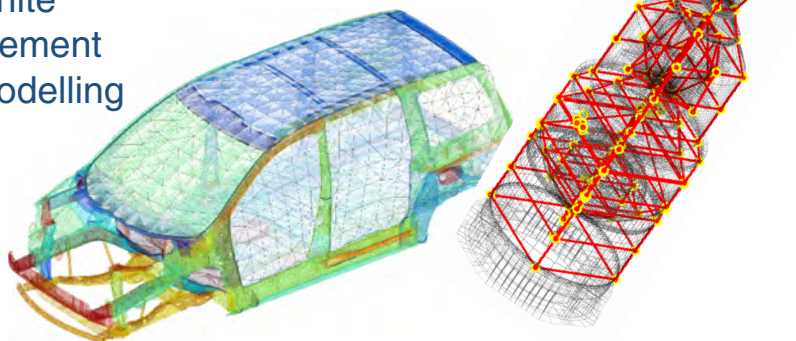
Key features

Finite Element Modeling

3-D multiphysics Finite Element Modeling with an open architecture and state of the art performance

Structural, acoustic, piezoelectric, thermal … formulations

Pre-processing and visualization of FEM computations

Large scale solvers for statics, frequency and time domain dynamics, reduction, superelements and system model building

Physical parameterization of FEM models for optimization

FEMLink interface from/to NASTRAN, ABAQUS, ANSYS, SAMCEF, …

Experimental Modal Analysis

GUI based visualization of test data and frequency domain identification

Animation of ODS, modes and FEM results

Topology correlation, test/analysis criteria and SDM

Import/export routines for popular test and FEM model

Finite Element Modelling

Experimental Modal Analysis

System Dynamics

www.sdtools.com
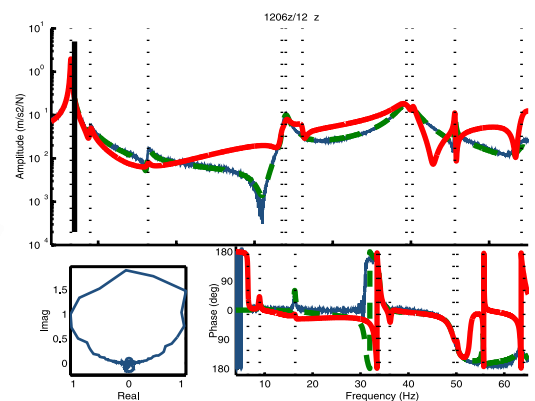
Finite Element Analysis

Pre-/post-processing
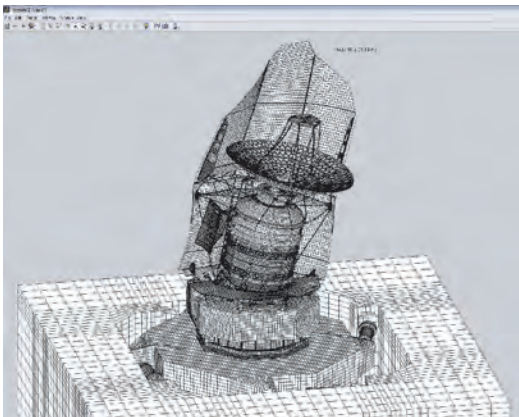
The femesh/feutil user interface enables the creation and extensive manipulations of finite element models. Commands allow element and node manipulation as selection, extrusion, revolution, …

The fe_case user interface allows GUI and script based manipulations of cases defining : boundary conditions, point and distributed loads, physical parameters, …

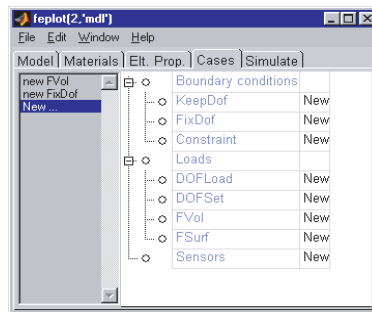feplot supports integrated GUI/script viewing of results.

Control design and validation of the HYDRA platform (ESA/ESTEC)

Pantograph/catenary

time simulations (SNCF)

Import/export

FEMLink opens the SDT to other FEM environments: NASTRAN, ABAQUS, ANSYS, Samcef, Universal File, …

Mesh import/export capabilities are used to handle industrial models that cannot be easily built with femesh (structured meshes) or fe_fmesh (unstructured 2-D quad meshing) or the interface to GMSH.

Imported results are used for test/analysis correlation or state-space building to pass FEM models SIMULINK.

Element or matrix import capabilities enable combined models using an external FEM model as a standard or parametric superelement.

A general purpose FEM architecture

The SDT integrates the OpenFEM architecture developed in cooperation with INRIA and others. This open source toolbox provides general specifications for models, multiphysics elements, and self extending pre- and post-processing tools. Topologies include 1D beam/bar, 2D volumes, 3D volumes and shells. Problem formulations include elasticity, large deformation, composites, acoustic, thermal, piezoelectric behavior.

Cyclic substructuring of a fan model (SNECMA)
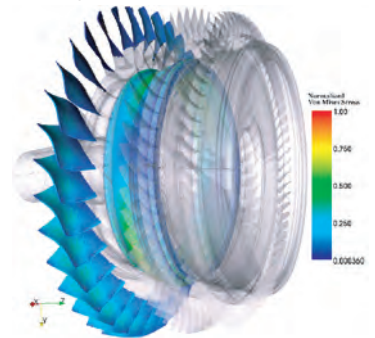
Optimized solvers

The SDT provides alternatives to the MATLAB sparse libraries thus handling much larger problems. Model size is only limited by the computer memory. Out-of-core solutions are implemented in some cases (model, reduction, assembly, …).

Standard solutions are provided for linear/non-linear statics and transients, mode computation, state-space model building (for use in SIMULINK or the Control Toolbox), and direct frequency response.

Reduction / superelements

Standard model reduction techniques (Guyan, Craig-Bampton, MacNeal, damped reduction, …) are implemented for large models.

A general superelement architecture helps using reduced models generated within SDT or imported using FEMLink. Import, use in solutions and optimized full and partial restitution are supported.

Physical Parameterization

The upcom function allows easy manipulations of large parameterized models. Physical parameter variations modulus, density, thickness, …) can be associated with arbitrary element set selections. Model matrices, modeshapes, modeshape sensitivities, and frequency responses can easily be computed at each design step of optimization, updating, viscoelastic vibration analysis, ...
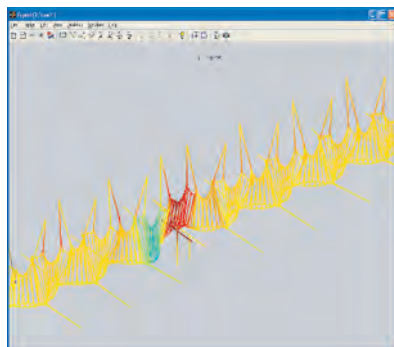
Experimental modal analysis

Data visualization and analysis

The iicom, iiplot graphical user interface for the visualization of Multiple-Input Multiple-Output (MIMO) datasets and FEM results.

Script and menus can be used to generate Bode and Nyquist plots, Multivariate Mode Indicator Function, complex residue phase spread, pole location, etc. Once the plots are generated, simple mouse/key movements let you scan through the data set, get information on certain points, zoom, animate Operational Deflection Shapes (ODS), etc.

Data can be imported from Universal Format files, but also through scripts defining time/frequency response as well as attributes of a data sets (units, physical meaning, headers, …). This is often easier for non standard imports from (Data Acquisition Toolbox, Dactron API, Siglab, …)

A number of signal processing tools are also implemented for filtering, transfer estimation, n^{th} octave band computation, …


SDT based GUI for hammer testing
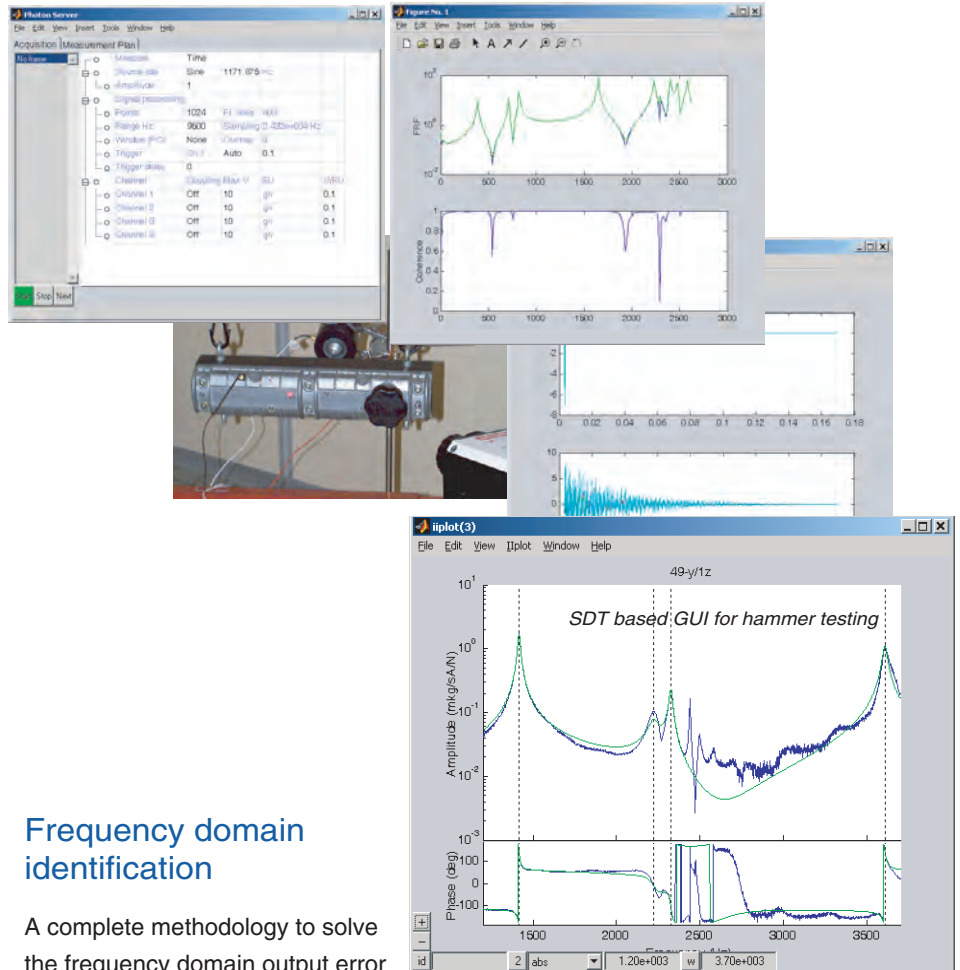
Frequency domain identification

A complete methodology to solve the frequency domain output error problem is proposed. This includes advanced single pole MIMO estimation and model tuning strategies which fully replace traditional procedures based on stabilization diagrams. This iterative approach is both more intuitive and very often more accurate than methods found in other modal analysis packages.

Post processing steps of the identification functions include treatment of MIMO models, multiple modes, real and complex modes, reciprocity, non-proportional damping models, as well as transformations between pole/residue, state-space, second order mass, damping, stiffness, or polynomial forms.

Model format conversion

The SDT provides a full set of two way model format conversion

functions for full order finite element models, truncated normal mode models traditionally used in structural dynamics, frequency response, pole/residue, state space, polynomial transfer function. Direct solutions are supported with an emphasis on providing numerically efficient solutions. Inverse problems correspond to identification phases and result in models can easily be used for Structural Dynamic Modification (SDM).
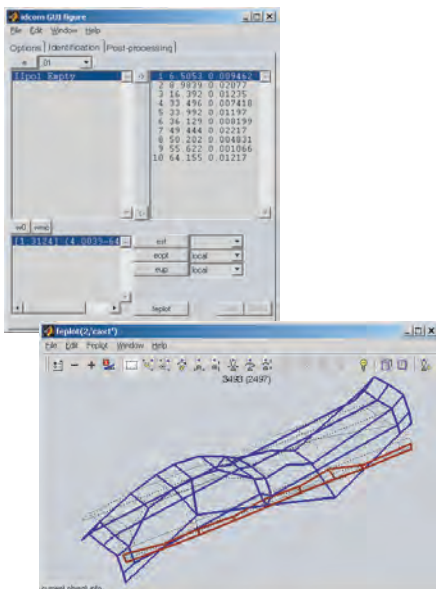
Identification and ODS GUI

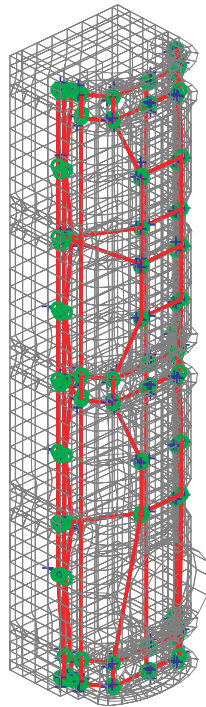*Engine cover (Renault)*

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Test/analysis correlation

Topology correlation

The SDT FEM specification supports a very wide range of sensors: translation, rotation, relative motion, strain, resultant, … These allow for arbitrary directions and non orthogonal sensors, specify laser measurements with a beam origin, … This specification is used for both analysis and test/analysis correlation.

Non-coincident test and FEM nodes are properly handled by finding the test node position within the matched element and using shape functions to relate the measurement to FEM motion at DOFs. Both automated and directed matching are available to accommodate the most challenging situations. The use of an observation equation gives access to all correlation and shape expansion methods with no need to modify the FEM model.

fe_sens also provides sensor placement algorithms including the maximum sequence algorithm which typically gives locations compatible with wire-mesh generation.

Engine cover (Renault)

Correlation criteria

The ii_mac GUI supports the COMAC, MAC, MACCO, POC, and relative error criteria, with standard graphical and direct tabular output to text, excel, tex, automated mode pairing, computation and use of reduced mass in all the criteria.
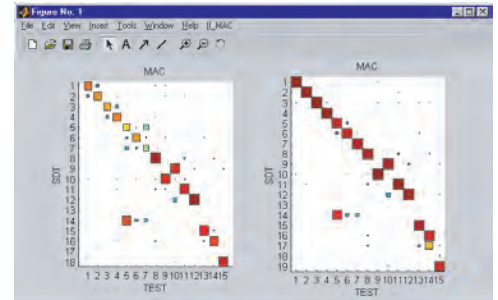
Updating of Ariane V model (EADS)

Shape expansion

Expansion methods for arbitrary sensor configurations are modal, static, dynamic, and the advanced minimum residual with and without measurement error. The use of FEM model reduction lifts the computational restriction on using advanced methods.

For demos, application examples, documentation, and pricing

- www.sdtools.com
  support.sdtools.com
- Contact SDTools directly

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About the product

Developed since 1991, SDT has a new release every year, version 6.2 was released in september 2009. There are more than 600 licenses installed in 20 countries with users at Airbus, Canon, Bosh, Daimler Chrysler, EADS, EDF, ESA/Estec, LANL, NASA, Nissan, PSA, Renault VI, Sandia, Siemens, Sony, Toshiba, Yamaha, …

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