

Structural Dynamics Toolbox 5

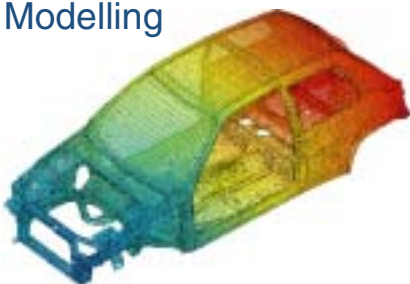
for modelling and testing mechanical systems

The Structural Dynamics Toolbox brings Finite Element Modelling and Experimental Modal Analysis capabilities to the MATLAB environment. Source code access and a library architecture allow very easy user customisation.

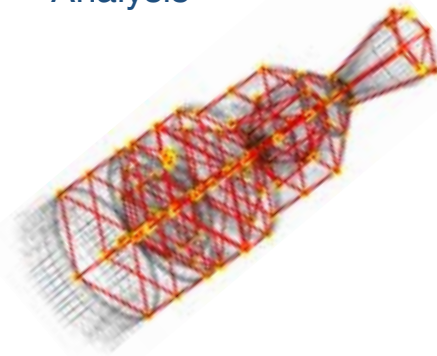
For analysis, the SDT provides a general multiphysics finite element architecture and specialized solvers for large FEM problems and vibration applications. Interfaces with popular FEM codes and Graphical User Interface (GUI) visualization tools let you build on the MATLAB/SDT ease of use to pre-/ post-process computations done, using SDT or other codes, and link with control oriented toolboxes.

For test, the SDT provides all the modal analysis tools needed to exploit frequency domain measurements. GUIs are provided for visualization of responses, frequency domain identification, animation of modes and operational deflection shapes, topological correlation, and test/analysis correlation criteria.

Finite
Element
Modelling



Experimental
Modal
Analysis



Key features

Analysis

3-D multiphysics Finite Element Modelling with an open architecture allowing easy user developments

Pre-processing and visualization of FEM computations

Large scale solvers for statics, dynamics, substructuring and system model building

Physical parameterization of FEM models for optimization or updating

Test

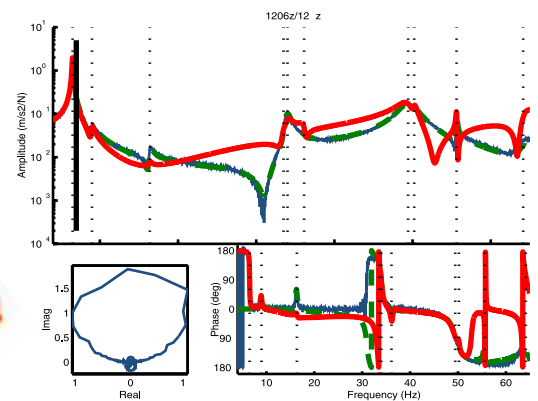
GUI based visualization of test data and frequency domain identification

Animation of ODS, modes and FEM results

Topology correlation, test/analysis criteria and SDM

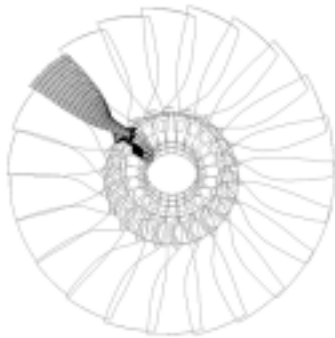
Import/export routines for popular test and FEM model formats

Specialized routines to go from test and finite element models to state-space and other system dynamics formats



System
Dynamics

Finite Element Analysis

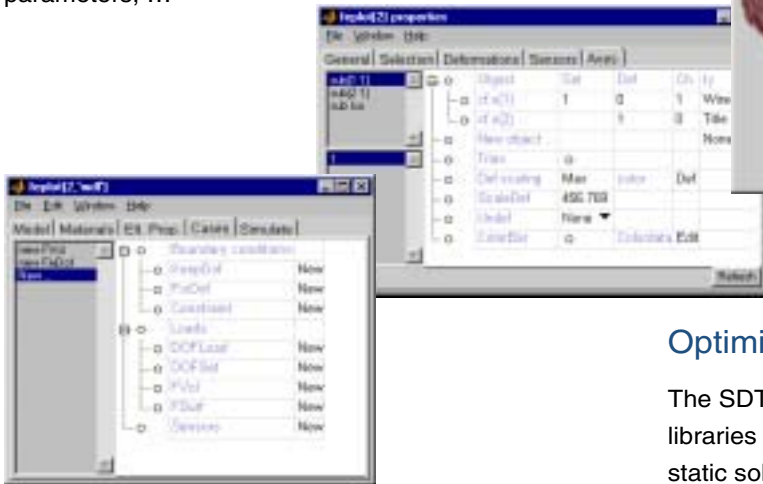


Cyclic substructuring of a fan model (SNECMA)

Model manipulations

The **femesh** user interface enables the creation and extensive manipulations of finite element models. Commands allow element and node manipulation as selection, extrusion, revolution, ...

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



Import/export

FEMLink opens the SDT to other FEM environments : NASTRAN, ANSYS, Universal File, PERMAS, ...

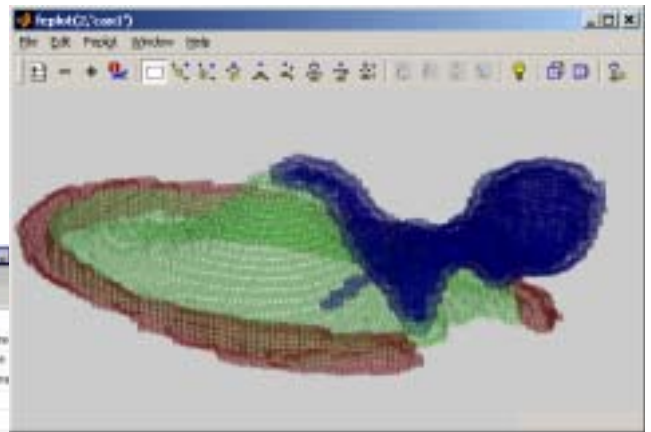
Mesh import capabilities are used to import industrial models that cannot be easily built with **femesh** (structured meshes) or **fe_fmsh** (unstructured 2-D quad meshing).

Result imports are used pass models between FEM environments and SIMULINK using the SDT capabilities for state-space model building from FEM modes.

Element matrix import capabilities transfer full model definition and use SDT solvers for parametric studies requiring physical parameterization.

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. It currently includes standard mechanical elements (beams, shells, 2-D volumes, 3-D volumes) with isotropic and orthotropic elastic and acoustic behaviour. Matrix assembly, distributed loads and stress computations are supported.



Anisotropic volume model of the internal ear (University Hospital Zuerich)

Optimized solvers

The SDT provides alternatives to the MATLAB sparse libraries thus handling much larger problems. This basic static solver is then used to provide partial eigenvalue solutions, model reduction bases (Guyan, Craig-Bampton, MacNeal, damped reduction, ...), transient and frequency responses.

The model reduction tools provided are particularly well suited to build models for use in SIMULINK or the Control Toolbox.

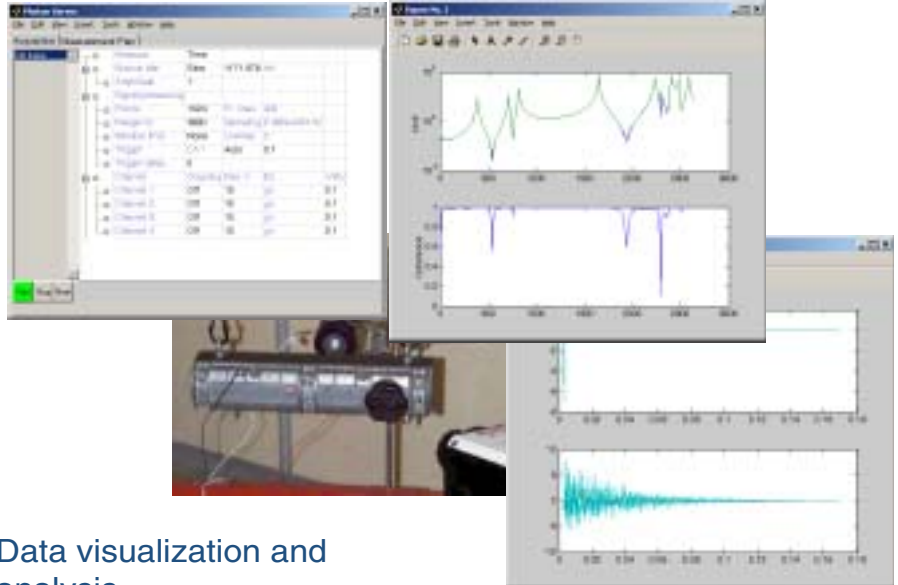
Physical Parameterization

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 management

The SDT manages sets of frequency domain measurements that are either acquired within MATLAB (Data Acquisition Toolbox, Dactron API, Siglab, ...) or imported from an external acquisition environment. The import is usually performed through Universal Format files, but scripts can also be used to define attributes of a data set (units, physical meaning, headers, ...)



SDT based GUI for hammer testing

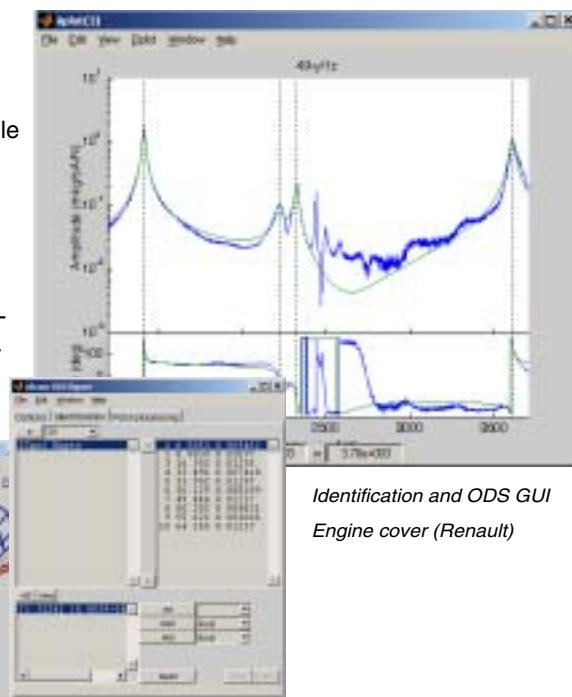
Frequency domain identification

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.

Data visualization and analysis

The *iicom*, *iiplot* graphical user interface for the visualization of Multiple-Input Multiple-Output (MIMO) datasets easily generates Bode and Nyquist plots, Multivariate Mode Indicator Function, complex residue phase spread, pole location, etc. Once the plots generated, simple mouse/key movements let you scan through the data set, get information on certain points, zoom, animate Operational Deflection Shapes (ODS), etc.



Identification and ODS GUI Engine cover (Renault)

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 *nor* models traditionally used in structural dynamics, frequency response *xf*, pole/residue *res*, state space *ss*, polynomial transfer function *tf*. Transformations from frequency response *xf* to *res*, *ss* and *nor* or are supported system identification phases. The resulting models can easily be used for Structural Dynamic Modification (SDM).

Transformations from *xf* and *nor* formats to full order finite element parameters correspond to finite element update problems. Other transformations have direct analytical expressions and are supported with an emphasis on providing numerically efficient solutions.

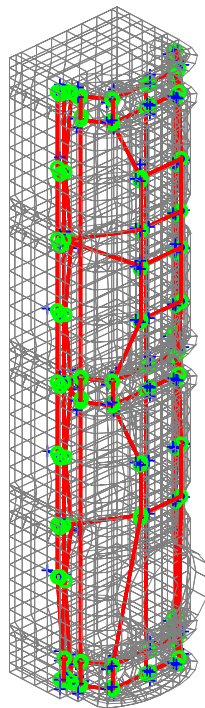
Test/analysis correlation

Topology correlation

SDT visualization and analysis tools support general sensor setups with mixed translation/rotation measurements, non orthogonal sensors, laser measurements, non-coincident test and FEM nodes,

[fe_sens](#) provides sensor placement algorithms and automated and/or directed test/FEM node linking with support of different test/FEM coordinate systems, mixed translation/rotation sensors, and rotation interpolation for non-coincident nodes of volume models.

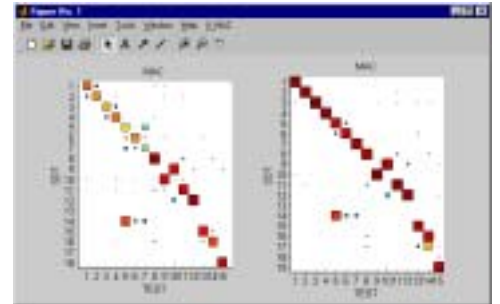
The use of observability equations gives access to all correlation and shape expansion methods with no need to modify the FEM model (a unique and very time saving feature).



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

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Fax: 33 +6 77 17 29 99
- See distributor list at www.sdtools.com/sales.html

About the product

Developed since 1991 by Etienne Balmès, version 5.0 was released in november of 2002. There are more than 500 licenses installed in 15 countries with users at Bosh, Boeing, Daimler Chrysler, EADS, EDF, Ford, Lockheed, LANL, NASA, PSA, Rockwell, Saab Aircraft and Dynamics, Renault VI, Sandia, Siemens, Sony, Toshiba, Yamaha, ...

