CAE Software for Structural Dynamics

As part of our expanded coverage of Computer Aided Engineering, S&V presents an overview of CAE software for structural dynamics currently available to experimentalists and analysts. Though it is neither a comprehensive review nor a competitive comparison, it is our hope that this "first look" will help introduce our readers to many of the CAE tools for this specific application that are available.

Listings are in alphabetical order by company name. This overview was compiled from information provided by selected software users, software suppliers, suppliers' websites and product literature, as well as the University of Illinois at Urbana-Champaigne's National Center for Supercomputing Applications (NCSA) software website, www.ncsa.uiuc.edu/UserInfo/Resources/Software/Repository/.

For complete information on any of the software products listed, we encourage you to go the web sites of the suppliers and contact their sales representatives. It is not possible to cover all the many features and applications offered by these products in this brief overview. For example, ANSYS contains over 1 million lines of code and many pages of their web site are required to adequately describe the product.

Product Types

The programs for structural dynamics listed in the Software Tables are categorized into five main types:

1. Finite Element Analysis. FEA codes that solve a wide variety of engineering problems. They can model many different phenomena including the applications that are addressed in this review – analytical modal analysis, linkage of substructures, linear and nonlinear structural response and transient dynamic response.

2. Experimental Modal Analysis. Programs that use experimental forced or in-operation vibration measurements to generate a structural model in terms of modal parameters including mode shapes, natural frequencies and damping.

3. Model Correlation and Updating Tools. Software tools specifically designed to compare two structural models with the general intent of improving the dynamic performance fidelity of a detailed analytical model so that it properly reflects observations made from verification experiments.

4. Hybrid Experimental/Test Dynamic Modeling. Software specifically designed to build a system dynamics model from multiple component models that may be either purely analytical or test-based.

5. Other Dynamic Modeling Software. Software that can build structural dynamics models and simulations using analytical methods other than finite elements.

User Focus

Software suppliers provide products that target almost every level of experience and application. The Software Tables include a column that categorizes each product's user focus into three classes:

1. User of CAE/Analysis software
2. User of CAT (Computer-Aided Testing) software
3. User of CAE/Testing software.

Pricing

The CAE Software Tables include a column of typical software costs/seat. The pricing of CAE software by suppliers is a complex formula that may involve such factors as the number of seats needed by a given customer, the software modules that are ordered, the usage history, special library package arrangements, site licensing and maintenance contracts. Actual cost of a software package to a given customer may vary substantially from the prices listed in the tables and suppliers' sales representatives need to be consulted for actual licensing and pricing quotations.

Most of the suppliers of CAE software offer special 'student' versions that are powerful packages but are limited to a maximum number of elements and nodes. These versions are substantially lower in cost compared to full-function versions, but are excellent for educational purposes.

Send comments and suggestions on this new software review service to: scott@SandV.com.

Company	Product Name	Type	Function	User Focus	US$/Seat
ABAQUS, Inc. 401.727.4200 www.abaqus.com	ABAQUS	1	Static and dynamic stress analysis with linear and nonlinear material models, acoustics, coupled structural-acoustics.	1	Contact Vendor
ALGOR, Inc. 412.967.2700 www.ALGOR.com	Professional Multiphysics	1	Includes static stress analysis and mechanical event simulation (MES) with linear and nonlinear material models and linear dynamics.	1	25,000+
	Professional Static/LM	1	Includes static stress analysis and is extensible to mechanical event simulation (MES) with linear and nonlinear material models and linear dynamics.	1	5,000+
	ALG/NASTRAN	1	Includes a compete NASTRAN solution for static stress with linear material models, natural frequency (modal), critical buckling load, extensible to mechanical event simulation (MES) with linear and nonlinear material models and linear dynamics.	1	8,000+
Altair Engineering 248.614.2400 www.altair.com	HyperWorks	1,3	Modeling, assembly, optimization visualization and process automation tools.	1	–
ANSYS, Inc. 724.514.2851 www.ansys.com	ANSYS/Mechanical	1	Finite element analysis of linear and nonlinear structural response, buckling, modal analysis, full harmonic response, transient dynamic response, electro-magnetic and fluid flow problems.	1	Contact Vendor
Brüel & Kjær 800.332.2040 www.BKhome.com	Structural Dynamic Test Consultants	2	Suite of software that graphically guides users through actual modal and ODS tests.	2	5,000-8,000
	Operatonal Modal Analysis	2	Response only modal analysis, calculate resonance frequencies/damping/mode shapes without measuring input force.	2	4,500-13,000

Company	Product Name	Type	Function	User Focus	US$/Seat
Brüel & Kjær (cont'd)	Multiple-Input Multiple-Output Analysis	2	Software option used to calculate multiple in/multiple out FRF and coherence.	2	1,800
Cambridge Collaborative, Inc. 617.876.5777 www.seam.com	SEAM	5	Modeling and predicting the acoustic and vibration response of complex structures at mid- to high-frequencies.	1	–
Comsol, Inc. 781.273.3322. www.comsol.com	FEMLab	5	Physical process modeling described with partial differential equations.	1	–
Dynamic Design Solutions, N.V. +32.16.40.23.00 www.femtools.com	FEMtools Framework	1-4	Analysis and scripting framework for linking analysis and test, simulation, process integration and optimization.	3	5,000-10,000
	FEMtools Pretest	1-3	Modal test planning from baseline FEA.	3	10,000-15,000
	FEMtools SDM	4	Structural dynamic modification.	3	10,000-15,000
	FEMtools Correlation	3	Test-FEA correlation analysis tools.	3	15,000-20,000
	FEMtools Model Updating	3	Sensitivity analysis, automated finite element model updating, uncertainty analysis.	3	20,000-25,000
Engineous Software Inc. 800.374.9235 www.engineous.com	iSIGHT	5	Integration tool for executing-simulation based design processes.	1,3	–
ESI Group 248.203.0642 www.esi-group.com	AutoSEA2	5	Real-time broadband noise and vibration prediction, analysis and design.	1	–
LMS International +32.16.384.200 www.lmsintl.com	LMS Virtual.Lab Modeling	1	System level modeling for static and dynamic analysis including general pre- post-processing.	1	Contact Vendor
	LMS Virtual.Lab N&V	1,3,4	N&V system level analysis including: dynamic response, contribution, correlation, sensitivity and updating.	1,3	Contact Vendor
	LMS Virtual.Lab Acoustics	1,4,5	Interior and exterior acoustic simulation and design (SYSNOISE).	1,3	Contact Vendor
	LMS Virtual.Lab Motion	5	Multi-body dynamics simulation (DADS).	1	Contact Vendor
	LMS Virtual.Lab Durability	1,4,5	Component and system level durability and life time analysis.	1,3	Contact Vendor
	LMS Virtual.Lab Optimisation	5	Multi-attribute design optimization.	1,3	Contact Vendor
	LMS Test.Lab Signature Testing	2,5	Signature analysis including operating mode shape and modal analysis.	2	Contact Vendor
	LMS Test.Lab Structures	2,5	SIMO, MIMO modal analysis and design.	2,3	Contact Vendor
	LMS Test.Lab Environmental Testing	2,5	Fixed base modal testing (operating).	2	Contact Vendor
	LMS Pimento	2	Structural testing and modal analysis software.	2	Contact Vendor
MSC.Software 714.444.5188 www.mscsoftware.com	MSC.ADAMS	5	Solves non-linear equations of motion of 3D mechanical systems. Results include forces, positions, velocities, accelerations and realistic animation.	1	Contact Vendor
	ADAMS/Vibration	5	Predict forced vibrations using frequency domain analysis to identify, isolate and refine system level vibrations.	1	Contact Vendor
	MSC.Nastran	1	Finite element analysis for simple to complex structures, linear and nonlinear analyses of structural, fluid, thermal, and coupled systems.	1	Contact Vendor
	MSC.Actran	1	Acoustics and vibro-acoustics performance of structural and mechanical systems.	1	Contact Vendor
	MSC.Dytran	1	Simulate extreme, short-duration dynamic events involving the interaction of fluids and structures, or problems involving the extreme deformation of structural materials.	1	Contact Vendor
	MSC.Marc	1	FEA program for simple to complex, linear and nonlinear analyses of structural, fluid, thermal and coupled systems.	1,3	Contact Vendor
	MSC.Patran	1	Open-architecture, interactive graphics providing a complete CAE environment for FEA modeling, meshing, and results evaluation.	1	Contact Vendor

Company	Product Name	Type	Function	User Focus	US$/Seat
MTS Systems Corporation 952-937-4000 www.mts.com	I-deas Pro	2,4,5	Wide range of single- and multi-input test control and post processing for structural, modal and acoustic testing and analysis.	2,3	5,000+
	I-deas Pro Correlation	3	Interactive comparison of modal and ODS test results or other reference models to FEM results.	3	5,000+
	CAE Calibrator	3	Automatic dynamic NASTRAN model updating and calibration to match test results.	3	10,000+
	I-deas Pro Structural Modification	3,4	Interactive design of tuned absorbers, local mass and stiffness additions, and other structural design changes based on experimental or FEM modal results.	2,3	5,000+
	Virtual Test Lab (VTL)	4,5	Include FEM- and MBD-based representations of laboratory durability test machines and actual lab drive signals, in virtual models of long-term dynamic durability simulations.	2,3	25,000+
	Experimental Dynamics Modeling (EDM)	4	Neural net representation of highly nonlinear components like dampers, mounts, tires and bushings, for use in FEM and MBD models.	2,3	25,000+
NOESIS Solutions NV +32.16.384.495 www.noesissolutions.com	OPTIMUS	5	Process integration and design optimization (PIDO), including DOE, model optimization.	1,3	Contact Vendor
SFE Gmbh Berlin +49.(0)30.467.767.0 www.sfe-berlin.de	SFE Akusmod	5	Interior acoustics modeler for noise and vibration studies, simulation of acoustic subsystems, noise prediction, sensitivity analysis and acoustic optimization.	1	–
	SFE Mecosa	5	General mesh-manipulating and coarsening tool for acoustic analysis and for crash results post-processing.	1	–
Structural Vibration Solutions Main: +45 9635 4422 US: 801.492.4789 www.svibs.com	ARTeMIS Testor 1.2	2	Test support tool for natural input modal testing. UFF and MATLAB ASCII input, geometry definition, DOF definition, data validation and data export.	2	3,000-6,000
	ARTeMIS Extractor 3.4	2	Natural Input modal analysis for mechanical and civil structures. Frequency domain and time domain identification with validation against other identifications or FEM.	2	2,000-17,000
Spectral Dynamics 408.918.2500 www.spectraldynamics.com	STARModal	2	Modal analysis, curve fitting, acoustic intensity analysis, operating deflection shapes, structural dynamics modification, forced response simulation.	2	1,200-2,400
	STARAcoustics	5	Acoustic intensity analysis, noise source identification, sound power analysis.	2	1,200-2,400
UGS PLM Solutions 513.576.2400 www.eds.com	I-deas NX Series MasterFEM	1,4,5	Advanced linear and nonlinear FE modeling and CAE results visualization for time and frequency domain dynamics, virtual modal analysis, statics, strength analysis, fatigue, thermal, combined flow/thermal, crash and multi-body dynamics simulations.	1	17,500+
	NX Scenario	1	CAD-integrated motion simulation and easy-to-use FE-based linear static strength, durability and steady-state thermal analysis.	1	13,500+
	FEMAP	1	Pre/post processing and NX Nastran-based solutions for linear and nonlinear statics, dynamics, thermal, and strength studies.	1	7,000+
	NX NASTRAN	1,4,5	Solver now provided by UGS PLM for advanced linear and nonlinear structural analysis including: stress, vibration, buckling, dynamic response, superelements, aeroelasticity, DMAP and multi-CPU parallel processing.	1	15,000+
Vibrant Technology 831.430.9045 www.vibetech.com	ME'scope VES 4.0	2,3,4	ODS analysis, modal analysis, acoustics analysis, response simulation, structural modifications, experimental FEA.	2	3,000-16,000