IMAT™ v2 | Interface for MATLAB®, Analysis, and Test

SOFTWARE

OVERVIEW

IMAT is a suite of utilities offered by ATA Engineering, Inc. (ATA) which facilitates data sharing between MATLAB, analysis tools, and test software. The IMAT Toolbox provides a framework for easily importing FEA simulation data and measured test data into the MATLAB environment to access its versatile programming and mathematical strengths.

With the IMAT Toolbox, test and simulation data such as mode shapes, time histories, spectra, and other functions can be viewed and manipulated in MATLAB with all of the data attributes preserved.

IMAT+ is a new package with advanced functionality and features that extends IMAT. IMAT+ allows the user to work with their Nastran and ABAQUS simulation data. It also has a new full-featured GUI for plotting and editing functions.

MATLAB ACCESS TO SIMULATION DATA

The IMAT Toolbox allows users to acquire test data or recover simulation data in Nastran, I-deas®, or ABAQUS, then operate on that data using the full capabilities of MATLAB. Operations such as matrix multiplications and repetitive data calculations can be performed in the powerful MATLAB matrix language.

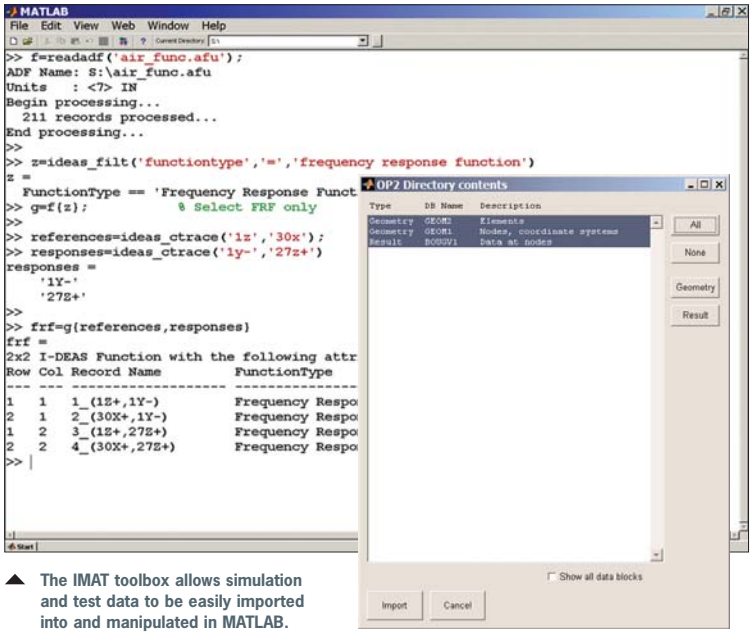
Several different platform-independent methods are provided accessing simulation data from within MATLAB. Nastran users can read data directly from the binary result database (.op2) or the ASCII result output punch (.pch) file. I-deas users can import associated data files (ADFs) or can read the I-deas universal file format (.unv). Data from ABAQUS simulations is read directly from the output database (.odb).

The IMAT Toolbox makes it easy to perform powerful operations on simulation data. Selection, sorting, and filtering of multiple functions are straightforward, thanks to built-in data types for function selection filters and coordinate traces. You can even build three-dimensional spectral matrices (inputs x outputs x frequency) using the multi-dimensional data types in MATLAB.

FEM entities such as coordinate systems, nodes, elements, and tracelines can also be imported into MATLAB. Several utility functions provided with IMAT allow for coordinate transformations and plotting, allowing you to display and animate mode shapes. You can even create AVI files of your mode shape animations.

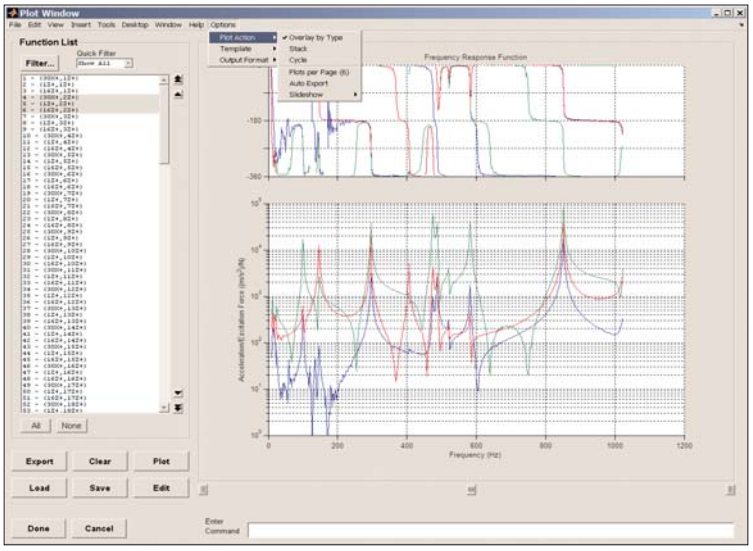
MATLAB ACCESS TO TEST DATA

With the IMAT Toolbox, users can also easily import, manage and manipulate collected test data. IMAT imports test universal file formats (.unv). IMAT supports files written from B&K I-deas Pro test software, LMS test software, and ME'Scope by Vibrant Technology.



▲ The IMAT toolbox allows simulation and test data to be easily imported into and manipulated in MATLAB.

▲ IMAT+ GUI for user selection of ABAQUS data and Nastran OP2 data to be imported into IMAT.



▲ Plot time history data in IMAT+ with new plotting interface.

IMAT supports common test data attributes including reference coordinates, response coordinates, abscissa type, ordinate type, number of data points and resolution, and many others. These data attributes are associated to the x-y data through the IMAT object model.

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TOOLBOX COMPONENTS

The IMAT toolbox has four components:

- Definition of the structures and methods for both simulation and test data.
- Direct access programs that allow I-deas, MSC.Nastran, NX Nastran, and ABAQUS simulation data to be imported into MATLAB.
- Direct access programs that allow I-deas, LMS, and ME'Scope test data to be imported into MATLAB.
- Examples directory containing useful functions that utilize IMAT to compute mode indicator functions, orthogonality, FRF synthesis, and others.

SUPPORTED DATA TYPES

IMAT includes methods for storing and manipulating these data types:

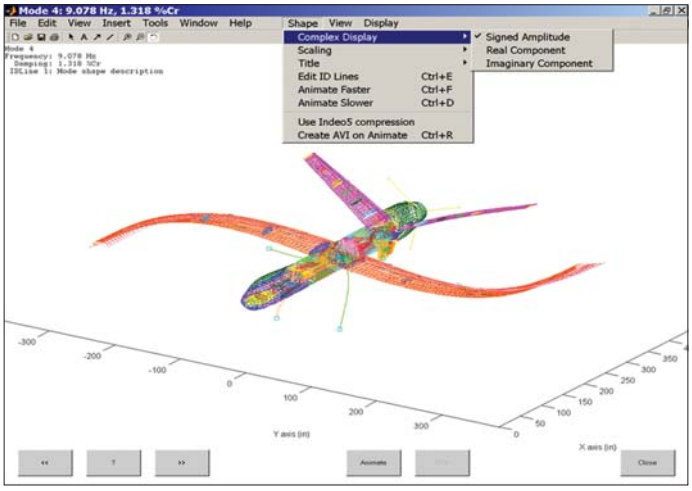
- Functions and time histories
- Mode shapes
- Coordinate traces
- Function selection filters
- FEM connectivity (nodes, elements, tracelines and coordinate systems)
- Substructures (mass, stiffness and back expansion matrices)

IMAT reads the following files:

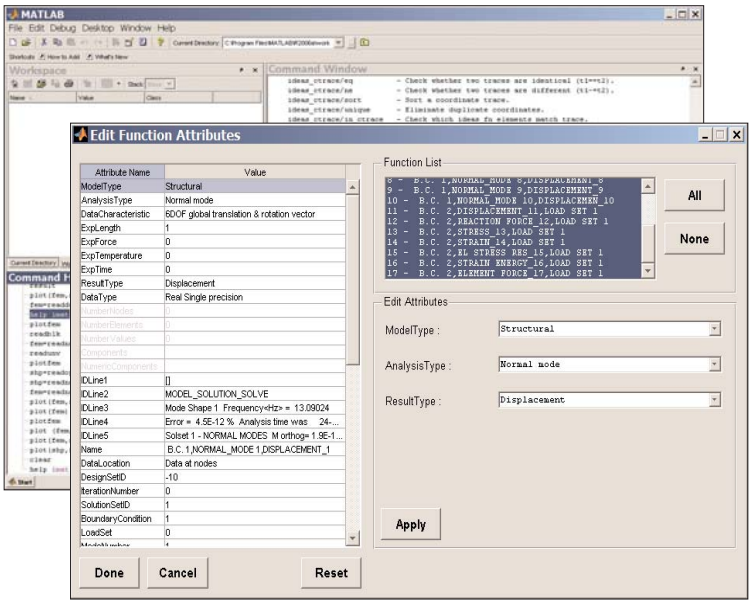
- Nastran punch, OUTPUT2
- Nastran DMI and DMIG matrices
- ABAQUS output database (.odb)
- I-deas Associated Data Files (.afu, .ati, .ash)
- Universal files written by I-deas, B&K I-deas Pro, LMS, ME'Scope, others

NEW FEATURES IN IMAT V2

New Functionality	IMAT	IMAT+
Supports MATLAB R2006a	X	X
Imports NASTRAN OP2 and bulk data files		X
Reads Nastran PCH DMI and DMIG-formatted files		X
Reads results from Abaqus ODB files		X
Accelerations treated as G units	X	X
Support for "universal dataset 18" (coordinate systems)	X	X
New 3D plotting capability and enhanced 2D plot funcitonality	X	X
New Results Object		
Work with various result types such as stress, strain, force and many others	X	X
Easily convert other IMAT data types to a Result	X	X
New I-deas Function Capabilites		
Full-featured GUI for plotting functions		X
Convenient GUI for editing function attributes		X
New functions filterf, fft, psd and truncate	X	X
Display functions on a 3D axis	X	X



▲ IMAT allows you to display and animate mode shapes in MATLAB and create AVI files of the animated modes.



▲ IMAT+ allows you to edit I-deas shape/function/results attributes

HARDWARE PLATFORMS

The MATLAB toolbox was written primarily in the MATLAB language. Licensing code is written using MATLAB's MEX facility. Versions are available for Windows, Linux, and SUN platforms. Older versions of the toolbox are available for SGI and HP-UX. MATLAB R2006a (or higher) is a prerequisite. Previous versions of IMAT support older MATLAB versions.

ABOUT ATA

ATA Engineering has more than 25 years of experience in the field of structural dynamics analysis and testing, and is a world leader in the area of test-analysis correlation and model updating. For more information please visit www.ata-e.com.

OVERVIEW

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IMAT+ is a new package with advanced functionality and features that extends IMAT. IMAT+ allows the user to work with their Nastran and ABAQUS simulation data. It also has a new full-featured GUI for plotting and editing functions.

IMAT+Testkit offers significant functionality that extends IMAT's capabilities for the test engineer. IMAT+Testkit is a collection of utilities to aid in test planning and post processing. It includes methods for pre-test analysis to allow users to optimally select accelerometer locations for a modal test, provides procedures for reducing a full FEM down to the test measured degrees of freedom, as well as curve-fitting routines for extracting shapes from the test data.

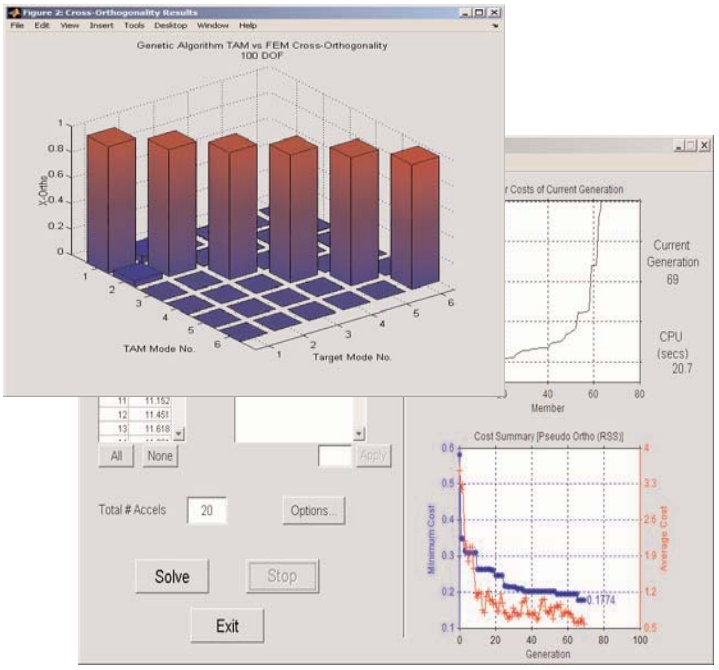
The IMAT+Testkit toolbox is comprised of several components including the Test-Analysis Model Toolkit (TAMKIT), the Genetic Algorithm (GA), and the Modal Test Kit (MTK), which includes the Alias-Free Polyreference (AFPoly) curve fitter.

PREPARE/PLAN MODAL TESTS WITH IMAT+TESTKIT

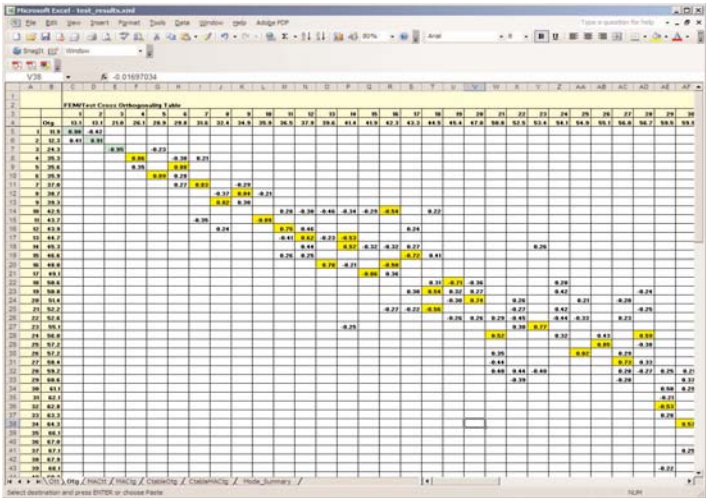
The **Test-Analysis Model Toolkit** (TAMKIT) is intended for structural dynamics engineers who perform pretest analysis and posttest correlation of modal survey tests. It provides procedures for selecting the instrumented degrees-of-freedom and for reducing the FEM matrices to these DOF. It is implemented as a set of Nastran DMAP alters, with some Matlab functions used to read and interpret the Nastran data. It also includes procedures for comparing two similar models, and for comparing test and analysis modes on completion of the modal test.

With the use of the **Genetic Algorithm** (GA), users can optimally select accelerometer locations for a modal vibration test. The GA will efficiently select a set of accelerometer locations to maximize the linear independence of test-measured mode shapes. Users can accommodate multiple FEM configurations, simultaneously selecting the best accelerometer locations for multi-configuration modal tests to minimize the test setup time.

The **Modal Test Kit** (MTK) is a MATLAB toolbox that contains routines that are useful when performing modal survey tests. These routines include methods for sensor and exciter placement, extracting modes from test data, verifying shape extractions through FRF synthesis comparisons,



▲ Genetic Algorithm cross-othrogonality results and accelerometer selection.



▲ MTK xy-plot of frequency response functions and cross orthogonality report.

providing shape independence and completeness checks, and other useful routines. FEM entities such as coordinate systems, nodes, elements, and tracelines can also be imported into MATLAB. Several utility functions provided with IMAT allow for coordinate transformations and plotting, allowing you to display and animate mode shapes. You can even create AVI files of your mode shape animations.

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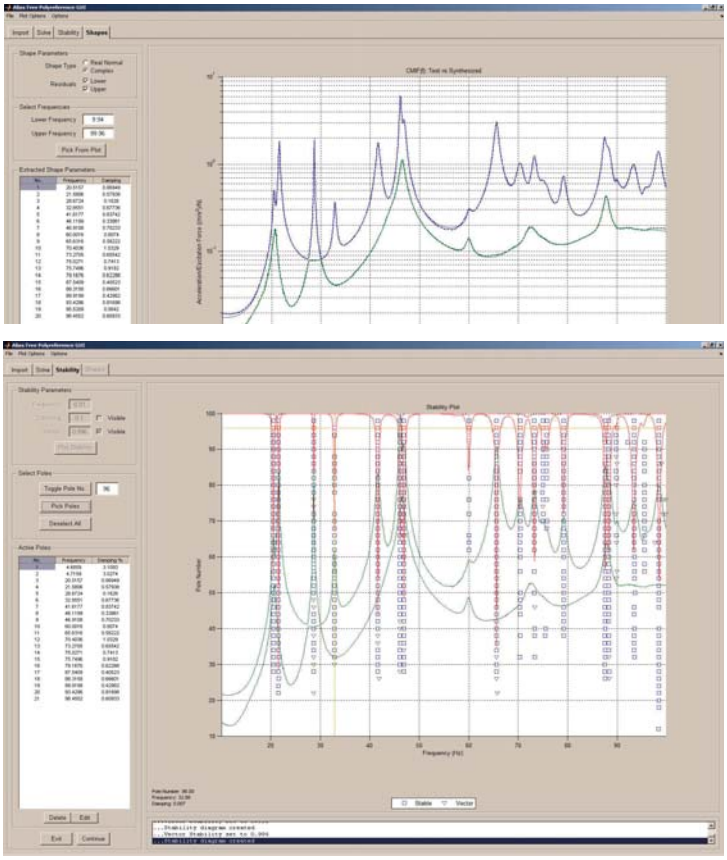

▲ Synthesized Mode Indicator Functions from extracted shapes, and stability plot generated by AFPoly.

EXTRACT MODAL PARAMETER WITH IMAT+TESTKIT

AFPoly™ stands for "Alias-Free Polyreference" and refers to a multi-reference modal parameter estimation technique that was recently developed by ATA Engineering. AFPoly is a frequency domain Laplace method that uses orthogonal polynomials, and accounts for out-of-band poles when solving for modal parameters.

The AFPoly GUI guides users through the process in solving for modal parameters (shape coefficients, damping, and natural frequency) in a step-by-step manner. After importing frequency response functions (FRF) into the GUI, the user will solve for roots. A stability diagram helps the user select the valid roots. Shapes are then extracted and verified by overlaying various test and synthesized mode indicator functions. Once the shapes have been verified, they can be exported.

IMAT+ TESTKIT KEY FEATURES

Key features in the Genetic Algorithm

- Direct Nastran compatibility
- Works with multiple FEM configurations and can simultaneously select accelerometer locations on multiple FEM configurations
- Automated and GUI driven
- Uses industry-standard Pseudo-Orthogonality or Self-MAC cost functions to rank the effectiveness of a set of accelerometer locations
- Orthogonality, MAC, and frequency comparisons can be exported to Excel-compatible XML format to document results

Key features of the MTK toolbox

- Pretest activities including:
  - Exciter selection & Pretest results summary in xml file
- Single and multiple reference mode indicator functions.
- Mode shape extraction utilities including:
  - Polyreference GUI, Single reference and Enhanced FRF extraction methods
- FRF synthesis from modal parameters
- Test Mode Shape Verification
  - Independence and Completeness Checks based on MAC or orthogonality.
  - Test vs. FEM Comparison Tables
  - Test summary xml files
  - Advanced tools such as grid point energy checks.
- Supplemental Routines
  - Sort modes from multiple extractions to generate final mode set
  - Remove bad sensor from TAM (Test-Analysis-Model) matrices
  - Back expand mode shapes to test display model for viewing

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