Virtual OMA for Test Planning

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Dynamic Design Solutions (DDS) NV

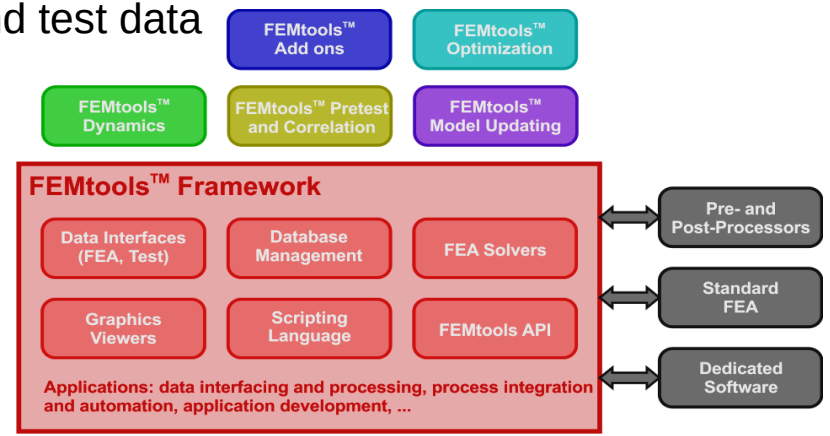
IOMAC 2025 – 23 May 2025

Dynamic Design Solutions

FEMtools
simulate > validate > update > optimize

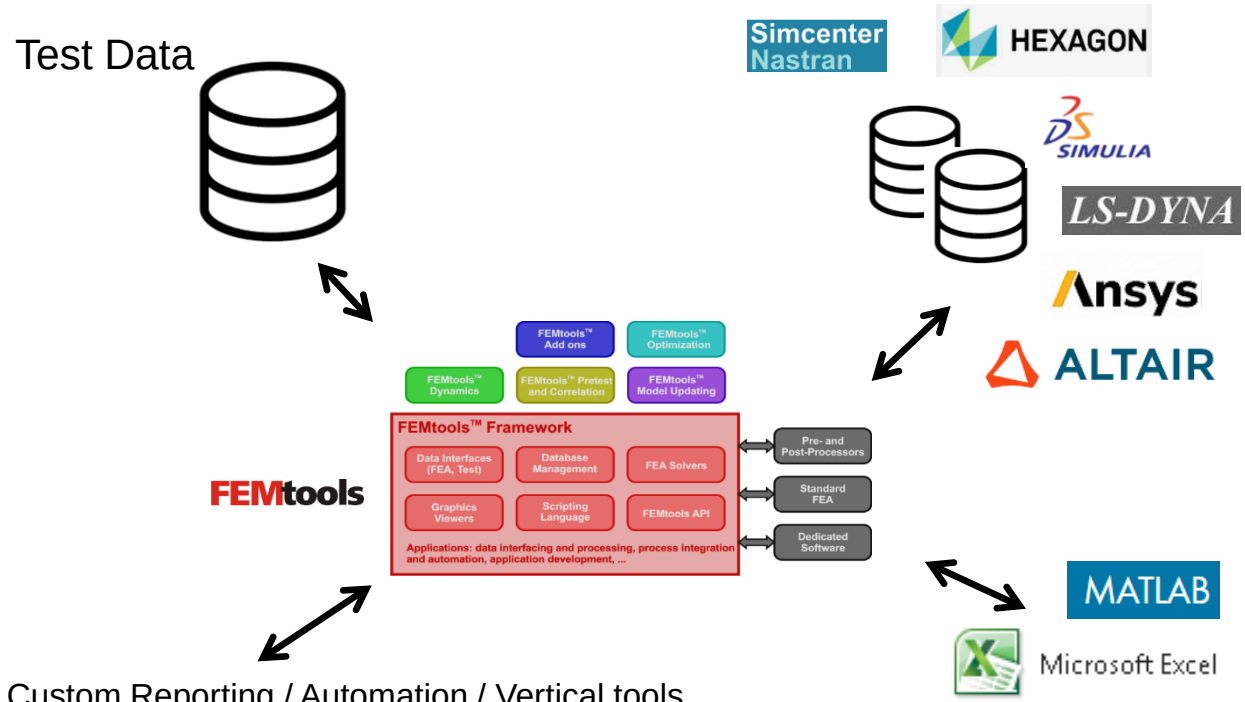
Dynamic Design Solutions

- CAE software development and services
- Specializing in structural dynamics, integration of FEA with testing, validation and updating of finite element models
- Key functionalities of software
  - Multi-functional, cross-platform and solver-independent CAE software suite providing analysis and scripting solutions
  - Neutral, open database combining FE and test data
  - Easy integration in any CAE workflow
  - Customizable, extensible

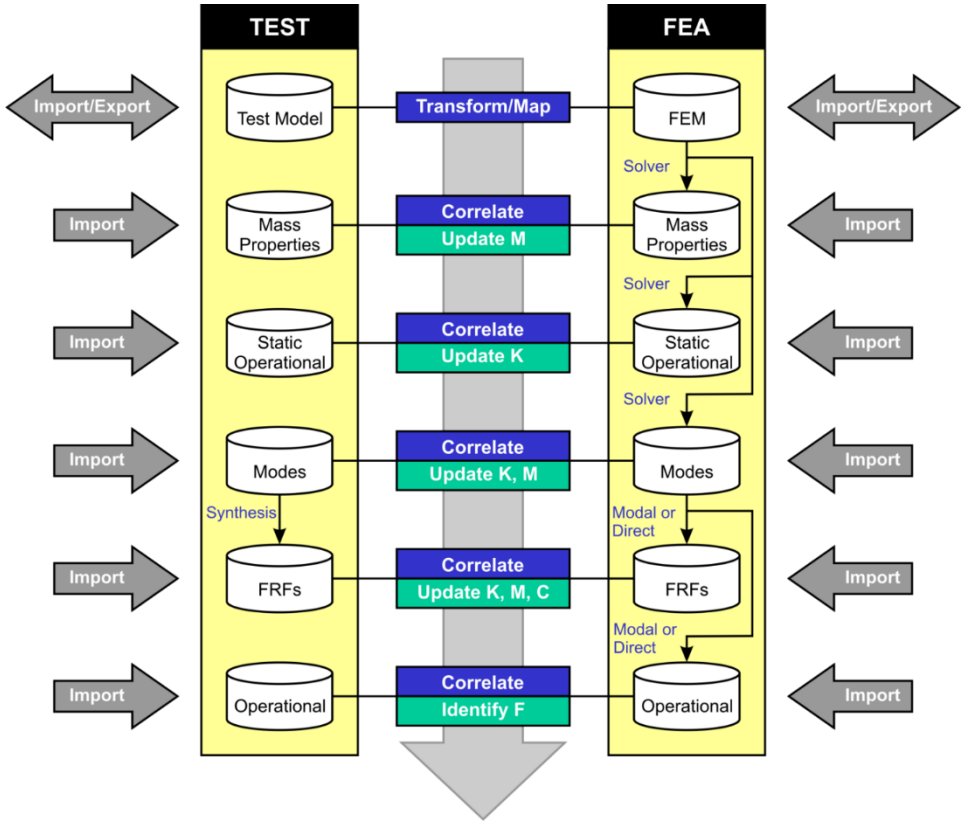


FEMtools
simulate › validate › update › optimize

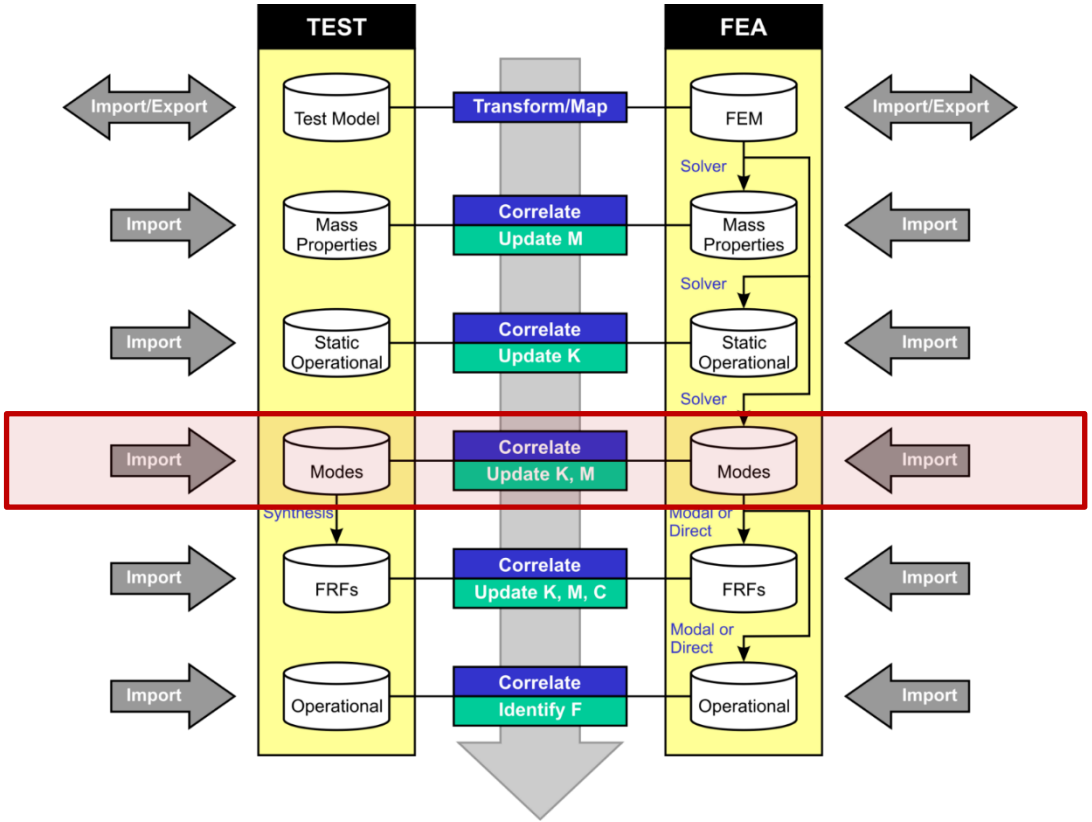
Bridging Test and Simulation



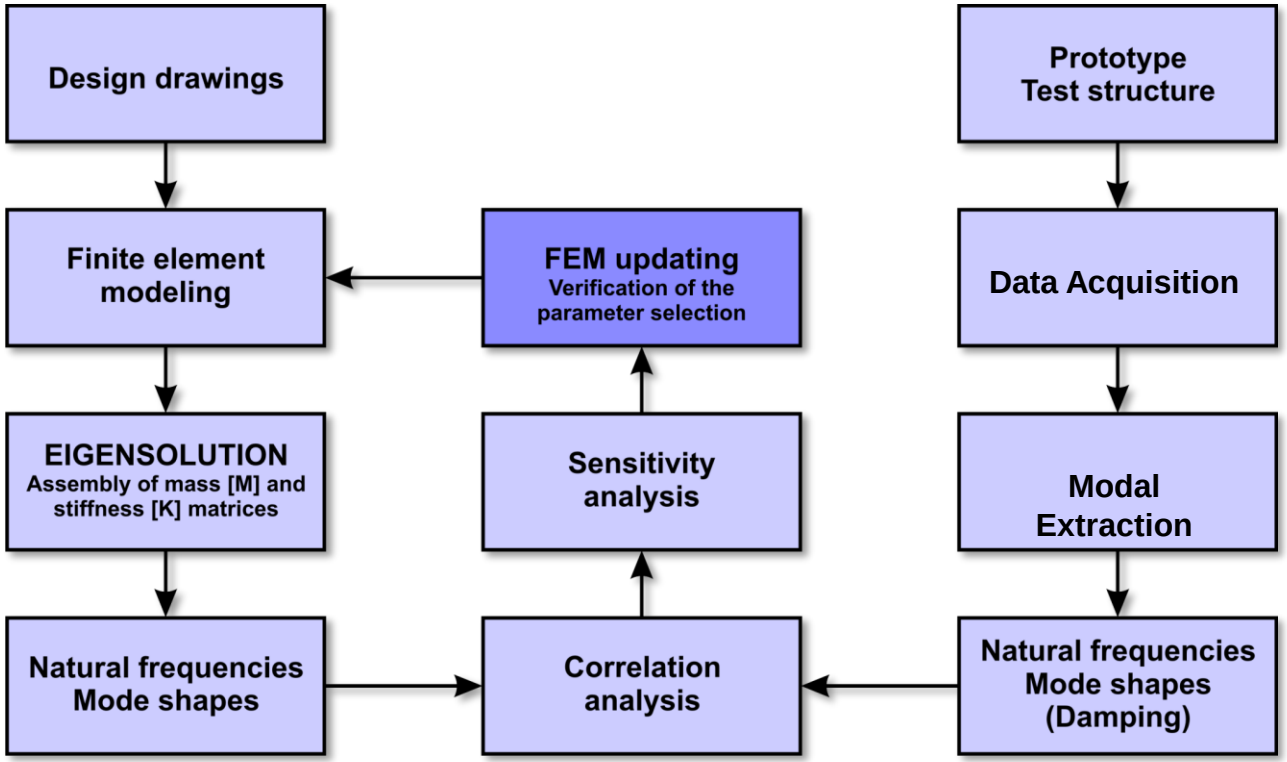
Correlation and FE Model Updating - Overview



Correlation and FEM Updating - Overview



Modal–Based Correlation and Model Updating



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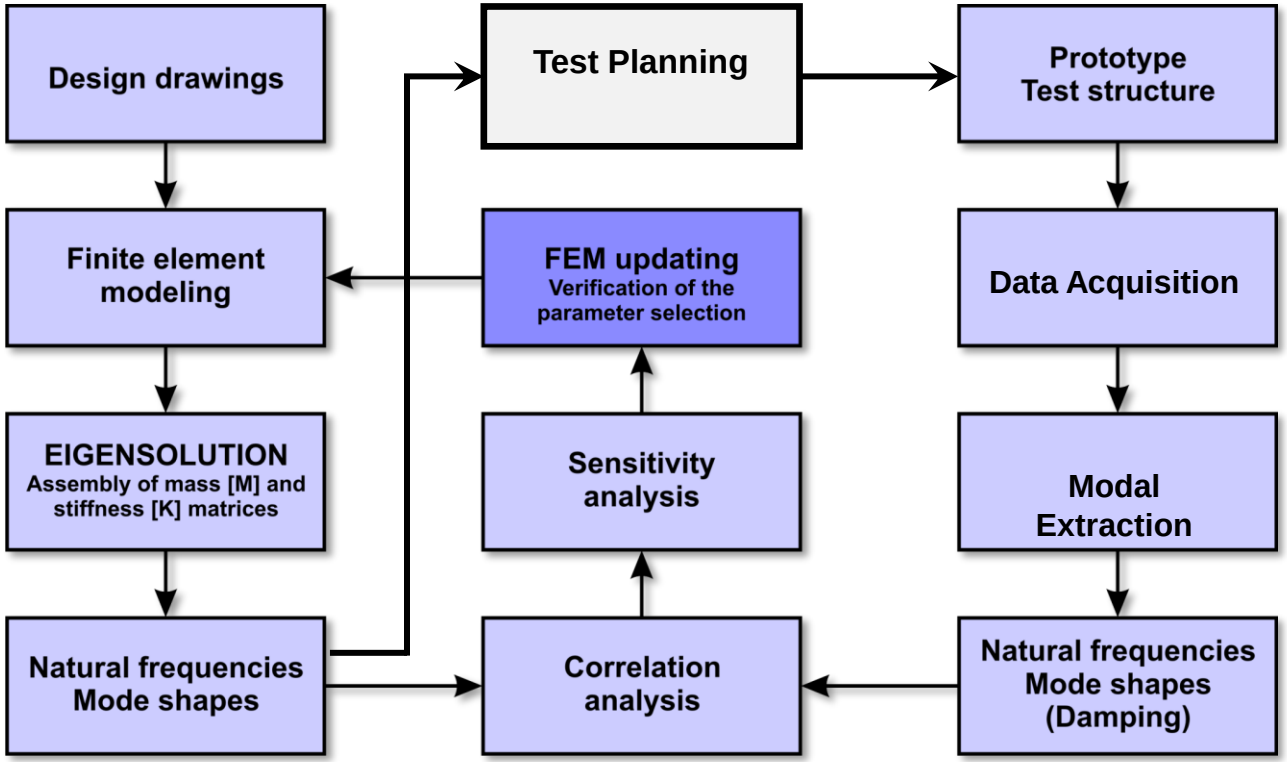
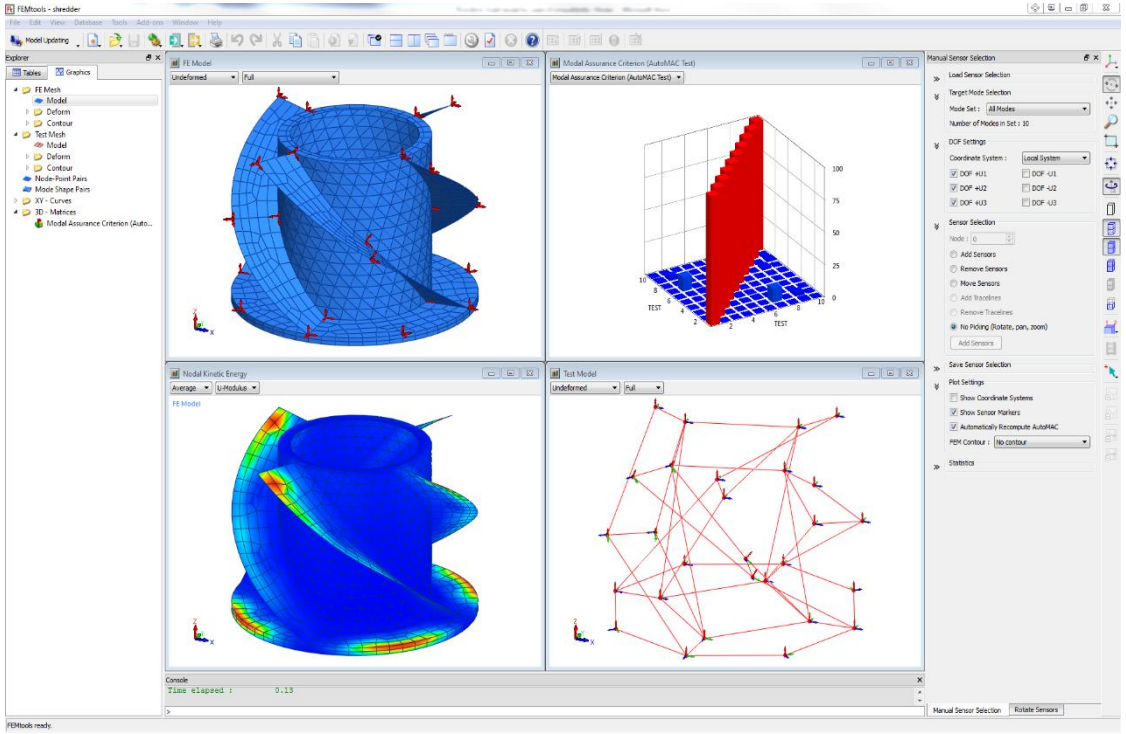
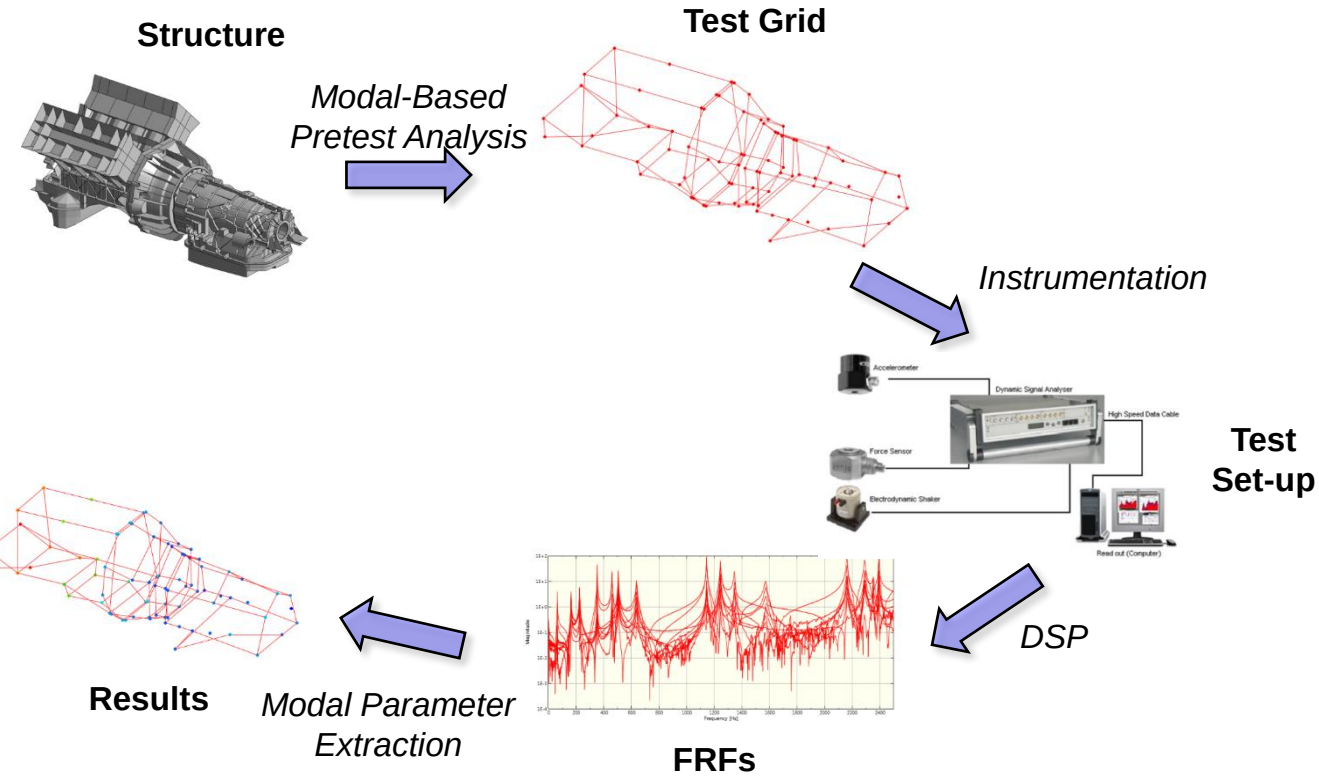


Test Planning using a Baseline FE Model

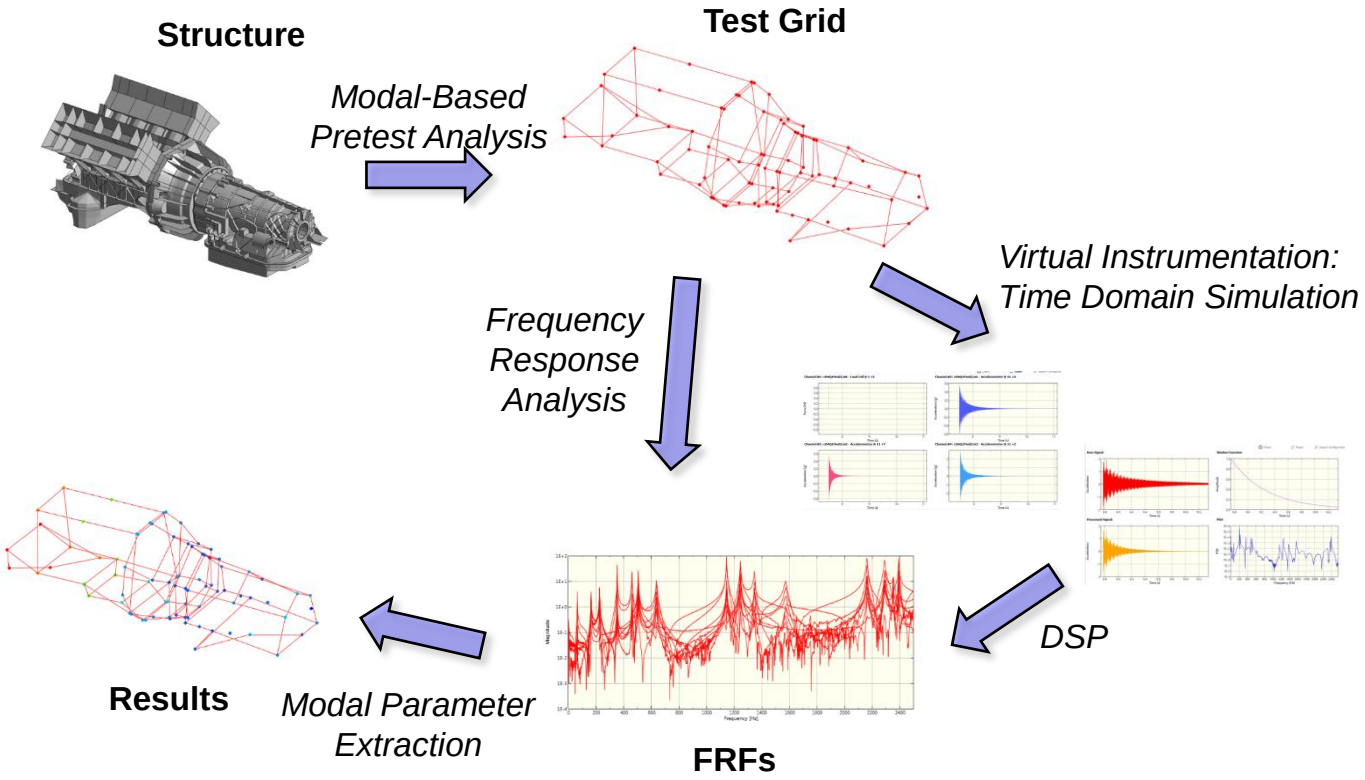
- Where to test, how many sensors, how to excite, how to suspend, what to expect,…



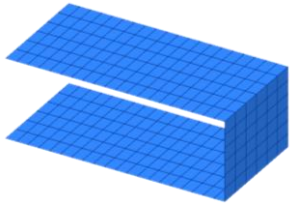
The Physical Modal Testing Workflow



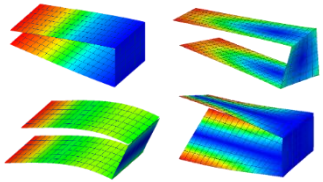
The Virtual Modal Testing Workflow



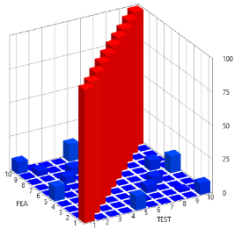
Virtual Try-Out by OMA Simulation



FE
Model

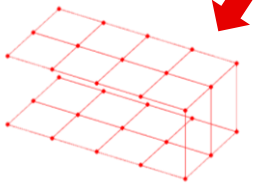


Analytical
modal base

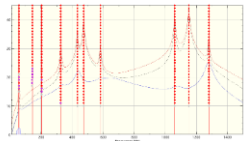


Correlation
(MAC)

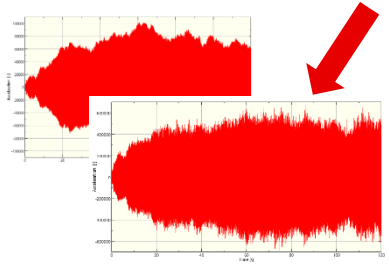
Modal-Based
Pretest Analysis



Test Model

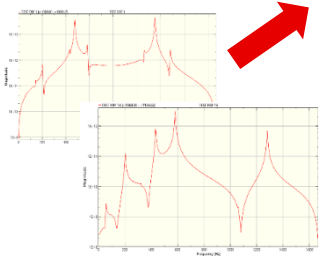


MPE

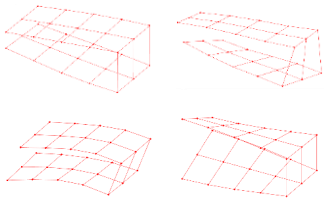


Simulated Test Data

DSP



Cross Power
Spectra

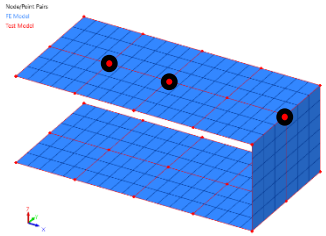


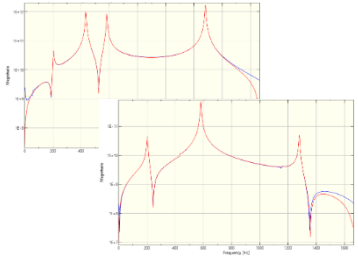
Test modal base

Some Applications

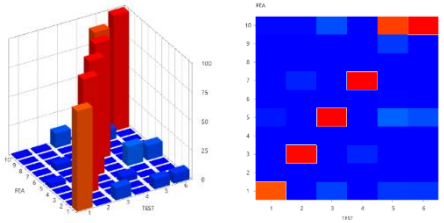
- Automation for parametric studies
- Decide on parameters for excitation signal, time domain simulation, DSP, modal parameter extraction
- Selection of reference channels for OMA with roving sensors
- Additional pretest analysis tasks
  - Simulation for Rigid Body Properties Extraction (RBPE)
  - Mass loading evaluation
  - Sensor batch creation
  - Stress analysis to avoid overloading
- Test model preparation:
  - Computing normal directions at test locations
  - Export the test model to test software

Reference Channel Selection for OMA

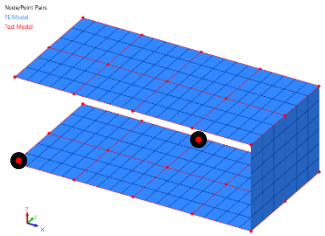


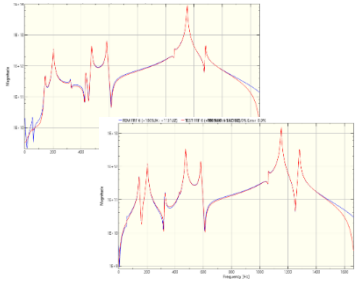


BAD CHOICE

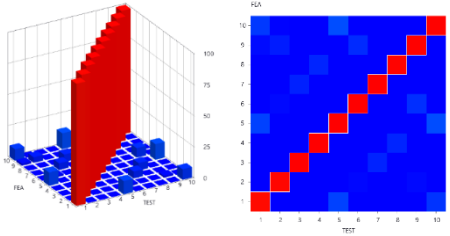


MISSING MODES





GOOD CHOICE



ALL MODES FOUND

Automation for Parametric Studies

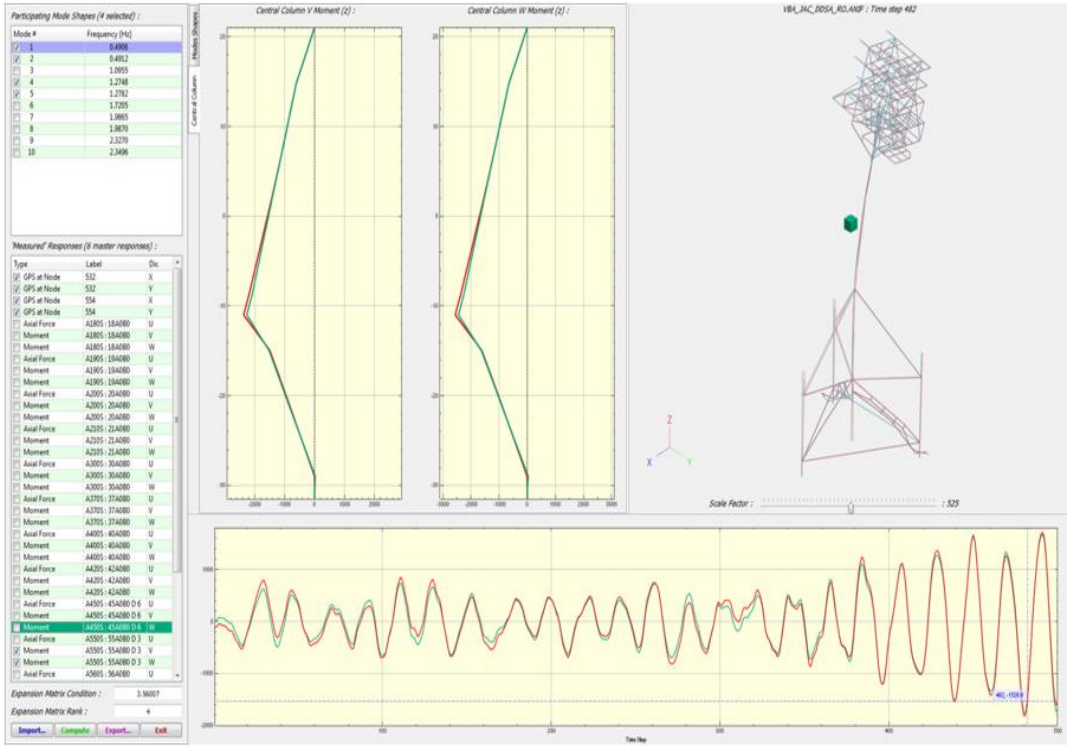
- Automation through scripting can be used for parametric studies and to study uncertainties and variability.
- Excitation
  - Location, direction, amplitude
  - Excitation signal (impact, chirp, random, burst random)
- Time domain simulation
  - Signal length, time step
- DSP
  - Blocksize, windows, filtering
- MPE
  - Maximum order
  - Min and max frequency
  - Pole selection

```
clear all

search fem format femtools file jimbeam.fdb

compute mass stiffness
dynamic vector 10 fmin 10

define tdssignal  1 node 1000 dof +uz type force

define tdssignal  2 node 1000 dof +ux type acceleration
  ...
set tds length 120 step 0.0003
tds generate signal 1 type random amplitude 0.5 distribution uniform
tds plot signal 1
tds compute
tds convert force off # copy signals to test database
   ...
dsp xps blocksize 1024 reference 61 73 56

set mpe maxorder 45
set mpe minfreq   10
set mpe maxfreq 1500
set mpe type complex

# Extract the modes
mpe poles extract
mpe poles store
mpe modes extract

pair mode all

examine mac
matrix mac
```

Pretest Analysis for Virtual Sensing – Custom GUI for optimization

Before installation:
Check that the layout of sensors are able to re-produce the original synthetic data.

After installation:
Installation of a ”blind” strain gauge allows for monitoring of the performance of the expansion process.



Summary and Additional Thoughts

- Integration of simulation (FEA), signal processing and modal parameter extraction enables the Virtual Modal Testing process
- Combined with modal and FRF-based pretest analysis, the test setup can be optimized for specific goals like FE-test correlation analysis, virtual sensing,…
- Automation through scripting of the workflow can used for parametric studies and to study impact of noise, uncertainties and variability.
- Additional physics can be added for more realism, like for example hammer tips, shaker model, sensor sensitivity, mounting properties, …
- Quality of the virtual process depends on the validity of the FE model !
- Modelling of damage scenarios and evaluation of the impact on vibration responses

For More Information…

- FEMtools product literature
  - www.femtools.com/products/download.htm
- Evaluation license with full support
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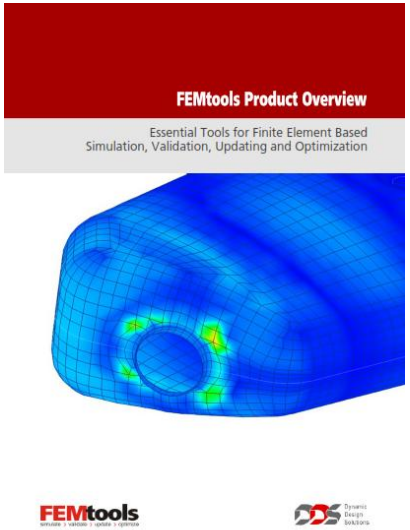

www.femtools.com