GDTECH engineering

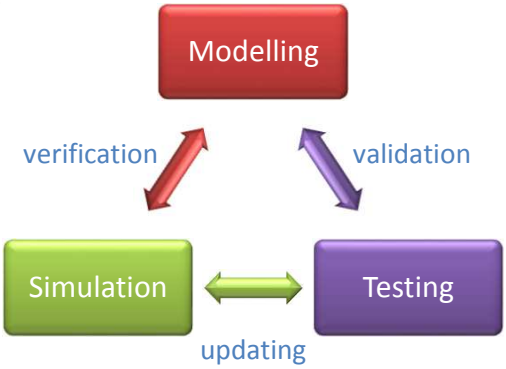
Advanced dynamic testing, modelling and analysis

Context

Assessing the dynamics of complex structures is a critical juncture in the design process, and it involves several challenging tasks from the model definition to its validation through vibration testing and numerical simulations.

Characteristic properties are the modal parameters (i.e. natural frequencies, mode shapes, damping ratios, participation factors), which can be computed starting from the Finite Element Model (FEM) or estimated by carrying out specific vibration tests. Good correlation between the numerical and the experimental parameters guarantees the reliability of the model, and it is often a demanding requirement which can be accomplished by means of modal-based or response-based updating methodologies.

Additional expertise is essential to enrich the models with nonlinear elements responsible for peculiar phenomena, such as the dependency of the modal parameters on the excitation amplitude and the effect of the initial conditions on the steady-state dynamic response.



Services proposed by GDTech

Studies at all the stages of the pyramid of virtual and physical testing (supported by CAD and CAE)

- Writing of tests specifications
  - sensor and excitation location
  - loading and boundary conditions
- Design, analysis and manufacturing of dedicated tooling
- Definition of instrumentation
- Tests follow up and reporting
- Accurate mesh definition and super-element exploitation
- Correlation between tests and simulations
- Updating of the finite element model
- Identification of nonlinear components from tests and integration in the model

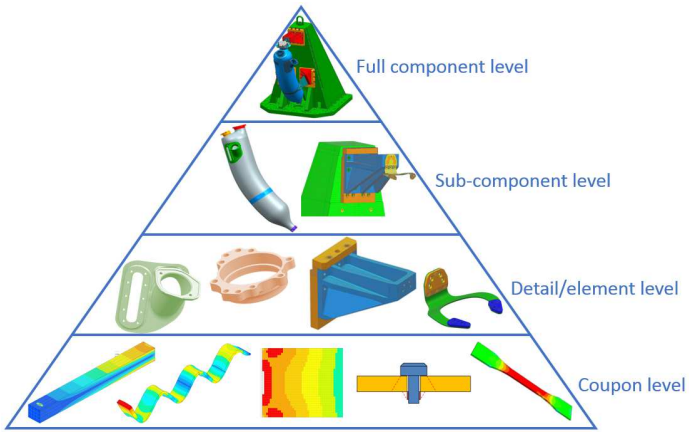
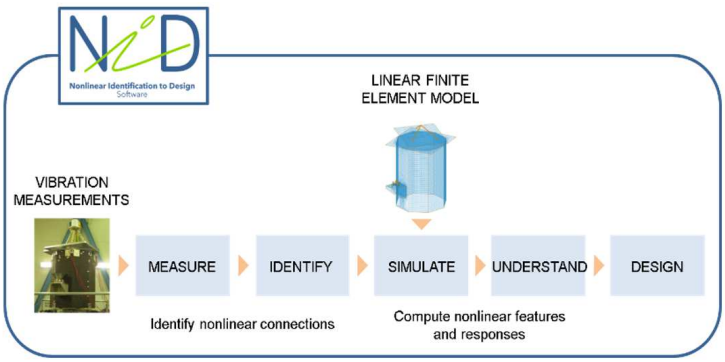


Illustration of the pyramid of simulations and tests

Modelling and analysis capabilities

- 0D, 1D, 2D, 3D, multi-harmonic 3D, interfaces, contacts, bolts, nonlinear connections
- Verification of the FEM through mesh convergence analysis
- CAD adaptation to structural simulations
- Super Elements generation and integration
- Modal analysis, forced harmonic response, random vibration
- Time-domain and frequency-domain simulations of nonlinear systems with continuation algorithms
- System identification from experimental measurements
- Structural optimization
- Nonlinear detection, characterization and parameter estimation (partnership with ULiege and Nolisys)
- Computation of nonlinear features (partnership with ULiege and Nolisys)
  - Nonlinear frequency response functions
  - Nonlinear normal modes and their variation with the amplitude of oscillation (or energy)
  - Stability of the solutions and bifurcation points

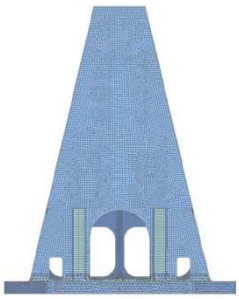


Nolisys nonlinear vibration analysis procedure

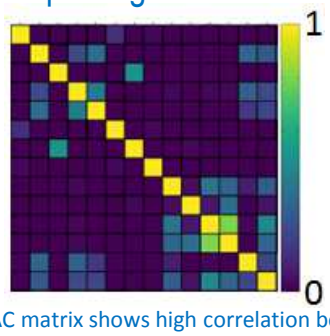
GDTECH engineering

Advanced dynamic testing, modelling and analysis

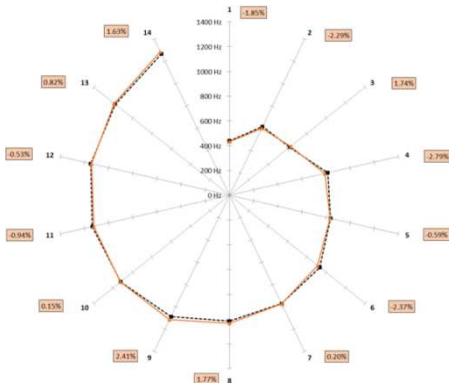
Illustration 1: modal correlation and updating



Numerical model and experimental setup

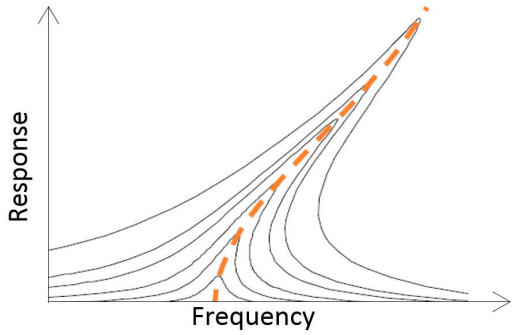


The MAC matrix shows high correlation between numerical and experimental mode shapes

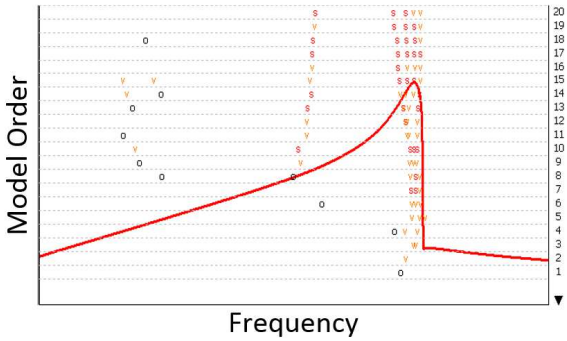


Natural frequency correlation between numerical and experimental modal analysis

Illustration 2: importance of using proper tools to identify nonlinear systems

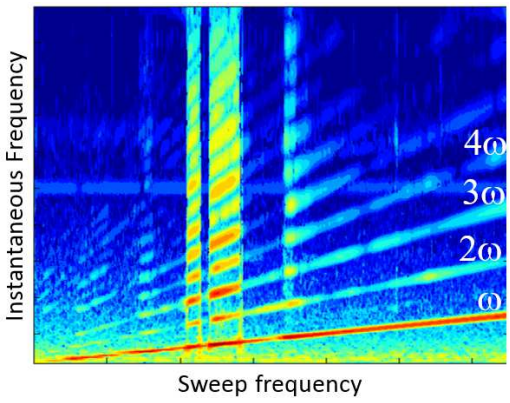


Multivalued frequency response function characterizing nonlinear systems



Wrong results in a stabilization diagram based on linear assumptions

Illustration 3: multi-harmonic response



Wavelet transform of the response of a nonlinear system undergoing base-excitation sine sweep

More information

In order to provide a comprehensive service in the field of vibration analysis, GDTech works with partners:

- University of Liège for nonlinear vibration (www.ulg.ac.be)
- Nolisys for nonlinear vibration (www.nolysis.com)
- V2I for dynamic testing (www.v2i.be)

About GDTech

Founded by engineers issued from the Aerospace Laboratory of the University of Liège, GDTech employs about 200 experienced and talented designers and engineers experts in CAD and CAE (Computational Structural Mechanics and Computational Fluid Dynamics). GDTech is located in Belgium (Liège area) and in France (Paris and Pau areas). With its Open Engineering subsidiary (developing the OOFELIE FEM solver), GDTech proposes a complete set of services in design and multi-physics simulation.

GDTech S.A. – www.gdtech.eu
7 Avenue de l'Expansion
B-4432 Liège (Alleur)
Tel. : +32 (0) 4 367 87 11 - Fax : +32 (0) 4 376 68 22
GDTech France S.A.S. - www.gdtech.fr
Site Aéropolis – F-64510 BORDES
Tél. : +33 (0) 5 59 82 35 35 – Fax : +33 (0) 5 59 02 08 67
Site de Buchelay - Immeuble INNEOS - 1401, Avenue de la Grande Halle -F-78200 BUCHELAY
Tel. : +33 (0)1 34 78 82 54 - Fax : +33 (0)1 34 78 82 63