MULTILEVEL APPROACH FOR VIBRATION CHARACTERIZATION OF A LAWN TRACTOR THROUGH NUMERICAL TOOLS AND EXPERIMENTAL ANALYSIS

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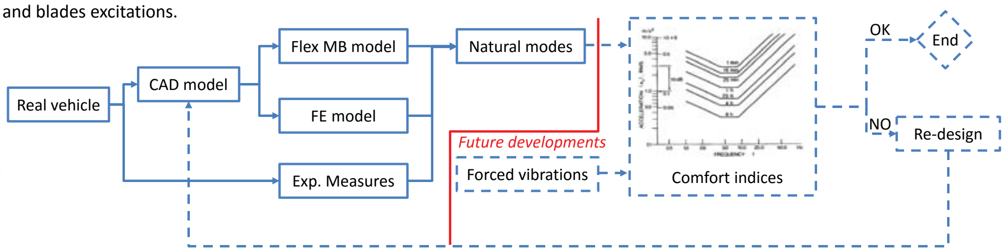
Introduction

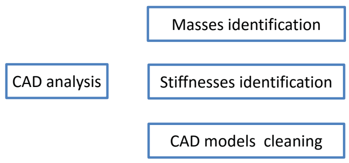
The activity was originated in the framework of a collaboration between University of Pisa and Global Garden Products (GGP). The goal of the activity was to develop multilevel simulation and experimental tools aimed at characterizing the vibration behavior of a Lawn Tractor and of its components, in the frequency range of interest for human comfort.

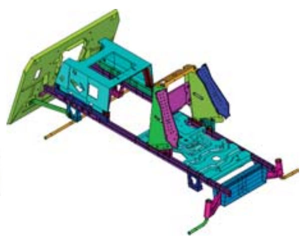
These tools can be used to improve the comfort of the driver of the tractor and to avoid components resonance due to engine and blades excitations.



CAD

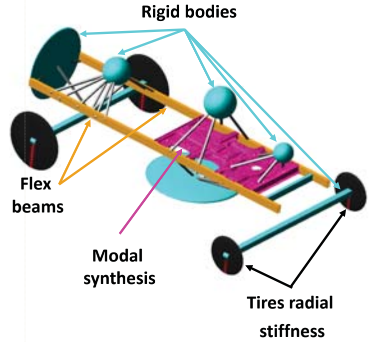
Tools development was based on analyses of the parts composing the real vehicle. Masses, flexible components and joints driving the vibrational response were identified. CAD geometries were also cleaned for mesh generation.





Semi-flexible MultiBody model (SMB)

A multilevel approach was used to develop the multibody model. The inertia properties of the most rigid parts were imported from CAD as rigid bodies and the flexible parts were identified and imported as lumped or continuos elements.



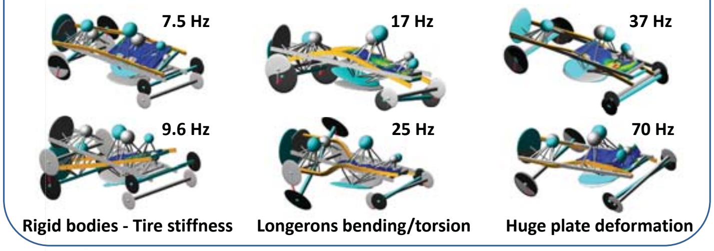
Rigid bodies
- Rear plate
- Cutting deck
- Axles
- Seat structure
- Steering system
- Engine

Flexible parts
- Lateral longerons

Lumped stiffnesses
- Tires radial stiffness

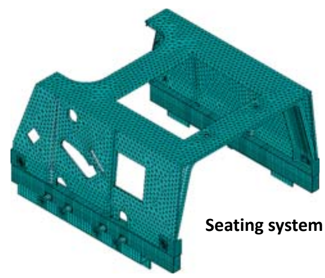
Distributed stiffness
- Central plate - *imported from FEA using Component Mode Synthesis (CMS) technique*

Natural modes – ***Some examples***

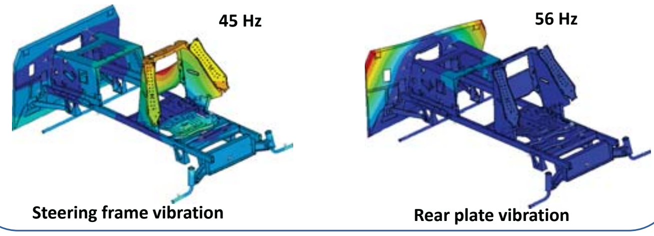


Finite Element Modal model (FEM)

Finite element method was used to develop the modal model. Engine, transmission, cutting desk and tires were implemented as concentrated mass and inertia whose values were derived from CAD geometries. The structural components were implemented by meshing the previously cleaned CAD geometries using 3D structural brick elements. Joints were implemented in order to reproduce the effective structural continuity and kinematics of the parts in the real vehicle.

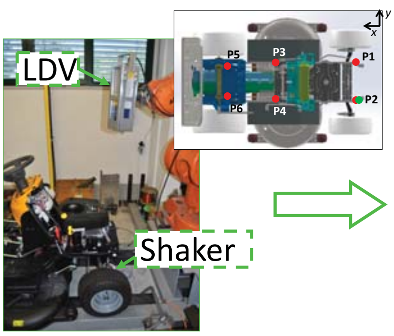


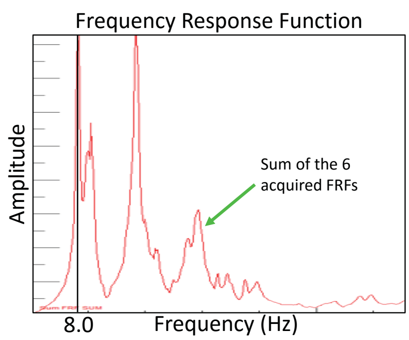
Natural modes – ***Some examples***



Experimental modal analysis

Single input (electrodynamic shaker) – multi output (Laser Doppler Vibrometer): 6 measurement points were chosen on the chassis. High precision sensor positioning was achieved through an ABB anthropomorphic robotic arm.





Results and conclusions

Natural frequencies (Hz)			
EXP	**MBS**	**FEM**	**Shape**
8.0	7.5	7.8	Roll
8.3	8.0	8.1	Heave
10.0	9.6	10.1	Pitch
18.5	17.0	18.9	Bending
29	25	27	Torsion 1
35	39	37	Torsion 2

A fairly good agreement was verified comparing the first natural frequencies and the mode shapes found with SMB, FEM and Experimental modal analysis.

Further modes related to higher frequencies are obtained by FEM model considering also single-part vibrations.

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