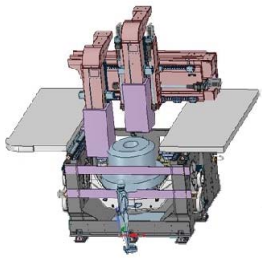
VIRTUAL MODELLING OF THE DYNAMICS OF A MILLING MACHINE THROUGH FEM AND MBS APPROACHES

Davide Piccinin , davide.piccinin@unipd.it
Andrea Ghiotti, andrea.ghiotti@unipd.it
University of Padova, Department of Industrial Engineering

Chatter in milling operations reduces the quality of the surface and also the safety of the operator, while increasing directly and indirectly the costs of production. Researchers agree that probably the main cause is the self-inducted vibrations developed by the interaction between workpiece and tool, along with stiffness of the machine, guideways, tool inclination and materials adopted.

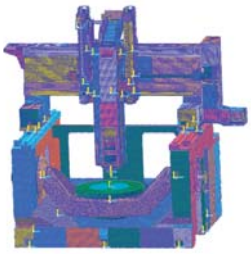


CAD MODEL

ANSYS MODAL REDUCTION

RECURDYN STATIC ANALYSIS AND F.R.A.

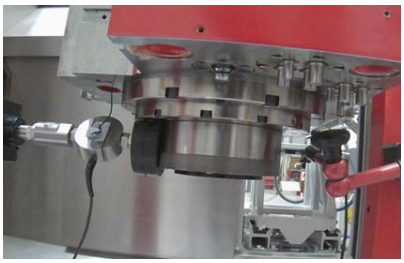
SPERIMENTAL COMPARISON

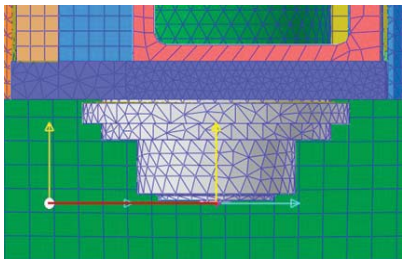


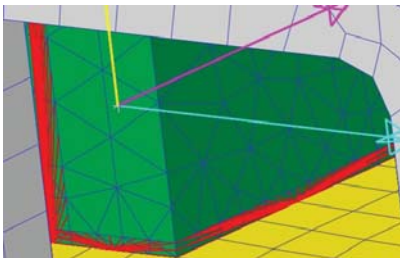
We reduced the whole 3D sketch of the CNC machine into an Ansys model. We discretised some parts as solids (e.g. guideways, tools, sliders) and some others as shells, allowing us to save a huge amount of nodes. We developed also a script in Ansys which allowed us to:

- **Bond shells along with solids** in a compatible way with RecurDyn - using some sort of spider web made of beams elements, connecting a master point in the solid with all the nodes on the edge of the correspondent surface.
- **Apply the modal reduction** based on the Craig-Bampton's method to each part composing the machine.

Then we imported the single parts into RecurDyn creating reduced flex bodies (RFlex), bodies that after undergoing modal reduction, presents the same characteristics of a full flex body, but can interact with other bodies only through the master point we picked. That translates into a massive reduction in weight of the model and also a massive time save, while sacrificing very little in terms of accuracy. We obviously picked the nodes that indeed interacted with the master points of other bodies, so sliders, guideways, rollers, tools, etc. The interaction between the master nodes, depended on the type of connection in that spot: since we had the factory data for guideways and sliders, we characterized their behaviour through the bushing command in RecurDyn, which allows to insert a spline to better represent stiffness and damping of the connection.







At this point, the machine was ready. We conduct a Static Analysis and a Frequency Response Analysis, comparing it to the sperimental tests we made at the factory. In Static Analysis we obtained errors of maximum **26µm** (other errors were **2, 6 and 15 µm**).

On the F.R.A. on the frequency band we tested, we found the same pattern as in the sperimental results, only shifted of roughly **10Hz.**