FORTISSIMO HPGA





4MS

HIGH PERFORMANCE GEAR ANALYZER

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PARTNERS

Application Expert: Vibrations and PowerTrain Lab UNIMORE

HPC Expert:

CINECA – Galileo Supercomputer

EndUser:

VE&D PULSAR DYNAMICS

APPLICATION SECTOR

Automatic optimization and design of gears and gearboxes both in static and dynamic fields with a FEA software:

- Reduce vibrations and noise
- Find optimal profile reliefs
- Commercial software require HIGH TECHNICAL SKILLS
- Pre and post processing are HIGH-TIME CONSUMING for the end user (manhours)
- Computational costs and hardware are **REALLY EXPENSIVE** both in time (manhours and computational time) and in hardware/software requirements and maintenance



HPGA MAIN FEATURES

STATIC LTCA (LOADED TOOTH CONTACT ANALYSIS) The main software component is capable to perform a Loaded Tooth Contact Analysis (LTCA) Accurate solution of the localized contact problem, the non-linear contact solving capability and the adaptive mesh are required

DYNAMIC ANALYSIS OF A GEAR PAIR check if quasi-periodic or chaotic response exists, thus preventing high vibration and noise level in gear pairs

GEAR OPTIMIZATION

optimal micro-geometric profile in order to reduce operating gear noise

PLANETARY GEAR DYNAMICS

combine the results of static analyses performed on gear pairs in a lumped static or dynamic model of planetary gearbox

- 1. Check consistency of input data and computes all derived data
- 2. Compute the enveloping gear profiles: the peculiarity of the method is that the whole procedure is numerical, so that non standard generating tools can be considered as well.
- 3. A module which interpolates the enveloping profile by means of NURBS curves (2D model) or surfaces (3D): the NURBS curves and surfaces are included in the finite element model.
- 4. Set up the model for the external FE solver.

- 5. Automatic extraction of all needed information from the static FE solution, i.e contact pressures, stresses and nodal deformation.
- 6. Automatic post processing:
 - Contact pressure;
 - Contact patter, computed by enveloping the contact pressures in all contact positions;
 - Static Transmission Error, computed using nodal deformations;
 - Equivalent fatigue stresses, as a result of the load cycle composed of the different contact positions;
 - Rigid body transmission error, which is present even if there is no load, because
 - of intentional profile reliefs;
 - Mesh stiffness, which is the equivalent torsional stiffness of the gear pair under load.







MAIN WEAKNESS:

MULTI-CORES SIMULTANEOUS RUNS - COMPUTATIONAL TIME A complete LTCA of a 3D gear pair takes about 8 hours on a dual Xeon workstation

SETTING UP OF THE SOLVER IN CONJUNCTION WITH HPC INFRASTRUCTURE PROVIDER OR WORKSTATION Needs expert technician, so that installing the software on a new workstation is not straightforward

LICENSE COST FOR SMEs The FE solver is proprietary code. The proprietary code is a weakness point for SMEs, as the license is expensive.

THE CLOUD TECHNOLOGY ON A HPC PLATFORM ALLOW TO OVERCOME ALL THE WEAKNESS

SOLVING THIS CRUCIAL POINT IN ORDER TO HAVE COMPETITIVE GEARS:

• REDUCING THE TOTAL COSTS

• INCREASE EFFICIENCY

REDUCE MACHINE DOWNTIME



POWERFUL FASTER CHEAPER



HPC AND CLOUD TECHNOLOGY SPEED UP AND SIMPLIFY COMPLEX PROBLEMS IN AN USER-FRIENDLY WAY

CINECA GALILEO SUPERCOMPUTER INFRASTUCTURE

Nodes: 516 Processors: 8-cores Intel Haswell 2.40 GHz (2 per node) Cores: 16 cores/node, 8256 cores in total Accelerators: 2 Intel Phi 7120p per node on 344 nodes (688 in total) RAM: 128 GB/node, 8 GB/core Internal Network: Infiniband with 4x QDR switches Disk Space:2,500 TB of local storage Peak Performance: xxx TFlop/s (to be defined)

END USERS



PULSAR DYNAMICS

- SOFTWARE BETA TESTING
- APPLICATION PERFORMANCES
- IMPROVE GRAPHICAL INTERFACE TO PRODUCE USER FRIENDLY APPLICATION
- SECURE CONNECTION AND STORING DATA VERIFICATION

CONCLUSIONS

- a unique integrated tool based on open source software;
- a pay-per-use model on high performance systems;
- a quicker solution than traditional tools (up to 60% time reduction for a single simulation, 95% time reduction to gears optimization);
- no investment necessary, only operational costs

CONCLUSIONS

- ability to perform many more simulations per time unit (at least 10x – single case ; 500x – multiple case);
- an innovative service that can be used by beginner users and not only by high technical skilled users.
- Multi- platform service [tablet , smartphone MacOS, Android/Linux, Windows]