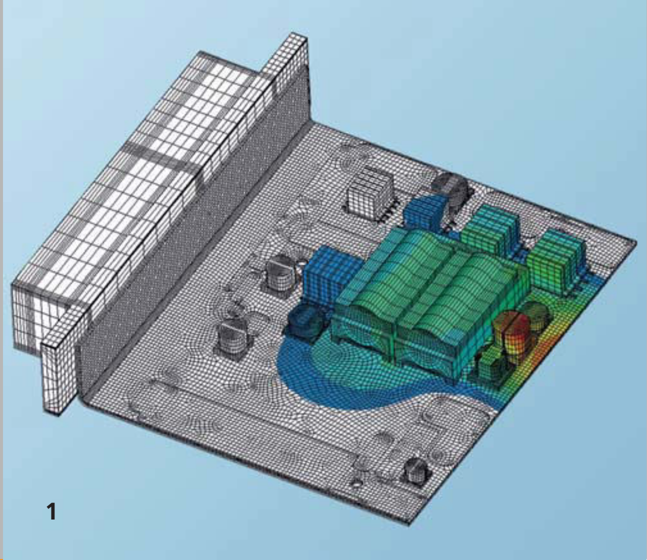

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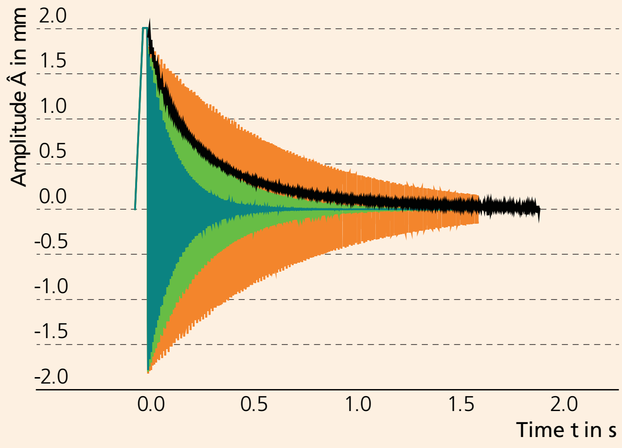

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DESIGN SUPPORT TOOL FOR SAFEGUARDING VIBRATION-RESISTANT ELECTRONICS

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Reliable electronics are a key component for high-value and safety-relevant products. The focus of the presented project rests on reliability of engine control units (ECU), which every automobile is equipped with. Their operational stability under mechanical shock as well as vibrations has to be guaranteed for every driving situation.

The structural-mechanical simulation by Finite Element Method (FEM) crucially contributes to the design and construction of ECU components. The simulation allows for the comprehension of complex mechanical interactions and the rapid realization of different construction and material variations. Providing a robust design for the ECU in preferably short time is the aim here so that no critical mechanical stresses lead to malfunction or early failures of electronic components.

In the framework of the project, a design support tool was developed, which realizes an extremely accelerated mesh generation of FEM models. The time factor is 1:250. Complex ECU packages can now be modeled within 10 minutes instead of 5 working days (Figure 1). The model includes the geometry, materials and load profiles. The design support tool is based on a FEM programming language (APDL-ANSYS) and accesses a created database, which carries parametric submodels for creating electronic components. This database can be tailored to the customer database of qualified components, i.e. small effort is required to extend the database with new qualified components.

Via a graphical user interface (GUI), all relevant design parameters are retrieved, which are necessary for a load calculation under vibration. The current version of the tool allows the load calculation in the form of Power Spectral Density (PSD) and harmonic vibrations.

The evaluation of well and less well placed components is based on the calculated mechanical stress. Within the project, a criterion was defined, which allows for the comparison of overused or unused components. Beforehand, a calibration of the vibration behavior of substrates based on experimental vibration measurements on a variation of real printed circuit boards was conducted. The results lead to the variable material dataset for the PCB with a copper, fiber glass and polymer mixture. Later, the substrates were equipped with electronic components. Furthermore, the mechanical stress limitations of the electronic components, which exist as criterion for their failure, were determined on the basis of vibration-mechanical step tests.

Right after the calculation, the tool hints at critical component positions or at stabilization steps of the whole package. The designer receives crucial results to stabilize the ECU package in short time.

The design tool approach shall also be transferred to thermal-mechanical stress analyses. Here, a combination of roughly and finely meshed components will be integrated into a solution routine.

Acknowledgements

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1 FEM mesh of an electronic assembly of an engine control unit modeled in 10 min, plot of calculated deformations and white noise vibration.

2 Measured damping behavior of a substrate and calibration of damping coefficients by FEM.

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