62. EFFICIENT INTERACTIVE GRAPHIC SIMULATION OF SHOCK AND VIBRATION TESTS

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SUMMARY

Shock and vibration testing can be very expensive because of both the equipment and time required, and even more so because tests occur late in the program after hardware has been assembled, when any design changes are costly. For this reason, there is an increasing demand for simulation of shock and vibration environments provided in product specifications to replace testing or to make sure the test is successful. The analysis can be challenging due to the use of test-measured environments as input to finite element dynamic analysis simulations and the cumbersome and tedious processes for performing dynamics analyses in standard finite element programs.

Some significant improvements that have been made to the simulation of finite element dynamic analysis are described and demonstrated in this paper. The approach uses modes, including static corrections in the form of constraint modes or attachments modes from Nastran, to perform a forced vibration analysis. The improvements include interactive graphical definition of random, shock, sine (harmonic), or time-domain events that describe the environment and can be used to organize the results. Tools for graphical signal processing of measurements and responses provide better understanding of the environments and predicted responses. An algorithm for quickly computing RMS results from random analysis without requiring the computation of the underlying PSDs has been implemented. This method computes results including von Mises stress, in some cases even for multiple input locations with correlations between inputs. Conversion of random and shock inputs to the time domain facilitates load combinations, animation of results, and fatigue evaluation. Automatic removal of measurement drift helps simulate base excitation analysis of equipment for which the excitation is acceleration from a redundant set of accelerations. Modeling of damping using the full damping matrix is also facilitated through the use of both discrete dampers and material loss factors to simulate modal damping as well as complex damping.

The improved efficiency and capabilities of this approach are illustrated with an application example using a spacecraft similar to an actual application of the software.