Drop Test Simulation of a Cordless Mouse

Summary
Portable, hand-held electronic devices have become commonplace due to their small size and light weight. It is inevitable that such devices will occasionally experience the shock loading associated with being dropped. Accounting for this loading scenario in the design process, both analytically and experimentally, allows for the development of more durable products. The ability to simulate drop-type loading reliably reduces the dependency on experimental testing. Abaqus/Explicit has been used extensively to examine the behavior of electronic devices experiencing mechanical shock loading.

Background
It is not uncommon for personal electronic devices to be subjected to mechanical shock loading, particularly that associated with being dropped from the hand or falling from a table. The ability to withstand such loading is critical to the design of a successful product.

Assessing the response of a prototype electronic device to shock loading typically involves a combination of laboratory testing and analytical simulation. Simulations have clear advantages over physical tests in that they offer repeatable results, provide information (stress, strain, acceleration, etc.) at any point in the model at any time during the analysis, can be performed at less cost, and can be included at any stage in the design process.

The analysis considered in this technology brief is a simulation of a 1-meter drop test of a cordless, optical computer mouse. The potential malfunction of electronic components is the primary focus of the analysis.

Finite Element Analysis Approach
The mouse model consists of housing components, a circuit board with electronic components, a wheel, and two buttons. The case components, buttons, and wheel are meshed with modified 10-node tetrahedral elements. These elements provide a robust solution during large-deformation and contact analyses and exhibit minimal volumetric and shear locking tendencies. They are also advantageous in that they can be used with automatic tetrahedral mesh generators, thus easing the task of meshing the complex molded geometry typical in electronic components.

The circuit board and electronic components are meshed with hexahedral elements. The electronic components are modeled as rigid bodies, connected to the circuit board with surface-based tie constraints. The tie-type constraint rigidly bonds surfaces together, and these bonds cannot break during the analysis. The advantage of using tie-type constraints is that the meshes to be joined are not required to match, allowing the electronic components to have relatively coarse meshes. The components making up the mouse are shown in Figures 1–3.

All the deformable parts use linear elastic material descriptions. This is typical for analyses of this type, where the strain in the components is expected to be small. An actual computer mouse is held together with screws, snap-fit clips, or other connection methods. While complete, detailed modeling of such features is possible, the present analysis focuses on the loading experienced by the electronic components.