

# Leveraging Upfront Simulation in a Global Enterprise

Corporate initiative at Delphi focuses on the benefits of simulation as an integral part of early product design at sites around the world.

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Most high-technology companies now realize the potential benefits of simulating the performance of their products using tools such as finite element analysis (FEA). They also clearly know that performing analysis early in the design cycle has the potential to identify and solve design problems much more efficiently and cost effectively compared to handling them later. One of the leading companies in employing upfront

analysis throughout the product engineering organization is Delphi Electronics & Safety Systems — a major division of Delphi Corporation specializing in mobile electronics and

transportation systems for the automotive and consumer product industries.

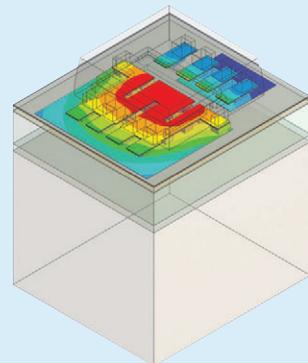
Beginning in the late 1990s, Delphi Electronics & Safety embarked on a program to take full advantage of FEA in the product development process. Along with other companies, Delphi Electronics & Safety had been using FEA in a more limited way as a troubleshooting tool often later in development. The new initiative intended to employ finite element analysis as an integral part of the product development process — especially focusing on the use of simulation up front in the design cycle.

To achieve this goal, Delphi put into place a comprehensive program to train design engineers in the use of FEA in the early stages of the design process. This program began by classifying engineers according to their skill levels in use of FEA and interpretation of analysis results. Gradually,

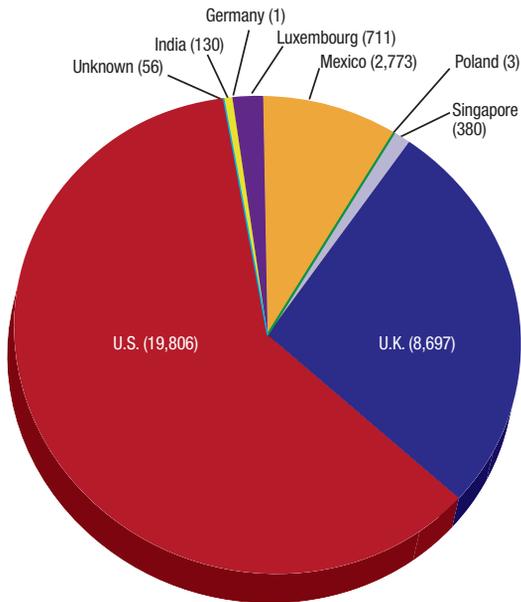
## Steady-State Thermal Analysis

The most common use of the ANSYS Workbench tool at Delphi is by design engineers engaged in product development. Analysis types include steady-state thermal, free vibration and linear static stress analysis. More advanced types of analysis, including those involving material or geometric nonlinearity, transient loading, fluid flow and multiphysics, are performed by full-time analysts using products from ANSYS or other commercially available analysis tools.

Delphi produces a number of products including those for use in the automotive and consumer product sectors that must meet stringent thermal requirements. A steady-state thermal analysis is, in many cases, the first step in ensuring that the final product will meet the thermal requirements of the customer. Based on usage data collected annually, the ANSYS DesignSpace tool is widely used to perform this type of analysis. Shown in the accompanying figure is an example of the results of a steady-state thermal analysis of an integrated circuit package used in a transmission controller unit. Once the steady-state performance is established, transient and system-level analyses are performed to completely characterize the system.



Steady-state thermal analysis of an IC package used in a transmission controller unit



Number of hours of ANSYS DesignSpace usage at various Delphi sites internationally

the program incorporated use of FEA into the Delphi Electronics & Safety product development plan. Safeguards such as peer reviews, engineering fundamentals training and mentoring were implemented to ensure proper use of FEA. Furthermore, Delphi Electronics & Safety has restricted use of this technology to engineers and scientists with a minimum of a bachelor's degree. Training in the use of the structural mechanics simulation software — in this case, ANSYS DesignSpace that uses the ANSYS Workbench platform — is a prerequisite at Delphi Electronics & Safety. Occasional users such as product engineers utilize the software to perform linear and static analyses. More advanced analyses involving nonlinearity or transient loading are referred to full-time analysts.

Today, the company has incorporated the use of structural mechanics simulation into the Delphi Product

Development Process (PDP) as a requirement. The PDP begins with the concept stage and proceeds to the validation stage when prototypes are built and tested, and finally the program is handed off to manufacturing. This has led to developing much more robust and reliable products as well as greatly reducing or eliminating validation failures. This process is enforced by a Design Failure Modes and Effects Analysis (DFMEA) plan represented by a spreadsheet of possible failure modes for a product and the required analyses to show that the product is immune to the specific failures.

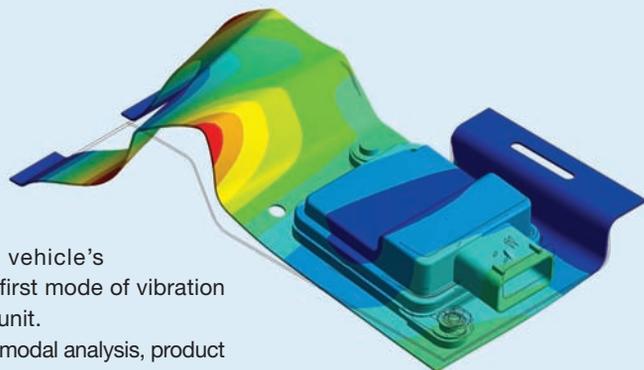
A large number of engineers around the world in the overall Delphi organization use these tools, including the full suite of software from ANSYS within the ANSYS Workbench interface, to perform thermal, stress, vibration and other general analysis in the course of product development. In 2007, the number of ANSYS DesignSpace users exceeded 200, and approximately 30 percent were Delphi Electronics & Safety engineers. Delphi Electronics & Safety users globally logged 11,151 hours of usage on the software, or 34 percent of the total for all sites internationally. The licenses for many CAE tools — including ANSYS products such as ANSYS DesignSpace — are supported from servers in Michigan, in the United States, allowing engineering management to stay up to date on the use of these tools.

By adopting a comprehensive approach for implementing FEA across the worldwide organization, Delphi has effectively incorporated an extremely powerful technology into the product development process. The initiative to focus on upfront analysis in particular has resulted in outstanding business value for Delphi in terms of improved designs developed very efficiently. The use of the ANSYS Workbench platform has certainly facilitated this process by providing the ability to perform a variety of analysis types of different complexities in the same familiar environment. Perhaps the best indicator of the effectiveness of this software in a business context is management support for its widespread use by such large numbers of Delphi engineers around the world. ■

## Finding Natural Vibration Modes

ANSYS DesignSpace software is often used for determination of the natural modes of vibration of a system. Many of Delphi's products are used by the automotive industry, and the first step in establishing that a product can be used in a vehicle is to ensure that the first few modes of vibration of the product are beyond the minimum values that can be excited by the vehicle's operation. The accompanying figure shows the first mode of vibration for a bracket used to support an airbag control unit.

Using the ANSYS DesignSpace tool to perform modal analysis, product engineers are able to determine if any changes to the initial design are needed to improve the vibration characteristics of the system. The design then proceeds to the next stage, in which harmonic and power spectral density (PSD) analyses are performed and any required changes are made.



First mode of vibration for bracket that supports an airbag control unit