# Multiphysics: All at Once

***Physical phenomena—and engineers—rarely work in isolation, so simulation software is addressing those facts.***
**By Jean Thilmany, Associate Editor**

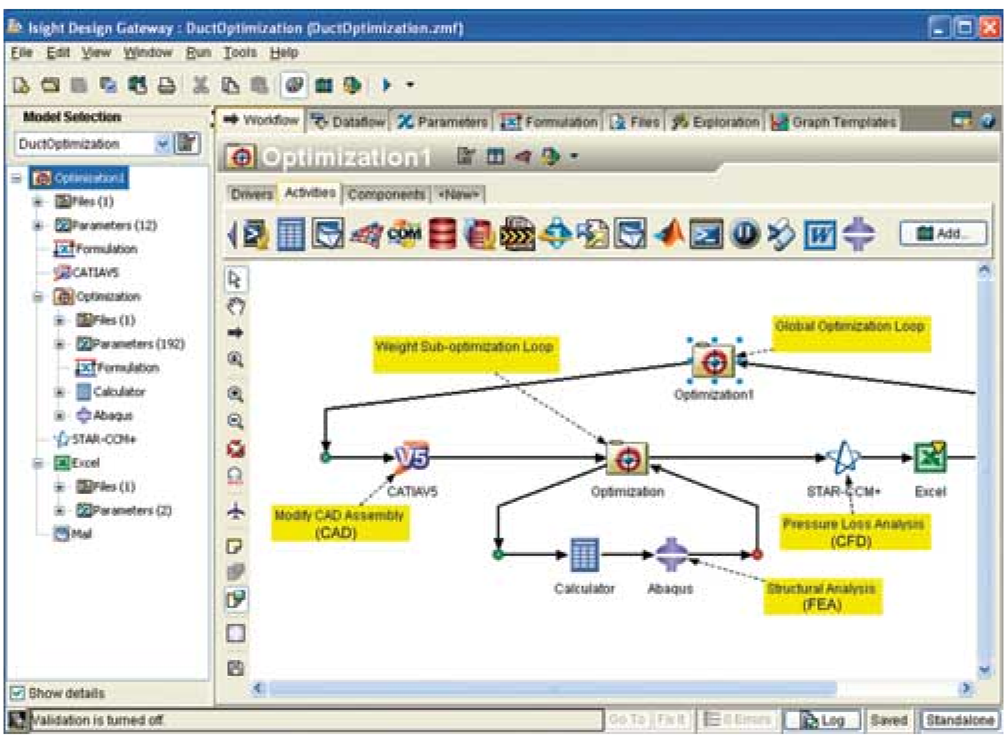
Multiphysics software is moving into the mainstream. It is also becoming a collaborative tool.

These applications simulate physical phenomena in tandem to depict real-life behavior on a virtual prototype.

As vendors work to boost ease of use and to tie simulation software to computer-aided design packages, engineers can expect over the next few years to see multiphysics become a bigger part of their everyday engineering practices, said Barry Christenson. He's director of product management at ANSYS Inc. of Canonsburg, Pa., which makes multiphysics software.

Not so long ago, trained analysts solved for one physical phenomenon at a time. They would model and solve for structural integrity, say, then import the model into another system to solve for aerodynamic behavior.

Multiphysics packages allow them simulate and analyze both these behaviors—and many more—at the same time.




***Some multiphysics software packages enable engineers to work on projects together on a common platform as they analyze and design.***

As the software gains popularity, vendors want these packages to move beyond the purview of trained analysts. They want to push multiphysics out to design engineers, for example, and want to allow engineers to work together on the same simulations, Christenson said.

“We see multiphysics becoming a bigger part of the normal analysis process,” he said. “Engineers increasingly want to have a more exact answer and to study all the physics factors happening within the systems they’re working on.”

Bernt Nilsson, vice president of marketing at Comsol Inc. of Burlington, Mass., agrees. His company makes Comsol Desktop, which allows users with all levels of physics modeling expertise to build and run simulations.

“Our target is the design engineer, not the specialist,” Nilsson said. “Design engineers are running more and more multiphysics simulations every day because they need to add reality into their models.”

Comsol Desktop is now linked to computer-aided design software in an effort to give design engineers a look at complexities of interactions and to give them a greater hand in analyzing their early designs, Nilsson said.

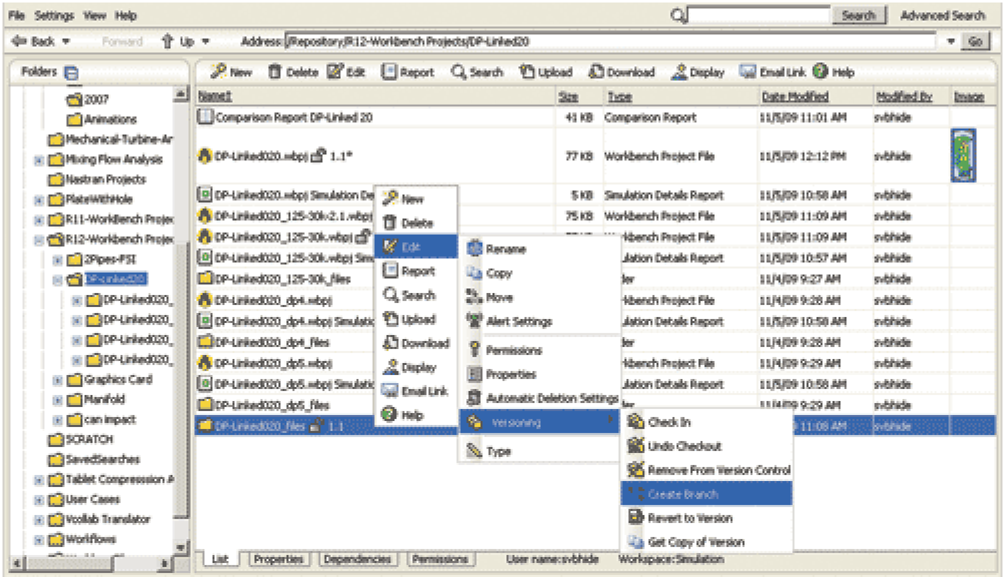
By running the simulations, design engineers can gauge how their design prototypes would operate in real-world conditions, he added.

To give engineers access to multiphysics packages, many vendors’ focus now is on speeding the applications and making them intuitive to use, Christenson said.

**:: Working Together**

Vendors are finding that as multiphysics applications mature and come into their own, engineers are asking for an environment in which they can collaborate on simulations and analyses, Christenson said.

For instance, Isight from Dassault Systèmes of Paris, is a common and open platform that allows engineers to integrate design and simulation using various CAD, finite element analysis, and other applications. The engineers can run thousands of simulations, without manual intervention, solving for a variety of physical phenomena in the process, in order to optimize their designs quickly, said Steve Crowley, director of product management for Simulia, a Dassault brand.



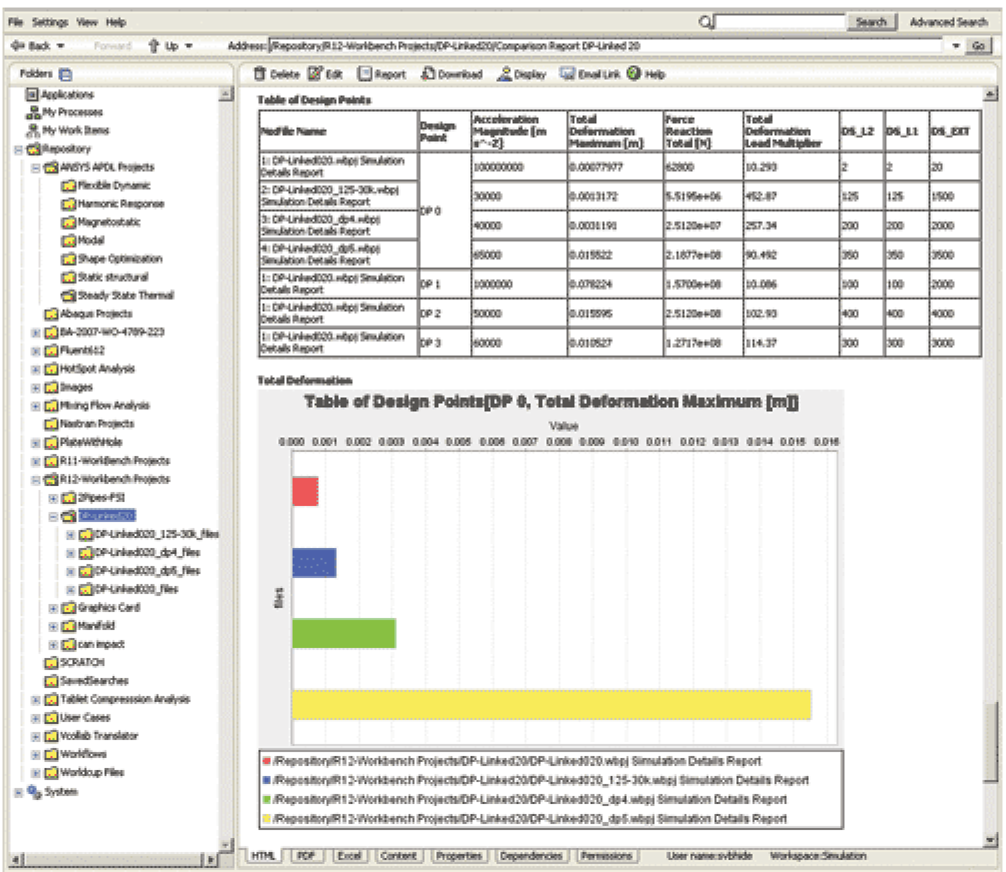
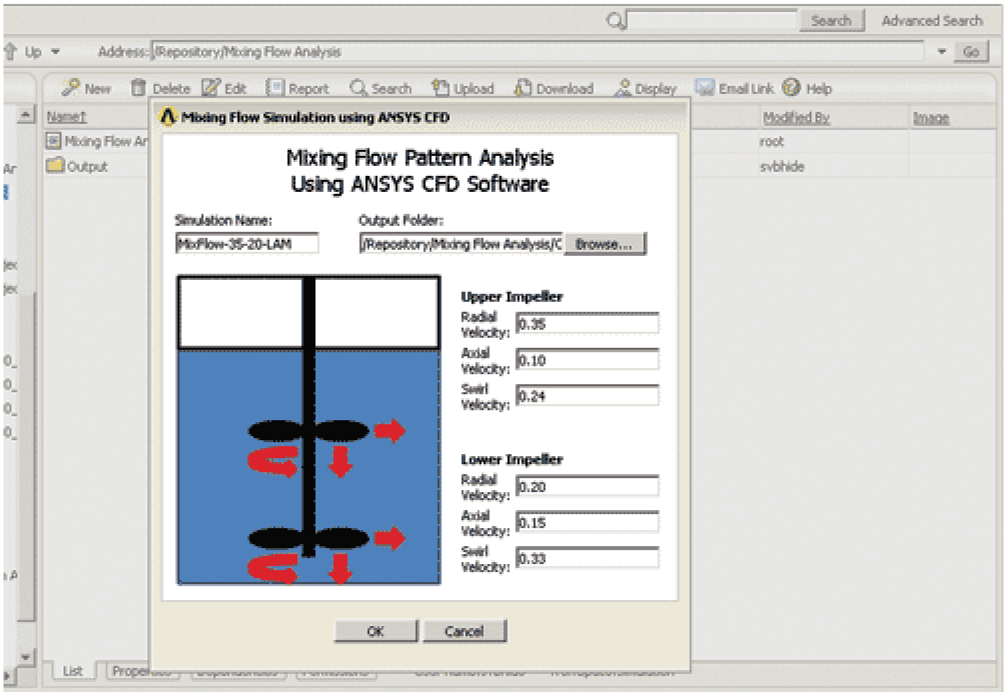


Table of Design Points
Nodfile Name | Design Point | Acceleration Magnitude [m s^-2] | Total Deformation Maximum [m] | Force Reaction Total [N] | Total Deformation Load Multiplier | DS_L2 | DS_L1 | DS_EXT
1: DP-Linked020.wbpj Simulation Details Report | DP 0 | 100000000 | 0.00077977 | 62800 | 10.293 | 2 | 2 | 20
2: DP-Linked020_125-30k.wbpj Simulation Details Report | | 30000 | 0.0013172 | 5.5195e+06 | 452.87 | 125 | 125 | 1500
3: DP-Linked020_dp4.wbpj Simulation Details Report | | 40000 | 0.0031191 | 2.5120e+07 | 257.34 | 200 | 200 | 2000
4: DP-Linked020_dp5.wbpj Simulation Details Report | | 65000 | 0.015522 | 2.1877e+08 | 90.492 | 350 | 350 | 3500
1: DP-Linked020.wbpj Simulation Details Report | DP 1 | 1000000 | 0.078224 | 1.5700e+08 | 10.086 | 100 | 100 | 2000
1: DP-Linked020.wbpj Simulation Details Report | DP 2 | 50000 | 0.015595 | 2.5120e+08 | 102.93 | 400 | 400 | 4000
1: DP-Linked020.wbpj Simulation Details Report | DP 3 | 60000 | 0.010527 | 1.2717e+08 | 114.37 | 300 | 300 | 3000
Total Deformation
Table of Design Points[DP 0, Total Deformation Maximum [m]]
Value




***ANSYS Knowledge Manager allows engineers to track and manage the extensive data generated during multiphysics simulations.***

Design engineers can also collaborate with colleagues using the open platform, he added.

ANSYS has a Knowledge Manager application that allows engineers—working within their various disciplines—to collaborate on a single project. They can assess their designs within individual disciplines and work together on multiphysics simulations, Christenson said.

Besides collaborative capability, considerations addressed by the creators of multiphysics applications include speed and, of course, ease of use, he added.

“Architectural characteristics are the first necessity, but from a mass market standpoint it’s how easy you make the multiphysics process that counts,” he said. “That will be the big change in that area over the next few years as we work to make multiphysics a mainstream solution.”

Managers at ANSYS, for example, are looking at the easiest way to import analysis results from one solver into another solver. The company’s software performs one type of analysis, then quickly and automatically passes those results to another type of analysis, Christenson said. The user need not manually transfer data.

“So if you’re a doing thermal electric analysis, the results become the inputs to another analysis—for example fluid structure,” he said. “When you solve the first one, that data is transferred, then solved, and then sent back to the first analysis to be solved again.”

The ANSYS Workbench application ties all simulations within one environment and allows these transfers, he said.

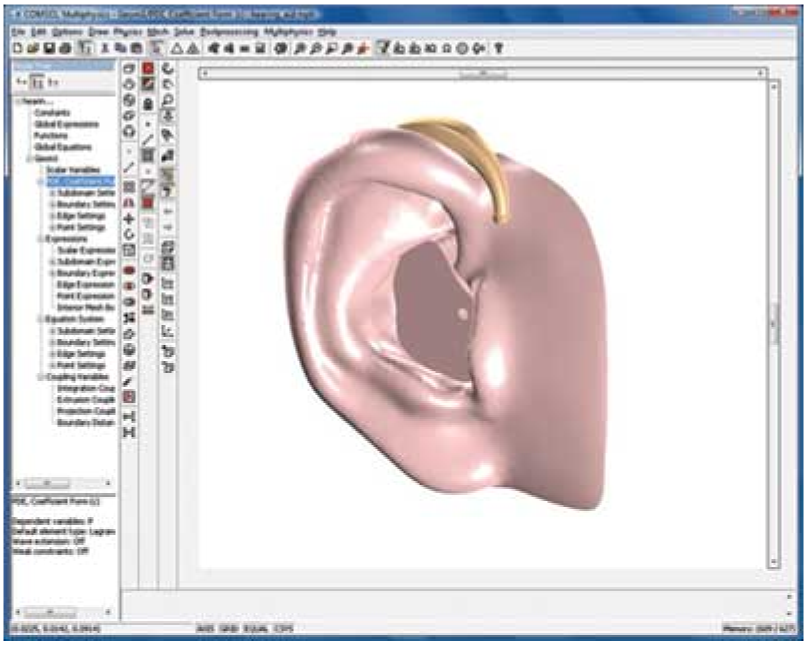
**:: Toward Feedback Free**

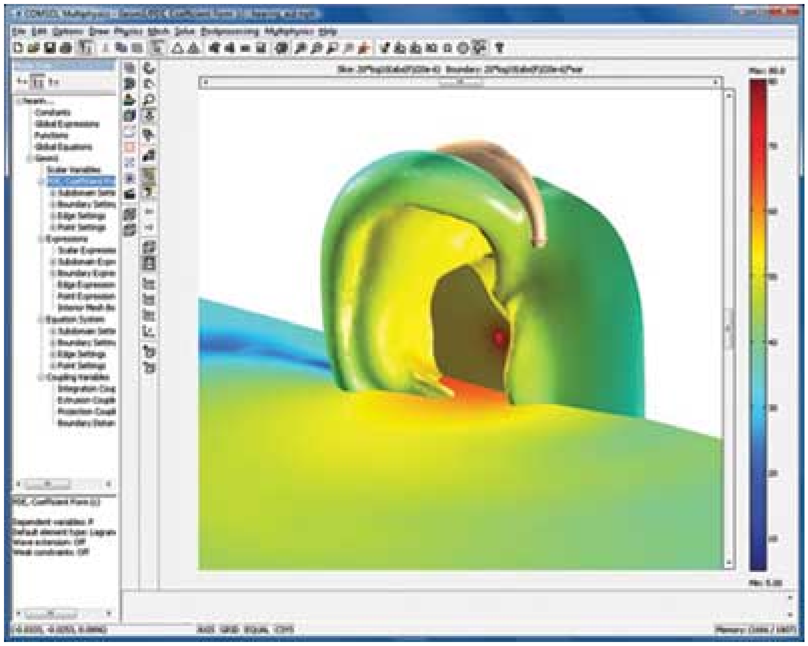
Multiphysics software analysis is helping to reduce feedback noise in hearing aids made by Widex of Copenhagen, Denmark. The company's engineers have turned to Comsol for help in optimizing design, said Mads Herring Jensen, a Widex audiologist and engineer.

The engineering team is always looking for ways to keep feedback to the barest minimum. The company's behind-the-ear models feature a tube that connects an electronic module to the earmold located in the ear channel.

A small amount of amplified sound inevitably leaks out from around the earmold. If the hearing aid isn't properly designed this sound can be picked up by the hearing aid's microphone. That sound leads to squawks and other feedback effects that are obviously annoying to the wearer, Jensen said.

To eliminate these effects, design engineers sought different materials for the tube. They also wanted to find the best way to place the microphones and to improve the algorithms that reduce feedback.





***Engineers at hearing aid maker Widex used Comsol multiphysics software to simulate vibrations within the ear, and thus to reduce hearing-aid noise and feedback.***

Engineers had initially determined the feedback algorithm by running experiments that relied mostly on the hearing aid's microphone, Jensen said. But they realized they'd need to consider aspects other than the microphone when trying to develop the best algorithm. They'd also need to take into account the shape of the outer human ear and the location of the hearing aid on the ear, Jensen said.

This is where multiphysics modeling came in. With the software, engineers could simulate and solve for elements—such as internal structural vibrations within an ear—that are difficult to acquire through experiments, Jensen said.

Mechanical engineers at Widex first made a model of the ear in Pro/Engineer CAD program from PTC of Needham, Mass. They set up the simulation in Comsol and transferred it to a specialized simulation environment created by Widex engineers and based on the technical computing software Matlab from MathWorks of Natick, Mass.

“With our modeling results, we’re starting to improve certain hearing aid features,” Jensen said. Findings include the place to position the microphone for the least amount of feedback.

Today, all the hearing aids in the company’s product line use roughly the same feedback algorithm, but it might be possible in the future to scan a wearer’s ear and use mathematical modeling to customize a feedback algorithm, he added.

**:: A Rust-Free Car?**

Meanwhile, engineers at steelmaker ArcelorMittal of Luxembourg City, Luxembourg, turned to multiphysics modeling to help them find the most corrosion-resistant steel possible, said Christian Allély, corrosion expert in the company’s Automotive Product Research Center.

To create galvanized steel, manufacturers coat the product with a thin layer of molten zinc. The exposed zinc reacts with oxygen to form zinc oxide, which in turn reacts with carbon dioxide to form zinc carbonate, a fairly strong material that inhibits corrosion, Allély said.

But when enough of the zinc disappears—which can happen when salt eats away at the surface—the steel begins to corrode. In the absence of zinc, the steel reacts with the atmosphere and the paint on the steel begins to delaminate, he added.

Researchers have found that how quickly corrosion begins and the paint delaminates depends on the relative thickness of the zinc to the steel, Allély said.

To hinder corrosion and delamination as much as possible, ArcelorMittal’s engineers sought to understand the mechanics behind those processes, he added. They used the Comsol multiphysics package to model zinc consumption after one day, five days, and 11 days of coated steel exposure to salt spray.

“We’re starting to get some good information,” Allély said. “We know that for a given thickness of steel, the delamination rate increases with a decrease in the coating thickness. Such knowledge has already helped us in practical applications.

“Before we had the model, our production engineers wanted to save money and deposit only a few hundred nanometers of zinc,” he added. “However our model showed that doing so makes no sense because this amount provides almost no anodic protection.”

The model is also helping engineers determine exactly how much zinc should be used in the automotive steel-making process, Allély added.

Developers of multiphysics software say they are addressing the reality that physical phenomena do not operate singly in nature. They believe that solving for multiple phenomena can make simulations more realistic. And they are designing software packages to be easier to use and more accessible, to put them into the hands of more engineers.