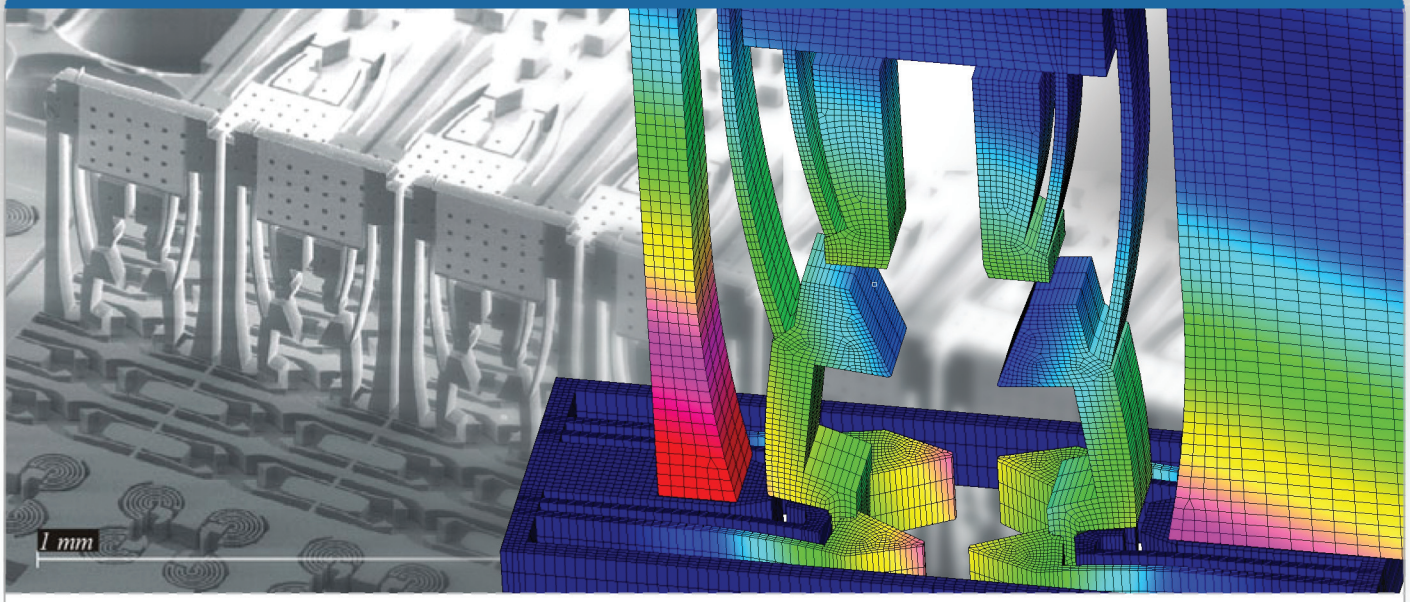
Altair HyperWorks Success Story



zyvex®

Accelerating Product Development at the Nanotech Level with Altair HyperWorks

In addition to looking for a way in which to reduce product development time through simulated modeling and analysis, Zyvex Corporation wanted to be able to communicate the features and value of its MEMS product more effectively to internal and external audiences. Using the Altair HyperWorks computer-aided engineering (CAE) framework for product design, Zyvex not only accomplished its goal to significantly speed time to market, but also used HyperView's visualization technology to prepare informative compact slide and PowerPoint presentations on the nanotechnology to various stakeholders, including Zyvex management and potential investors.

Altair Engineering

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Altair® HyperWorks®

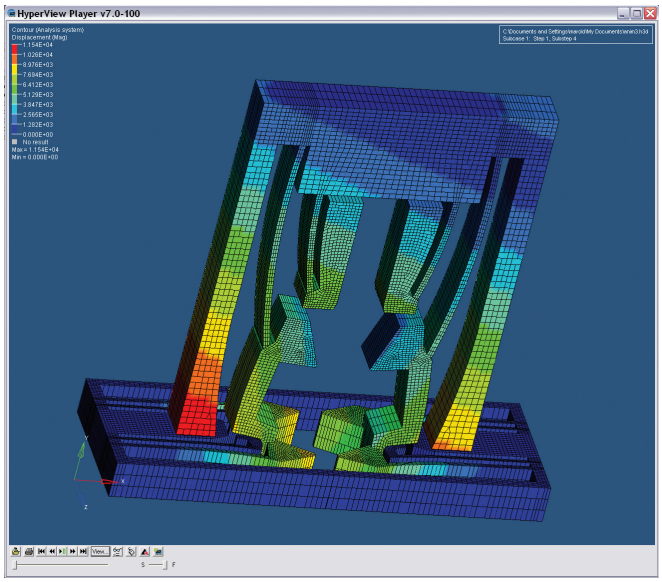
The Engineering Framework for Product Design™

It's one thing to model products that are human-scale, that can be seen and handled in the ordinary way. It's another thing entirely to design and build systems and devices with features only a few microns wide. Mechanical engineers at Zyvex Corporation work in a microworld, where parts and systems measured in nanometers and microns perform assembly tasks that can only be viewed with the help of microscopy. This is the world of micro-electro-mechanical systems (MEMS), where engineering design is only possible through the visualization power of computer-aided engineering (CAE) technology.

Zyvex (www.zyvex.com) creates devices that can physically grip and manipulate parts in a world where mechanical features may be no larger than five microns. HyperWorks CAE design tools have become an essential part of the product design process at Zyvex.

The Nanotech World of Zyvex

Zyvex, a Texas company, is the first molecular nanotechnology company. Much of its R&D work is grant-funded. The company markets tools, systems, and materials (nanotubes, for example), including MEMS microassembly devices that function at microscopic levels.



Results visualization of a typical MEMS structure with the Altair HyperView/Player

Typical MEMS devices — accelerometers, gyroscopes, pressure sensors, microphones, resonators — are fabricated using semiconductor manufacturing techniques. Most of them remain two-dimensional, because it's too costly to produce three-dimensional systems using existing micromachining methods. The industry has developed innovative ways to make 3D structures out of these 2D parts while leaving them tethered to the wafer. They have tried elevating them on hinges, deforming their shapes and applying surface tension forces. The problem has been that there was no useful way to move parts to other locations and assemble them to create true 3D structures.

Researchers at Zyvex have now come up with a solution.

Mechanical engineers Aaron Geisberger and Zoran Jandric of Zyvex's Structures section have developed mechanisms that can be de-tethered, taken out of the two-dimensional plane of the wafer and assembled at other locations in an automated process. One product of this work is the Zyvex NanoEffector® Microgripper. Another is a miniaturized scanning electron microscope. Both are developed with HyperWorks tools.

Using HyperWorks at the Nanotech Level

"When I set up the mechanical engineering facility," says Geisberger, "we began with multiphysics simulation tools such as ANSYS for electrothermal structural and electrostatic structural simulations.

"I found that it required quite a bit of work to make a fine mesh for accurate results with smaller features and still have a nice coarse mesh in larger areas. From my experience using HyperMesh in the automotive industry, I knew that I could use it to quickly build a mesh that would give us the densities we needed.

"The open architecture lets us easily integrate HyperWorks into our workflow and helps simplify our work. For example, we find that by customizing HyperMesh templates we can bring in third- or fourth-year engineering students and train them in a short time to set up problems and do a mesh.

"HyperMesh is definitely easier and faster to work with," says Jandric.

At Zyvex, all parts are made with microfabrication techniques, and are designed with a fairly primitive

2D CAD tool that resembles an IC layout tool. The geometry tools available in HyperMesh enable the engineers to start with the 2D model, and extrude and offset to build a 3D model. About 75 percent of their work is 3D, because many of the structures they design are electrothermally activated, and it's necessary to model the air around the elements. This requires considerable modeling in HyperMesh.

FEA: A Nanotech Design Essential

"Our work with MEMS couldn't be attempted at all without the analysis capabilities of finite-element analysis (FEA) tools," says Geisberger. "This is a fabless facility. We complete our design, including product design performance analysis, and send it to a silicon wafer foundry. When we receive the part, we have the characterization equipment and clean room facilities to characterize it.

"Without FEA tools, the only alternative would be an iterative process: make a design, send it to a foundry, wait (up to six months) to get the part, make corrections, optimize the design, and send it out again in a repetitive cycle until the design can be considered finalized. So it's clear that FEA tools have greatly accelerated our work."

Exploiting HyperView Visualization Tools

Geisberger and Jandric have found the visualization capability of Altair HyperView extremely useful for presenting results to management and funding agencies. They can show a complete 3D image of the structure and animate the microassembly process, showing the elevation, manipulation and insertion of components. The visualization can be saved in a compact slide-presentation format, and can be embedded into PowerPoint presentations.

"The open architecture lets us easily integrate HyperWorks into our workflow and helps simplify our work."

Zoran Jandric
Reseach Engineer, Zyvex Corporation

"I have also used HyperView for results analysis, viewing the movement of connectors into sockets and their interlocked positions," says Jandric. "Socket interconnects are the smallest parts of the entire assembly, and are often hidden under larger parts of the structure. HyperView lets us visualize the details underneath.

"We are also expanding our use of other HyperWorks tools, including HyperMorph and HyperStudy, which enable us to automatically create multiple shape variables and run design exploration studies."

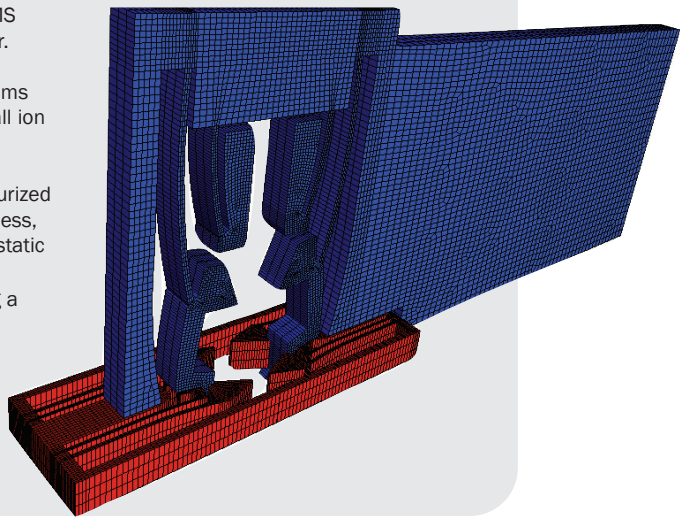
As Zyvex continues to work at the leading edge of nanotech research and development, HyperWorks will continue to serve as a suite of essential design tools — in an environment where things may be measured in billionths of an inch.

MINIATURIZING THE MINIATURE

An example of Zyvex nanotech design work is the scanning electron microscope (SEM) project on which Geisberger and Jandric are working.

"One of our current corporate goals is to develop applications for our MEMS technology that will help fund more research in this area," says Geisberger. "One class of applications in which this technology can make a significant difference is charged particle optics, meaning electron or ion optical systems for mass spectrometry. MEMS technology enables us to create a very small ion trap so that mass spectrometers can be greatly miniaturized."

Zyvex is also using these microassembly techniques to build highly miniaturized scanning electron microscopy (SEM) systems. They have developed a process, using MEMS connectors and sockets, for the manufacture of SEM electrostatic electron-beam microcolumns. All the components of the microcolumn – deflectors, lens elements, and apertures — are fabricated on silicon using a single silicon device layer. These components are assembled, in an automated process, onto MEMS sockets fabricated on the same wafer, to create a scanning electron microscope column with a footprint of less than a square centimeter and a beam diameter of 30 nanometers. This device, which is now in prototype, can be built as a low-cost, portable instrument that can be very useful at several steps of nanotech fabrication.



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