# Serving Up a STRONGER Server

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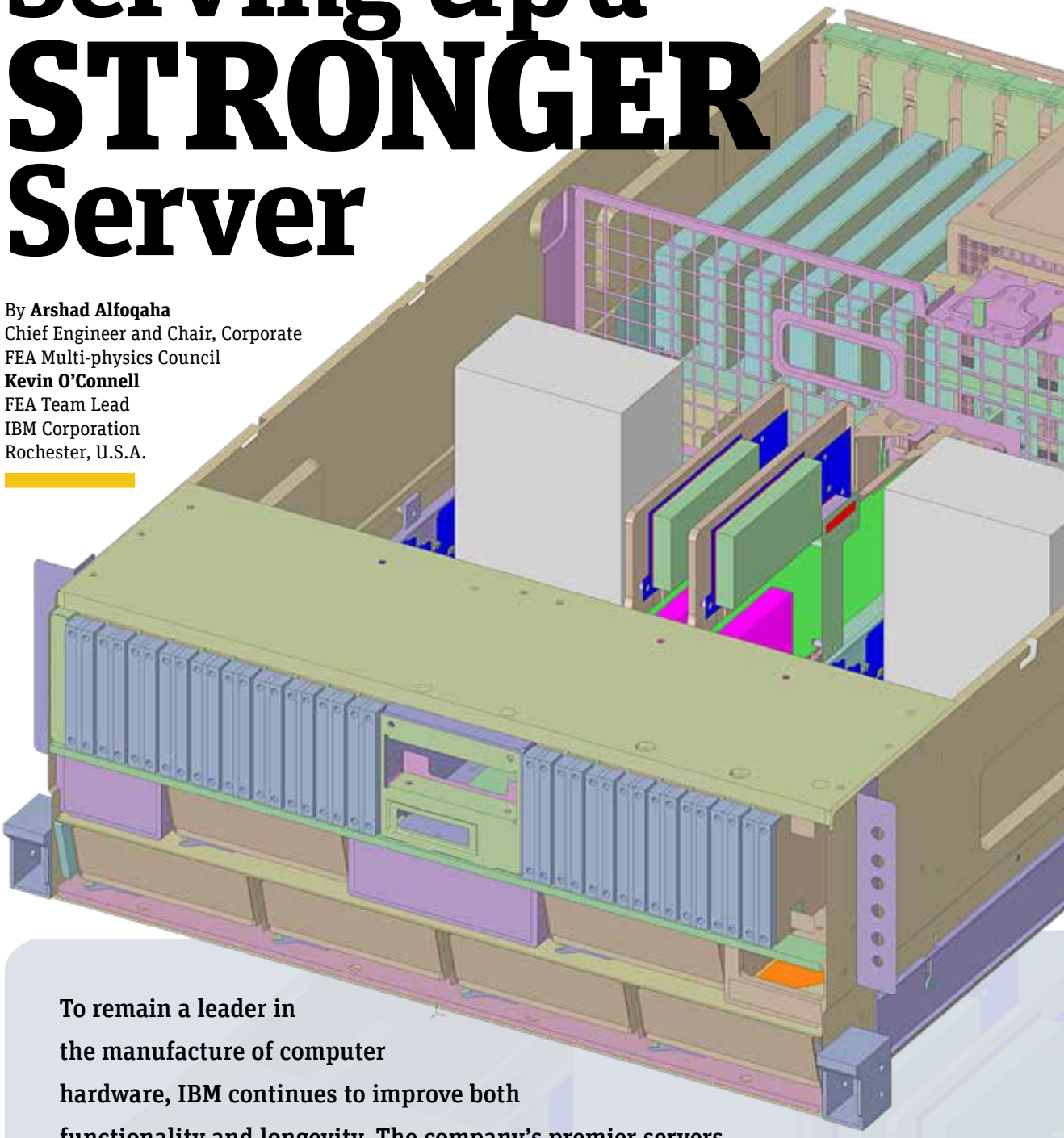
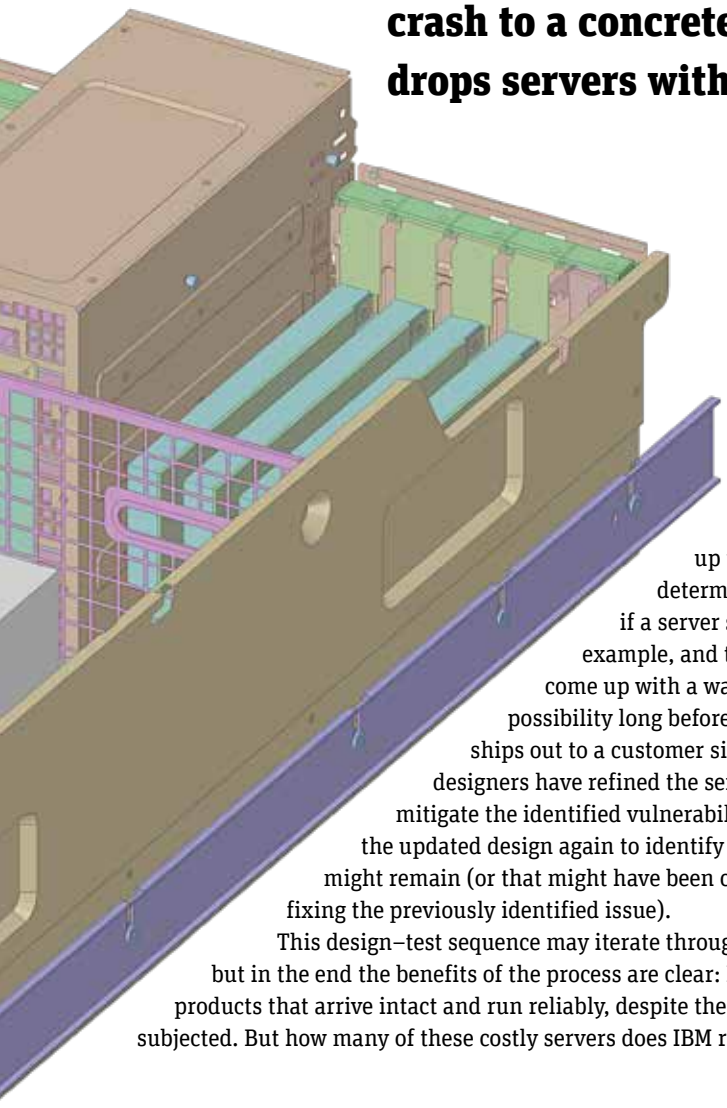


**To remain a leader in the manufacture of computer hardware, IBM continues to improve both functionality and longevity. The company's premier servers can command a premium price, but only if the hardware can stand up to the demands of the environment and ensure superior reliability. IBM ensures the integrity of its system designs with help from ANSYS Mechanical and ANSYS LS-DYNA.**

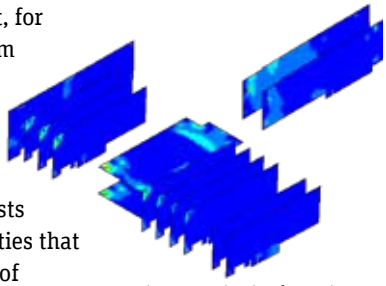
**Intro to the Workbench LS-DYNA User Interface**
ansys.com/ls-dyna

> **“Instead of watching 30 or 40 physical servers crash to a concrete floor, the MSPE team virtually drops servers within ANSYS LS-DYNA.”**



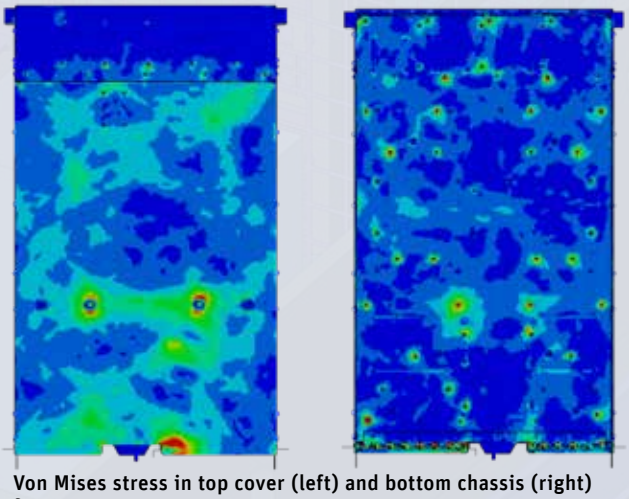
**A bare metal IBM Power System S924 server** — rack-mountable, four standard rack units (4U) in height — weighs in at 88 pounds when loaded up with a full complement of multicore IBM POWER9 processors, solid-state storage devices and communications cards. The engineers on the mechanical simulation and predictive engineering team (MSPE) at IBM get paid to drop them on a concrete floor.

There is a purpose to this, of course. The MSPE team tests the physical design of the system to help the new product designers build a server that will stand up to the rigors of the real world. The MSPE team's job is to determine what parts of the server are vulnerable to breakage if a server slips during shipment, for example, and to help the design team come up with a way to mitigate that possibility long before the first server ships out to a customer site. After the system designers have refined the server's design to mitigate the identified vulnerability, the MSPE team tests the updated design again to identify any other vulnerabilities that might remain (or that might have been created in the process of fixing the previously identified issue).

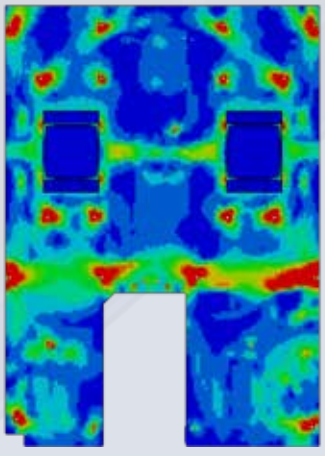


Upper maximum principal strain for the 2U peripheral controller and power supply cards

This design–test sequence may iterate through 30 or 40 testing cycles, but in the end the benefits of the process are clear: IBM can deliver leading products that arrive intact and run reliably, despite the bumps, drops and strains to which they might be subjected. But how many of these costly servers does IBM really want to drop during the design process?



Von Mises stress in top cover (left) and bottom chassis (right) for 2U Power System



Upper maximum principal strain for the 2U main PCB board

A 4U IBM Power System Server with the cover off

A 2U IBM Power System Server with the cover off

> **"Simulation helps accelerate product development while simultaneously reducing design cycle times and costs."**

Thanks to software from ANSYS, the MSPE team at IBM can keep that number as close to one as anyone could reasonably hope. The team has found that the measurements they obtain when conducting physical drop tests of these expensive servers are almost the same as simulated drop-test results obtained using ANSYS LS-DYNA. Instead of watching 30 or 40 physical servers crash to a concrete floor, the MSPE team virtually drops all those servers within ANSYS LS-DYNA.

### ITERATING THE DESIGN

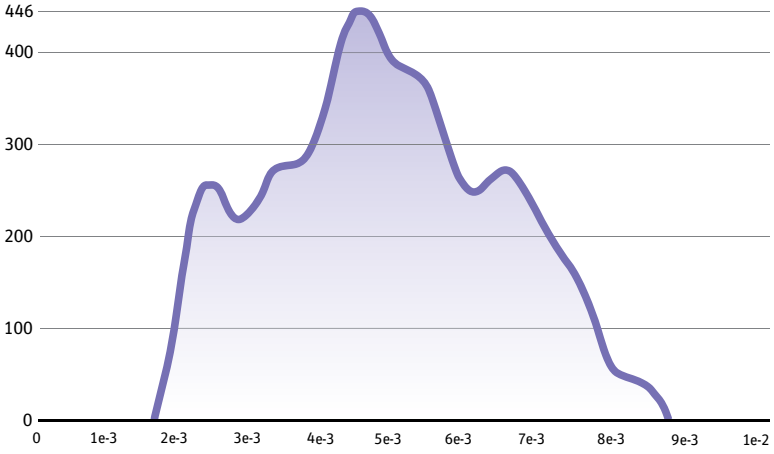
ANSYS Mechanical and ANSYS LS-DYNA lie at the heart of the simulation and testing efforts at IBM. The design team provided the MSPE team with raw 3D CAD files of the Power series servers (which are configurable in both 2U and 4U versions). Using ANSYS SpaceClaim with ANSYS Mechanical, the MSPE team optimized those 3D CAD files for finite element analysis (FEA). To reduce meshing and computation time for the Power server simulation tests, the MSPE team removed or simplified all the server features and geometry that would have no significant effect on the structural behavior of the systems.

The fully configured 2U and 4U models consisted of approximately 3,000 bodies with a combined count of over 500,000 shell and solid elements. The solid elements include four-node tetrahedral and eight-node hexagonal linear explicit elements; the shell elements include three-node triangular and four-node quadrilateral explicit elements.

### SIMULATING A SUDDEN SLIP

IBM wanted to understand what would happen to the physical structure of a Power server system during shipment. What happens to the rails, rear brackets and front latches if the shipping vehicle itself is bouncing down the road? What would happen to the critical components themselves — the motherboard and the cards clipped into the slots on the motherboard?

To answer these questions, the MSPE team imported the ANSYS Mechanical files into ANSYS LS-DYNA. They then loaded simulations to replicate the dynamics of a palletized rack drop test. The simulation used the nonlinear explicit solver to model the server falling at a rate of 70 inches per second, with a peak acceleration of

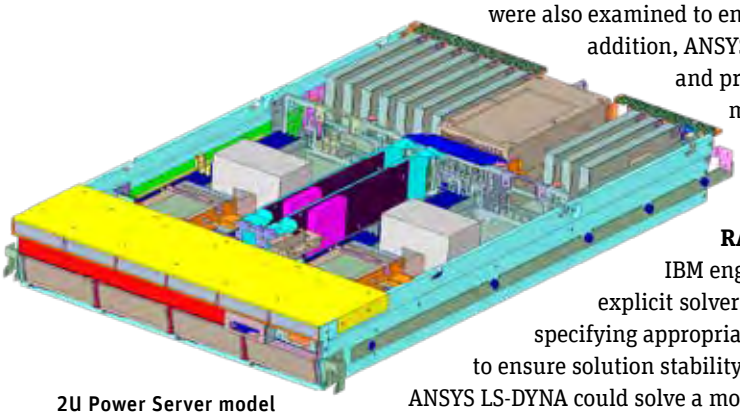



70 in/sec palletized rack drop profile

**"The teams were able to conduct more than 30 design/test cycles in a matter of weeks, a fraction of the time it would have taken without ANSYS simulation tools."**

approximately 50 g for 8.2 ms. Standard earth gravity was loaded into the simulation as approximately 385 in/sec$^2$ applied vertically.

During the explicit solution, results were checked to ensure accuracy. The energy ratio was plotted to check its value (which should be around 1.0). Kinetic energy, total energy, internal energy, damping energy and sliding energy were also examined to ensure that they were within acceptable limits. In addition, ANSYS LS-DYNA predicted stresses (such as von Mises and principal), strains (such as effective plastic and maximum principal elastic), internal energy, and nodal displacements and acceleration for all components in the systems.



2U Power Server model

**RAPID REFINE AND RETEST**

IBM engineers on the MSPE team note that the LS-DYNA explicit solver handles nonlinearities with relative ease — specifying appropriate time steps of approximately 1 x $10^{-7}$ seconds to ensure solution stability. When pulse durations were brief (about 30 ms), ANSYS LS-DYNA could solve a model in five to seven hours. If the pulse duration extended to 90 ms, it could take ANSYS LS-DYNA 15 to 20 hours to solve the simulation. The model utilized 18 cores of a 3.10 GHz Intel Xeon CPU along with 128 GB of RAM.

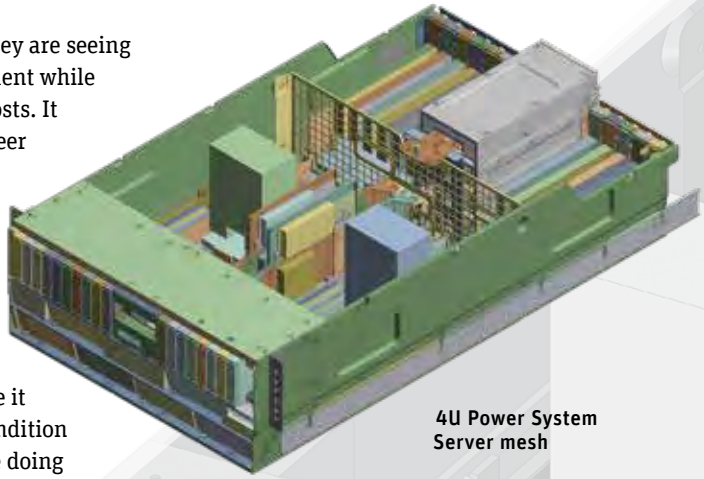
Because the MSPE team can provide insight to the design team within hours — and because the design team can quickly remodel components right in the CAD files, which the MSPE team can then bring right back into ANSYS LS-DYNA for retesting — the Power system design and testing teams were able to conduct more than 30 design–test cycles in a matter of weeks. That is a fraction of the time it would have taken to achieve the same design goals had IBM not been using ANSYS simulation solutions.

And, as noted, the MSPE team's reliance upon simulation significantly reduced the costs associated with server development. Early on, when the MSPE team did conduct a real-world drop test of fully configured 2U and 4U Power server systems, they discovered that the measurements derived from their strain gage rosettes were in strong agreement with the measurements derived via ANSYS LS-DYNA. The test verified that further physical destruction of these costly servers was unnecessary. The results that ANSYS LS-DYNA produced were just as accurate and far less costly.

**SIMULATION IS A BUSINESS BEST PRACTICE**

Executives at IBM have noticed these outcomes. They are seeing that simulation helps accelerate product development while simultaneously reducing design cycle times and costs. It streamlines resources, too, as a single MSPE engineer using ANSYS LS-DYNA can conduct all the tests associated with a given development project. This enables other members of the team to work on other projects in parallel.

While hearing praise from IBM management is always gratifying, there is one group — the customers — from whom the MSPE team at IBM hears very little. But that feels even better, because it means that the servers are arriving in excellent condition and that the members of the MSPE team at IBM are doing their jobs well.



4U Power System Server mesh