



ALL SIMULATION PACKAGES USE FINITE ELEMENT METHOD



ACCURACY OF RESULTS DEPENDS ON CORRECT SETUP, MESHING, AND SOLVING

Developers of finite element analysis (FEA) software often tout their solutions as being superior to those of competitors, whom they attempt to characterize as not being "up to par." However, they fail to explain that many of these packages utilize the same underlying mathematical approach: the finite element method (FEM). In other words, the accuracy of simulation results is not dependent on the underlying mathematical method, which generally is the same, and has a lot more to do with whether a problem is set up correctly.

FEM is a discrete numerical technique for approximating solutions to boundary value problems for the differential equations that govern physics and engineering. The model is represented mathematically as a discretization of the geometry—meshing and dividing the geometry into elements that are represented mathematically by an equation, combining element equations into a system of equations, and then using matrix algebra to solve those equations. Because the majority of FEA solutions, regardless of the package, are based on FEM principles, their solutions will always be an approximation of reality. Yet, when done correctly, this approximate solution is close enough to provide the accuracy required to make important design decisions.

Simply put, while there is a real, measurable physical response to a specific geometry, load, and boundary condition case, there is no perfect or ideal answer in FEA, only an approximation. However, the accuracy of that approximation—how closely it reflects actual physical reality—remains critically important for predicting and understanding design behavior, and making prudent design, engineering, and product development decisions. Because all FEA packages use the same underlying FEM principles, the accuracy of results is highly dependent on how well a simulation problem is initially set up through user definition of the boundary conditions for a specific instance, including constraints, degrees of freedom (DOF), material properties, and loads. Designers and engineers must accurately apply loads and boundary conditions in order to get as close to the real answer as possible. The intuitiveness and ease with which they can set up simulation problems plays a major role.

Thus, the accuracy of simulation results from the various FEA packages has direct correlations to easily and correctly setting up an FEA problem, and this is where we see are vast differences among available FEA systems. With the same mathematical underpinnings, FEA and simulation solutions are mainly separated by the technologies utilized for meshing, solving, preprocessing (setting up the simulation), and postprocessing the results.



VALIDATION STUDIES, CERTIFICATIONS, AND BENCHMARKS

So how can you gauge the accuracy of the results generated by different FEA packages when they all produce "approximate" solutions? Running the same, properly setup simulation problem in different FEA systems, how can we know which of the approximate solutions is the closest to the real answer? It's a losing proposition to compare approximations. A much better approach for determining the accuracy of FEA results is to compare those results to reality, using known testing data, or industry benchmarks and validation studies.

The International Association for the Engineering Modeling, Analysis and Simulation Community—better known as NAFEMS—is the recognized independent authority on best practices in engineering simulation. It's mission is to provide knowledge, international collaboration, and educational opportunities for the use and validation of engineering simulation. As part of NAFEMS' work, the organization conducts and publishes validation studies and benchmarks, against which all of the commercial FEA packages compare the accuracy of their results.

For example, there are more than 100 NAFEMS validation studies embedded for reference within SOLIDWORKS® Simulation software under the Help menu. NAFEMS benchmarks, as well as those conducted by AFNOR (the French standardization association), have shown that SOLIDWORKS Simulation results generally fall within 1 percent of the real solution. When evaluating the accuracy of the results generated by different FEA packages, make sure to find out how they compare to benchmarks performed by independent groups like NAFEMS and AFNOR. While designers and engineers often feel that accuracy within 5 percent of the real solution is good enough, depending on the product, FEA packages that produce results accuracy within 1 percent of the real solution and make it easier to set up FEA problems, like SOLIDWORKS Simulation, will provide a level of accuracy equivalent to, if not better than, other simulation programs.

In addition to looking to independent benchmarks like NAFEMS when assessing FEA accuracy, also consider whether the solution has received certification from a reputable industry group. The DIN - Aerospace Standards Committee (NL) is responsible for German national standards. It represents German standardization interests at the European (CEN) and international (ISO) levels in fields ranging from materials, technological processes, and mechanical parts, to flight mechanics and equipment, air freight and ground equipment, and electronics. SOLIDWORKS Simulation software has received NL certification. SIMULIA Structural Professional Engineer (SPE) software, which leverages Abaqus solver technology, has had the NL designation since its very introduction, as well as certification as the best NL solver for technology and advanced mechanics.



With SOLIDWORKS design, simulation, PDM, inspection, and technical communication solutions, Resemin has realized substantial productivity gains during design, manufacture, and assembly of its underground drilling machinery and related equipment.

BENEFITS OF CAD INTEGRATION AND CLOUD-BASED SOLVERS

As we've seen, gauging the accuracy of results generated by a specific FEA package has more to do with how a user defines simulation problems than with the underlying mathematics. This is why a simulation solution that provides capabilities that are easier to use generally produces more accurate results.

SOLIDWORKS Simulation technology traces its origins back to COSMOS software, which was developed in the early 1980s by Structural Research Analysis Corp., acquired by Dassault Systèmes SOLIDWORKS in 2001. Since then, the software has been completely embedded within the SOLIDWORKS CAD design system, providing the best CAD integration and ease of use in the industry. With SOLIDWORKS Simulation, there's no third-party translator, data corruption, or clunky geometry to repair. In short, there's no need for an additional pre-processor in SOLIDWORKS Simulation because the CAD system is the preprocessor. For instance, you define your material properties in SOLIDWORKS CAD and don't have to input them again to run a simulation unless you want to change the material.

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> — Fernando Díaz Engineering Manager, Resemin

"SOLIDWORKS Simulation Premium software provides accurate results and produces solutions much faster than the ANSYS[®] FEA software that we used in the past," explains Fernando Díaz, engineering manager of Resemin, a top international manufacturer of underground drilling machinery and related equipment. "A nonlinear contact with plasticity analysis used to take two days to solve with ANSYS. With SOLIDWORKS Simulation Premium software, we're solving the same type of problem in a couple hours. This saves a lot of time in validating our designs prior to prototyping."

SIMULIA software is a cloud-based solution that runs on the Dassault Systèmes **3DEXPERIENCE**® platform. Leveraging robust Abaqus nonlinear materials and contact analysis technology, SIMULIA is a well-established FEA brand known for the simulation of advanced mechanics. With

SIMULIA, designers and engineers can run simulations on their local desktop or in the cloud, providing a level of flexibility that can help enhance problem setup and results accuracy. Instead of tying up computing resources on their desktop solving simulations, or investing in bigger, more expensive computing hardware, designers and engineers can spend more time on the desktop setting up problems correctly and ensuring accuracy, and less time waiting for simulations to solve.

"Because SIMULIA is on the **3DEXPERIENCE** platform in the cloud and is fully compatible with our SOLIDWORKS modeling data, it provides additional advantages," notes Peter Kjellbotn, mechanical engineer and simulation specialist at InFocus Energy Services, an innovative developer of down-hole products for the oil and gas industry. "It's hardware-independent, freeing



up our workstations for other things, and utilizes SOLIDWORKS data, saving time and money because we don't have to go through time-consuming import/export protocols. The solution also automatically stores data in the cloud and supports collaboration. With SIMULIA, we are only limited by our imagination."

So the next time someone questions the accuracy of a certain FEA package or says, "It's not up to par," remember that simulation accuracy correlates with the correct setup of simulation cases, and think about the systems that are adding capabilities and features to make this easier, and those that are not.

TO FIND OUT WHAT'S NEW IN SOLIDWORKS PRODUCT DEVELOPMENT AND LEARN MORE ABOUT HOW INTEGRATED SOLIDWORKS SOLUTIONS CAN HELP YOUR COMPANY TAKE ADVANTAGE OF THE OPPORTUNITIES PRESENTED BY INTEGRATED SIMULATION TOOLS, <u>CLICK HERE</u> OR CALL 1 800 693 9000 OR +1 781 810 5011.

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