SIMULATION AND YOU
GETTING TO THE TRUTH OF ANALYSIS

THE TRUTH OF ANALYSIS

There's no doubt about it: Simulation has come a long way since its inception.

For decades, analysis was the exclusive domain of expert analysts. They would develop carefully crafted mesh models to assess only the most critical applications, such as automotive crash tests or the tension in a threaded connector. The stakes were immense. Accuracy was paramount. The significant effort invested in those simulations was worth it.

Fast forward to today, and many things have changed with simulation. Automated meshers can produce robust, highquality simulation models. Cloud-based solvers can yield results in minutes. Easier-to-use interfaces make analysis available to practically anyone. And while that technological progress is irrefutable, many companies labor to figure out how to incorporate analysis into their development processes.

MANY QUESTIONS FOR SIMULATION

Today, there are many outstanding questions:

- How accurate do analyses need to be? Should they always be as precise as possible?
- What effect does simulation have on prototyping? Does it eliminate it? Decrease it?
- Do analysis results take the place of experience in decision-making?
- Where else in development can simulation be used? Is it for verification and validation only?

The intent of this white paper is to answer these questions and more. Along the way, we also provide details on how **3D**EXPERIENCE® on the cloud Simulation tools support these efforts.

The role of analysis in development has changed and expanded. Analysis can provide value in whole new parts of the development process. Read on to learn more.

NEED FOR SIMULATION ACCURACY VARIES

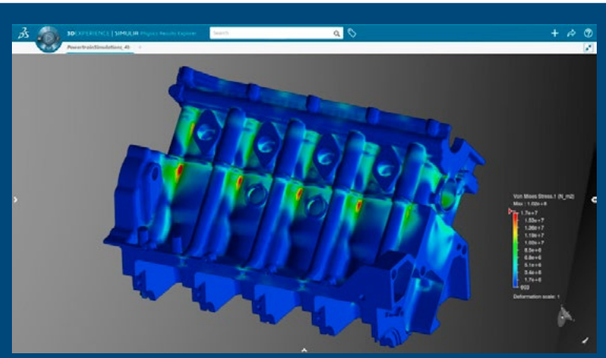
How accurate does a simulation need to be?

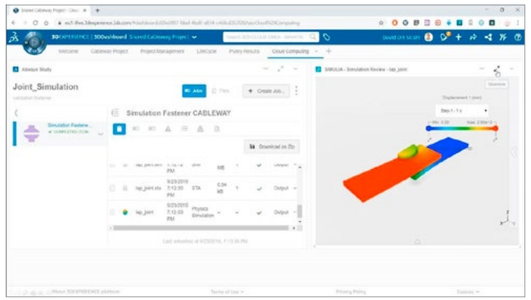
For many, answering this question is a scary and confusing proposition. If you make a decision based on an analysis that isn't accurate enough, you set yourself up for failure at some point in the development. As a result, many fall back to the most conservative position: Simulations must always be highly accurate. That creates an impossibly high bar for the use of analysis. For some, analysis solutions with any uncertainty are a risk. For others, assessing the accuracy of a solution is too burdensome and, as a result, they shun its use entirely. The truth is that the need for simulation accuracy varies from stage to stage during the development process.

Early in concept design, engineers use simulations to compare the performance of different design ideas, much like any trade study. These simulations are often highly simplified models under generic loads that don't resemble the design's detailed conditions. Why? The purpose is to uncover each concept's underlying behavior early, when the final details of operation may not even be known yet. Engineers use these analyses to gain insight into the feasibility and innovation potential for each idea, ultimately selecting one to take to detailed design. Keep in mind that this isn't some final check for the design; it is the first, simple assessment. Such designs will be refined and digitally tested to greater depth in detailed design and beyond. As a result, the cost of inaccuracy here is very low.

QUICK FACTS ON SIMULATION AND ACCURACY

- The need for simulation accuracy varies by product development stage. Early, accuracy can be lax. Late, it must deliver high fidelity results.
- Simulation doesn't replace prototyping, yet it can reduce it.
- Simulation has a natural application in testing as well.
- Simulation doesn't replace experience; it augments it. Engineers can make better decisions with more information about a design's performance.





In detailed design, the needs of engineers change. They use simulations to contrast the impact of specific decisions in fine-tuning a design. This process includes selecting the right material grade, determining wall thicknesses, or selecting off-the-shelf components. These simulation models roughly represent the design's final operating environment. The purpose of these analyses is still directional; the results here are comparative and not absolute. More formal simulations and tests will catch design flaws later. The cost of inaccuracy here is low.

The need for simulation accuracy ramps up significantly in digital verification and validation. At this point in development, engineers and analysts perform a final and formal check of a design's performance before moving to prototyping and testing, where hard monies are spent to build something physical. The idea is to catch and address design issues here to avoid costly physical prototype failures. The cost of inaccuracy here is moderate.

The reality is that the need for analysis accuracy increases as you progress from concept design through digital verification and validation, corresponding to the risk of the task. It starts low. It ends high.

SIMULATION DOESN'T REPLACE PROTOTYPING

Can you replace prototyping with simulation?

No. To be perfectly clear, companies should not have any expectation that prototyping can be completely replaced with simulation. Every product should be physically tested to verify and validate the satisfaction of requirements, conformance to constraints, and performance against the engineer's intent. That does not change with simulation. Period.

Can simulation help reduce the number of prototypes built?

Yes. Absolutely. Using simulation in verification and validation allows engineers and analysts to digitally check performance before a prototype is built. These highly accurate simulations catch most design flaws before any money is spent on hardware. Furthermore, analyses can reveal secondary and tertiary failure modes. Engineers can mock up changes and rerun the analyses, verifying that their new designs do, in fact, pass the check. This stands in stark contrast to a testing-reliant approach that requires many prototype iterations to uncover a failure, perform a root-cause analysis of the issue causing the failure, make modifications to the design, and then build another physical prototype. The difference is quite simple: One relies on digital approaches while the other relies on physical approaches.

There are, however, significant implications of this difference for companies. The Cloud Adoption study (see page 4) conducted by Lifecycle Insights found that a single round of prototyping and testing costs $46,720, on average, and takes 30 days to complete. Findings from the study show that respondents averaged 2.6 rounds of prototyping and testing per project. That totals $121,472 and 78 days per project. Obviously, these metrics will vary from industry to industry and company to company. However, this is one area where simulation can have a significant impact, on both keeping projects on schedule and reducing project costs. The truth is that companies will not eliminate physical prototyping and testing with simulation. This is a key step in the development process. Companies can, however, dramatically reduce the amount of money and time spent on prototyping and testing through the use of simulation. Specifically, simulation calls for the application of highly accurate analysis in verification and validation, a step immediately before prototyping and testing.

SIMULATION DOESN'T REPLACE EXPERIENCE

Can simulation replace experience in making design decisions?

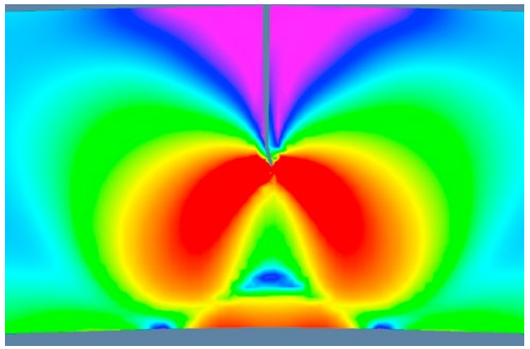
No. This is another misconception about simulation. No company should use simulation results to overrule an engineer's experience in making a design decision. At the end of the day, engineers make design decisions. Simulation is no replacement for engineering experience. However, simulation can enable engineers to make better design decisions in a couple of ways.

First, analysis results augment an engineer's experience. During the development process, engineers use many different sources of information to make their decisions. That includes material specifications, industry standards, codes and regulations, reference works, periodicals, patents, and much more. Simulations only add to this set of information that engineers use to make their decisions. Armed with more insight, engineers make better decisions.

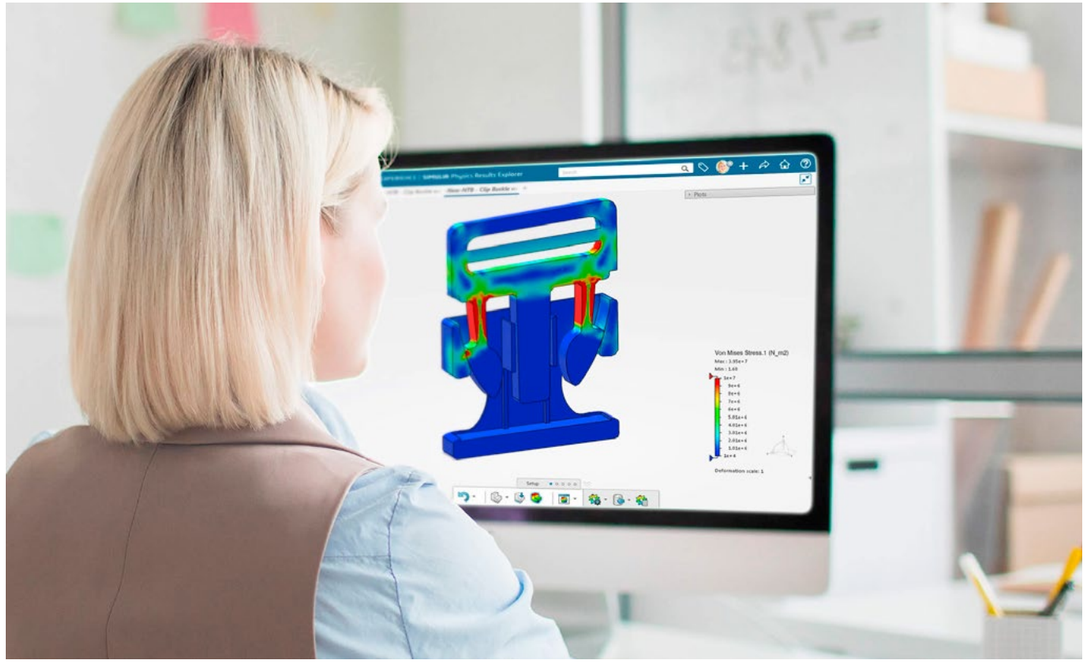
Second, simulation can validate and even extend an engineer's experience. Individuals often know not to design components with certain features or traits because they fail in prototyping and testing. However, they might not know why those parts fail. A simulation run before—or even after—prototyping and testing can uncover the root cause of the failure. This allows engineers to authenticate their hypotheses. With that insight, they can augment that feature or trait to make it feasible in ways they might not have previously considered. Simulation can reveal the engineering physics behind the failure, deepening engineering's knowledge about the behavior of their products

"I wanted to leverage the cloud, but I also needed some access to some legacy Abaqus capabilities, such as fracture mechanics, advanced material models. Engaging online really allowed me to come up with a solution that met both those needs: I can run a medium size model locally with licenses or I can use tokens and increase the number of calls or if I have really large jobs."

Gregory Brown,
Principal
Blue Ring Engineering LLC



Using the **3D**EXPERIENCE on the cloud design and simulation capabilities, Blue Ring Engineering has shortened design cycles for its positioning systems, reduced development costs, and accelerated time-to-market.



Engineers, of course, have a lot to gain by achieving more insight into product performance. Design flaws, once they get past design release, transform into change orders. Those are costly for the company, in terms of both money and time. However, there are serious implications for engineers as well. Those change orders are disruptive when they return to an engineer's desk. It means the engineer must drop their current project and dedicate time to addressing the change order. Meanwhile, the deadlines don't move for the current project, putting the engineer further and further behind. Simulation can enhance your experience in order to catch those issues before design release, allowing you to avoid change orders altogether.

Ultimately, simulation is meant to aid engineers. It augments their experience. It deepens their knowledge about the physics in their designs. It allows them to eliminate extra rounds of prototyping and testing as well as sidestep change orders. Simulation adds to the decision-making process; it does not replace it.

LIFECYCLE INSIGHTS' 2019 CLOUD ADOPTION STUDY

Lifecycle Insights' Cloud Adoption study focused on the current challenges in product development as well as the adoption levels of cloud-based solutions. It was conducted between November 2018 and March 2019. The findings reported here represent the responses from 187 survey participants from a variety of company sizes and industries.

SIMULATION CAN AID IN TESTING

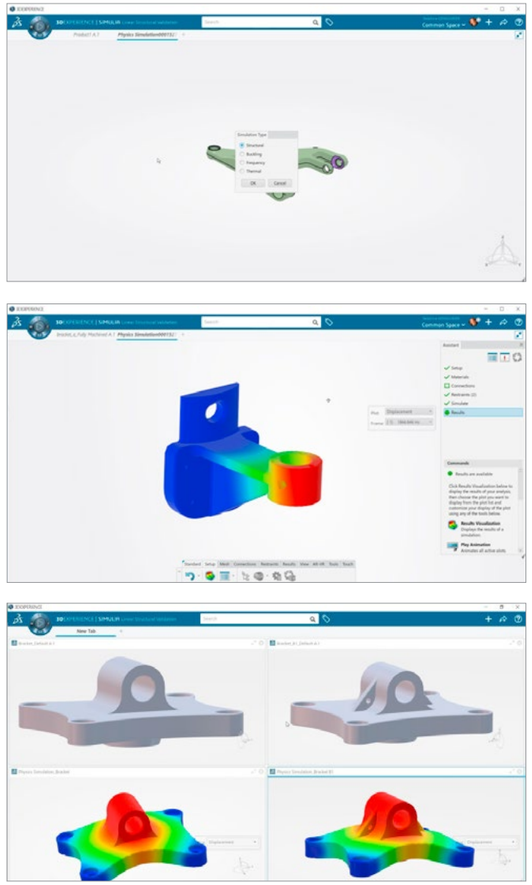
Is there a fit for simulation in prototyping and testing?

Actually, yes. Much of the value that simulation provides focuses on reducing rounds of prototyping and testing. However, analysis applied in testing provides great benefit. To truly understand the impact simulation can have, it is key to think about the process without analysis.

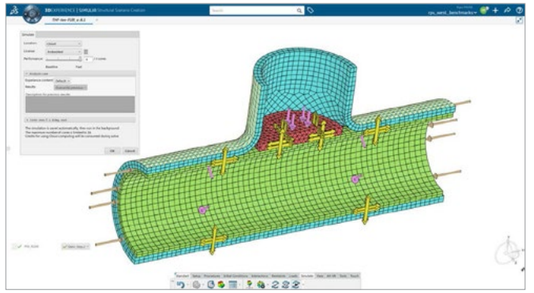
Late in the design cycle, engineers and others build the first prototype. They set it up for various test cases. When one of these prototypes fails, they have proof of how, when, and where it failed. The problem is that they don't know why it failed. As a result, engineers must formulate a hypothesis for that failure and come up with design changes that address it. The problem, of course, is that the engineer doesn't know if their hypothesis is correct until the next test. If the next prototype fails, then they don't know if the hypothesis was wrong or the design change was inadequate. Furthermore, they don't know if the failure was due to the initial design flaw or a secondary or tertiary one. This process repeats until one of the prototypes passes testing. This high-stakes, high-risk, iterative, testing-reliant approach is costly. Remember, the Cloud Adoption study conducted by Lifecycle Insights found that a single round of prototyping and testing, costs $46,720 on average, and takes 30 days to complete.

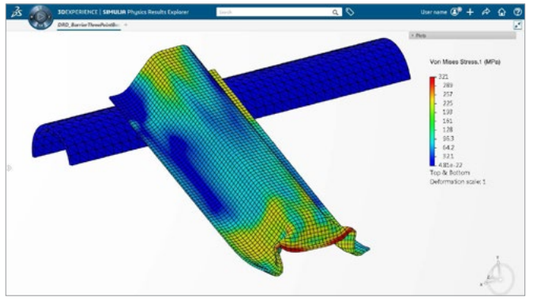
This process changes dramatically with simulation. After the initial failure, an engineer or analyst runs an analysis on the current design. The results reveal not only the initial design flaw, but secondary and tertiary ones. This confirms or refutes the engineer's hypothesis of the failure. Armed with insight, the engineer can develop design changes that address the first failure and any other design flaws. As a result, they have a much higher likelihood of passing the second round of prototyping and testing. Note that this process change does not require the use of simulation at any point prior to testing.

Many think of simulation as something that happens long before testing. However, it can be a great aid in testing. Using simulation in testing reveals the cause of the initial failure as well as any secondary and tertiary ones. This accelerates the resolution of a failed prototype without using simulation at any other point in design.



Structural Simulation





A SCALABLE SIMULATION PORTFOLIO FOR STRUCTURAL DESIGNERS

Early in development, the simulation requirements for accuracy and complexity can be lax. Use the scalable portfolio of designer simulation on the **3D**EXPERIENCE platform to improve and validate your designs.

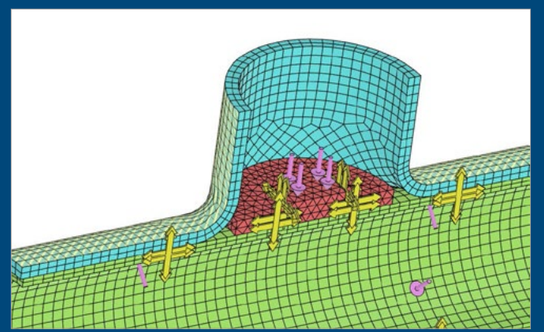
Fully embedded in the design environment using the design geometry directly, cloud-based simulation on the platform is an efficient and powerful part of your everyday design best-practice.

- Buy only what you need: Linear and nonlinear statics and dynamics of parts, assemblies, and structures is provided within a scalable portfolio
- Replaces and extends CATIA V5 Simulation functionality
- Guided simulation workflows make simulation easy to access within the design environment
- Re-run simulation immediately following updates to the design geometry

Another significant advantage for Structural Professional Engineer lies in the tight integration with SOLIDWORKS and all the other **3D**EXPERIENCE apps. SOLIDWORKS models can be easily shared with Structural Professional Engineer and vice versa.

Using our tools, simulation is integrated in the design process, and fully based in the cloud. As a result, engineers can access it from anywhere through a browser. Engineers can also share simulation models and results with any internal or external stakeholders by simply providing a link. The cloud-based nature of the **3D**EXPERIENCE platform simulation apps also offers flexible computer power. Multithreaded processing delivers rendering and visualization of large-scale simulations fast.

Being part of the cloud-based **3D**EXPERIENCE portfolio means any engineer can easily access advanced simulation without the need for expensive hardware. An added benefit is faster product delivery, thanks to real-time collaboration and data sharing capabilities.



INTEGRATED BEST-PERFORMING SIMULATION TOOLS

CATIA V5 on the cloud Simulation integrates seamlessly structural simulations, all on a unified **3D**EXPERIENCE platform on the cloud, that leverages the Abaqus solver, a long-standing, industry renowned, accurate solution.

SUMMARY AND CONCLUSIONS

Today's simulation plays a wide range of roles in development. In concept design, engineers use analyses to assess the feasibility and innovation potential of new ideas. During detailed design, they apply it to refine designs and make better, more informed decisions. With verification and validation, they employ simulation as a way to check performance digitally. During prototyping and testing, they use it to confirm the root cause of failures and identify secondary and tertiary failures. Each use of simulation delivers separate, independent benefits.

Accuracy, of course, is an important topic to address with simulation. It can start at a low fidelity in concept design. However, the need for higher accuracies increases as development progresses.

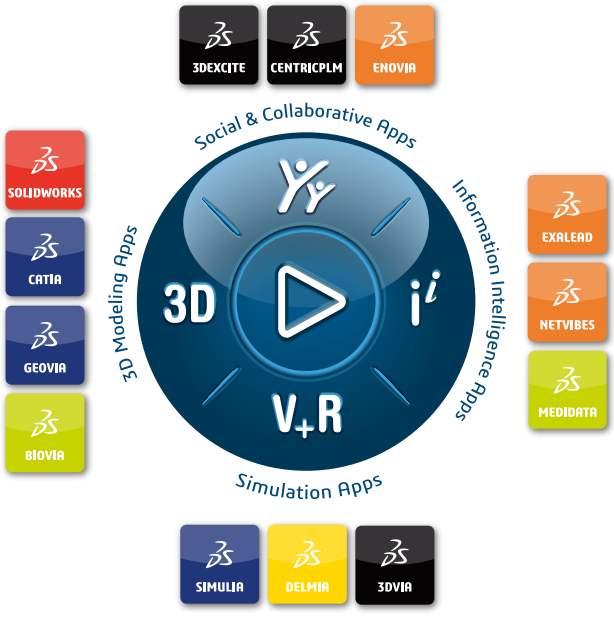
As we are conscious of these challenges and understand the need for performance, we created the **3D**EXPERIENCE platform on the cloud simulation roles. These provide design engineers powerful tools to perform linear static and dynamics simulations of structures during the design process.

Simulation is now a key part of product development. Dassault Systèmes provides a powerful scalable portfolio of designer simulation roles, on the **3D**EXPERIENCE platform on the cloud, to improve and validate your designs while ensuring maximum accuracy and data alignment.

Our **3D**EXPERIENCE® Platform powers our brand applications, serving 11 industries, and provides a rich portfolio of industry solution experiences.

Dassault Systèmes, the **3D**EXPERIENCE Company, is a catalyst for human progress. We provide business and people with collaborative virtual environments to imagine sustainable innovations. By creating 'virtual experience twins' of the real world with our **3D**EXPERIENCE platform and applications, our customers push the boundaries of innovation, learning and production.

Dassault Systèmes' 20,000 employees are bringing value to more than 270,000 customers of all sizes, in all industries, in more than 140 countries. For more information, visit **www.3ds.com**.



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