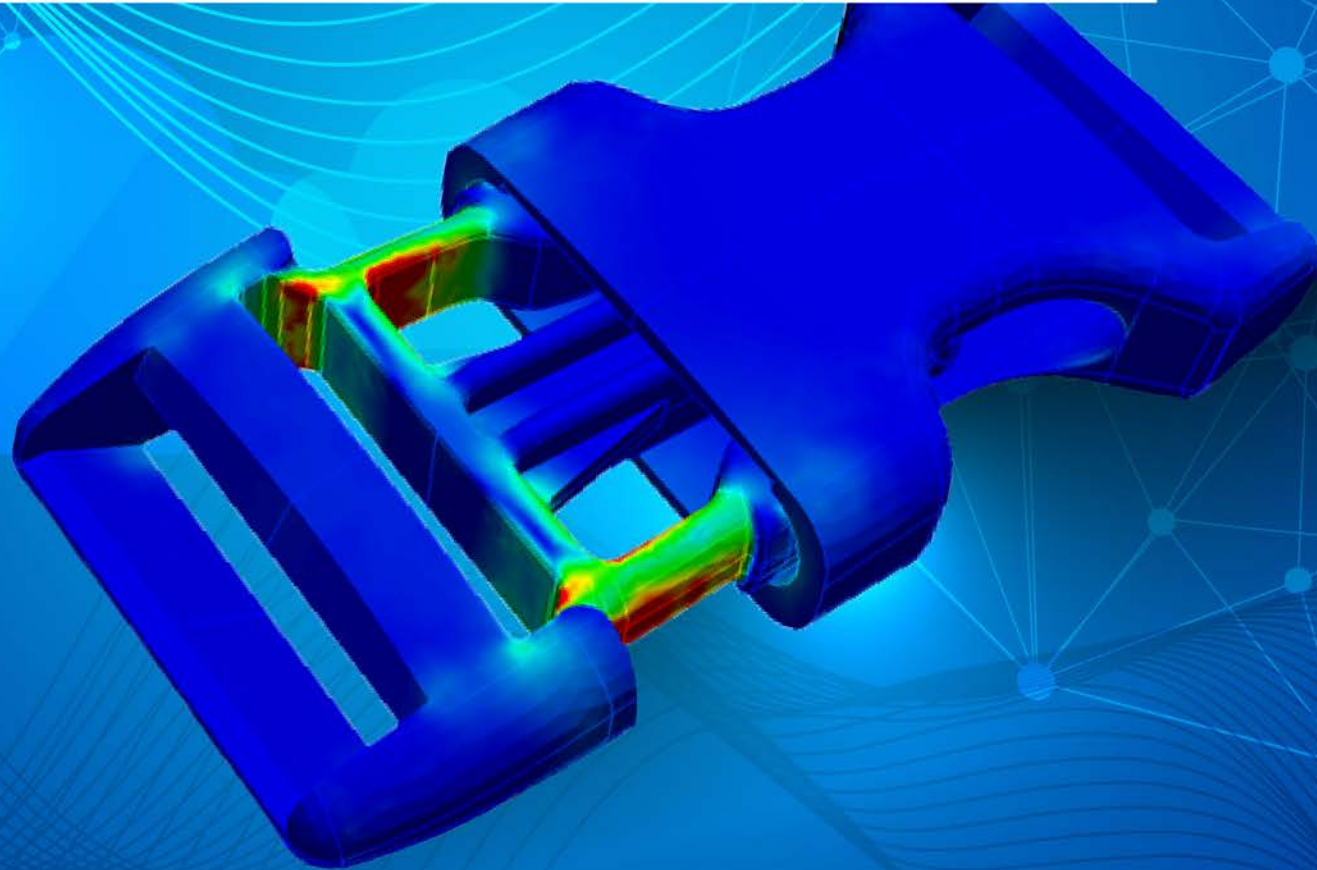


How to Survive and Win New Markets by **GETTING EVEN MORE VALUE FROM SIMULATION**

Michelle Boucher | Vice President | Tech-Clarity



Becoming Even Better Engineers

Supporting Engineering Decisions

What is the best way to help design engineers engineer the most competitive products possible?

As it continues to become harder and harder for products to stand out in our global economy, the engineering behind today's modern products has become increasingly critical. As we struggle with challenging economic times created by COVID-19, companies will need to work even harder to win over customers. At the same time, products have become increasingly complex, making those critical engineering decisions that much more difficult. In fact, 44% of manufacturers say design decisions have gotten even harder, with many relying on personal experience and guesswork to guide decisions. Workforce shortages resulting from economic cutbacks and retirements will likely mean even fewer resources for engineers, while more is expected of them. What can companies do to overcome this and support engineers?

About this Study

This research study, based on a survey of 272 manufacturers, examines how to help design engineers make more informed engineering decisions. However, limitations in traditional infrastructures limit some of the value. The research shares best practices for overcoming those limitations.

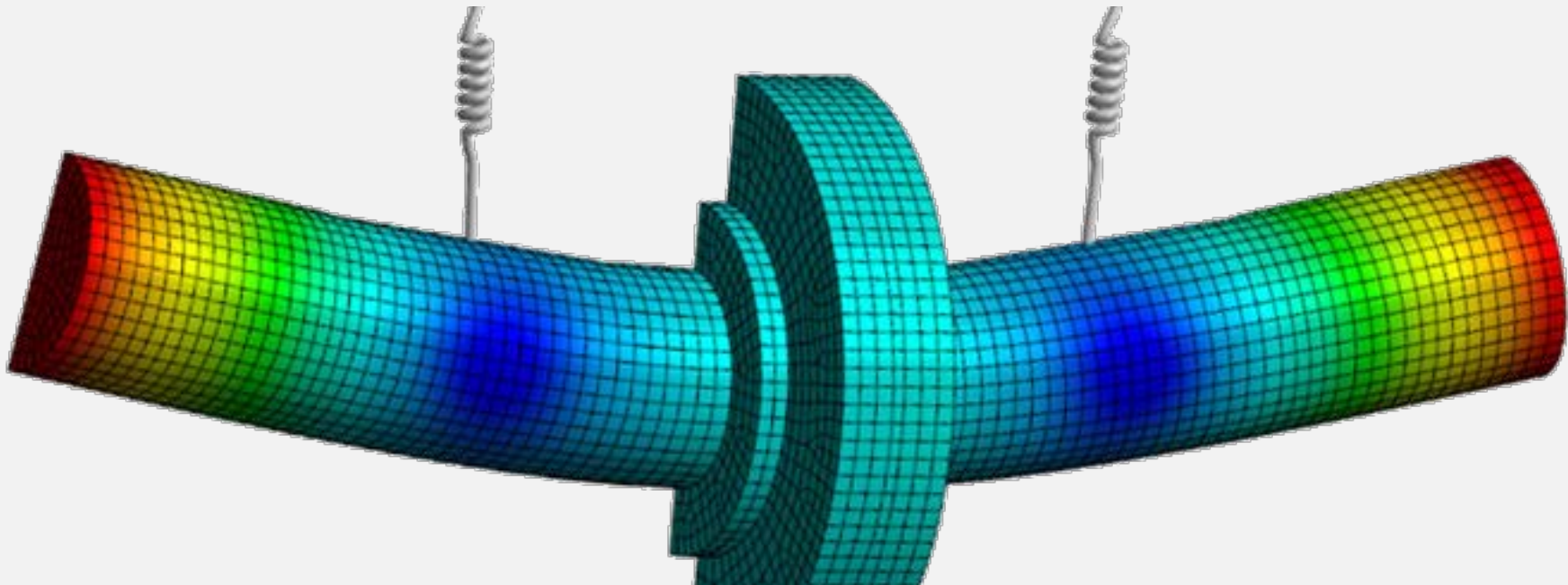
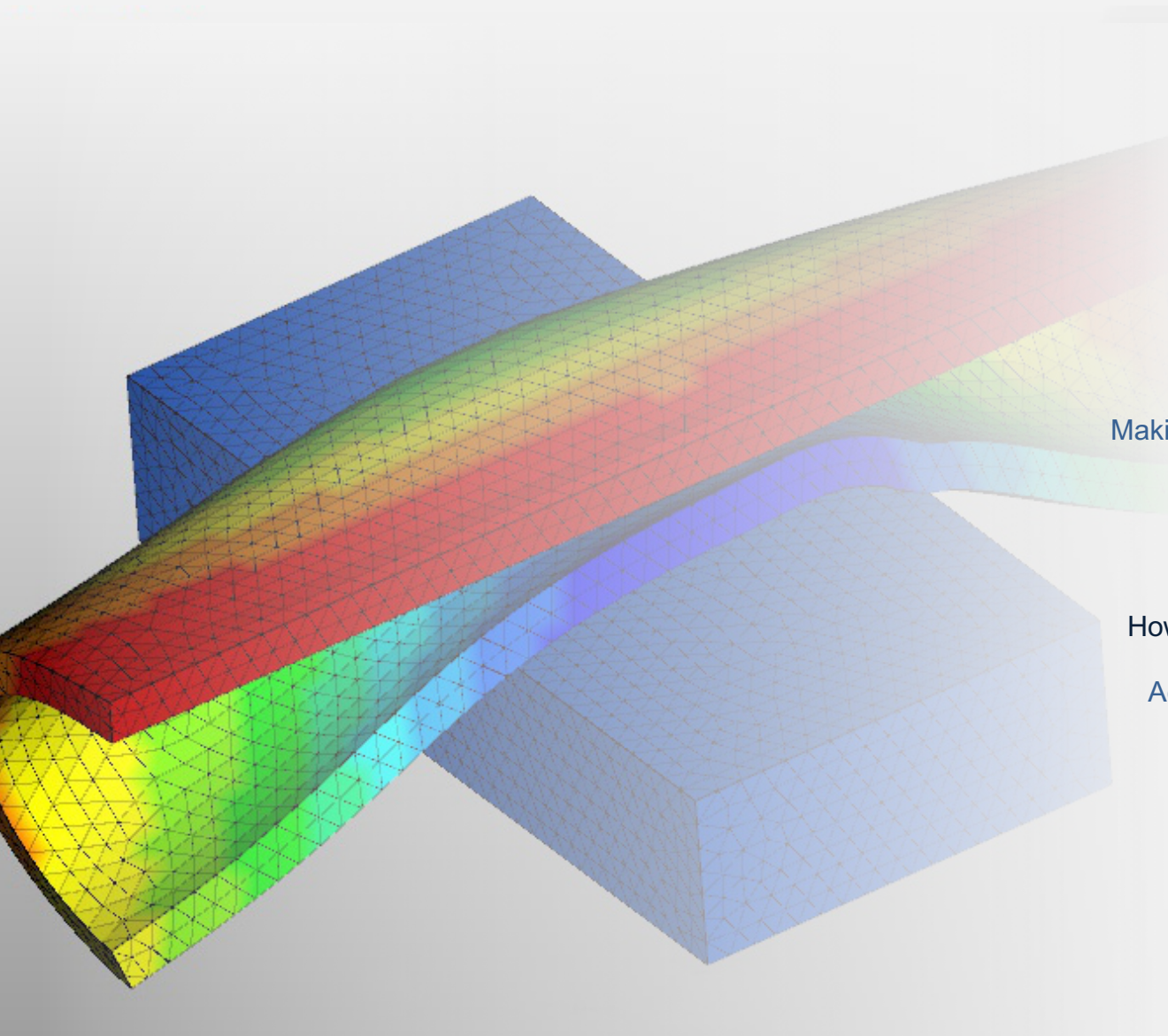


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Executive Summary

Designing in a Modern Era

As products become more complex, engineering decisions are getting harder. The good news is that there is help. Respondents report that both experience and better software tools help. In fact, 74% of Top Performing companies empower their design engineers with simulation tools. The research explored best practices for supporting design engineers to adopt simulation.

Getting More Value from Simulation

While simulation offers many advantages, there are opportunities to get even more value. Often, it is the lack of knowledge that holds them back. This is likely why 83% of Top Performers say that if design engineers could collaborate more easily with a simulation expert, it would help them.

Better Collaboration

The majority of respondents, 54%, agreed that the best way to enable collaboration between analysts and design engineers is to send a link to collaborate on a model in real-time. A cloud platform is a way to allow this, which is probably a contributor to why Top Performing companies are 3.9 times more likely to use cloud software, including for simulation. While better collaboration is a powerful benefit, the leading advantage of those using simulation in the cloud, reported by 71%, is the additional computing power and faster results. Top Performers would use this extra time to

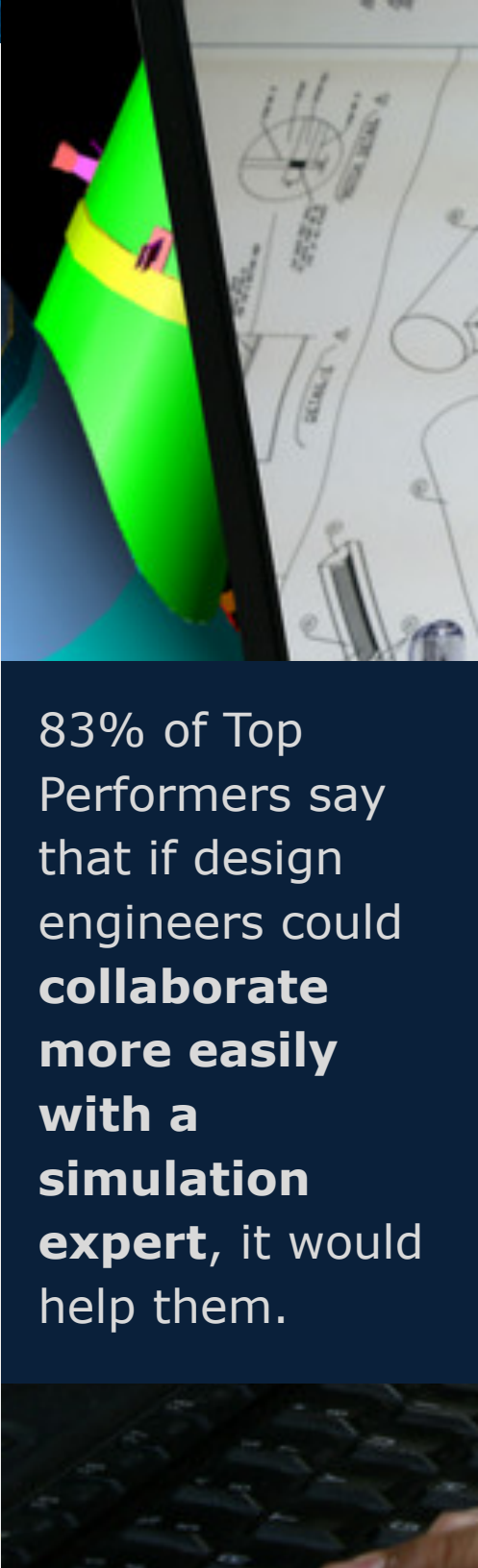
complete design work faster, innovate more, and conduct additional simulations. The research also finds that those using simulation in the cloud report more benefits than anticipated by those who don't use it. This indicates that once you start using simulation in the cloud, it will likely help you in ways that you may not expect.

Fast Access to Needed Data

Another way to support design engineers is to make sure they have access to the required data to support simulations. The research finds that Top Performing companies are 63% more likely than Others to agree that the cloud is the ideal way to manage the different data types needed for simulation. Incidentally, those using the cloud for simulation are more likely to manage material data, best practices, test data, past simulations, and real-world performance data. Respondents identified all of these as data types that should be managed.

An Integrated Platform

The cloud is also a way of supporting an integrated platform. Companies reported many benefits of an integrated platform. Interestingly, the more complex the product, the more likely respondents were to report more benefits. Easier collaboration between design engineers and analysts, better traceability, more flexible licensing, ease of sharing and controlling access to results, and access to multiple physics were among the most commonly reported benefits.

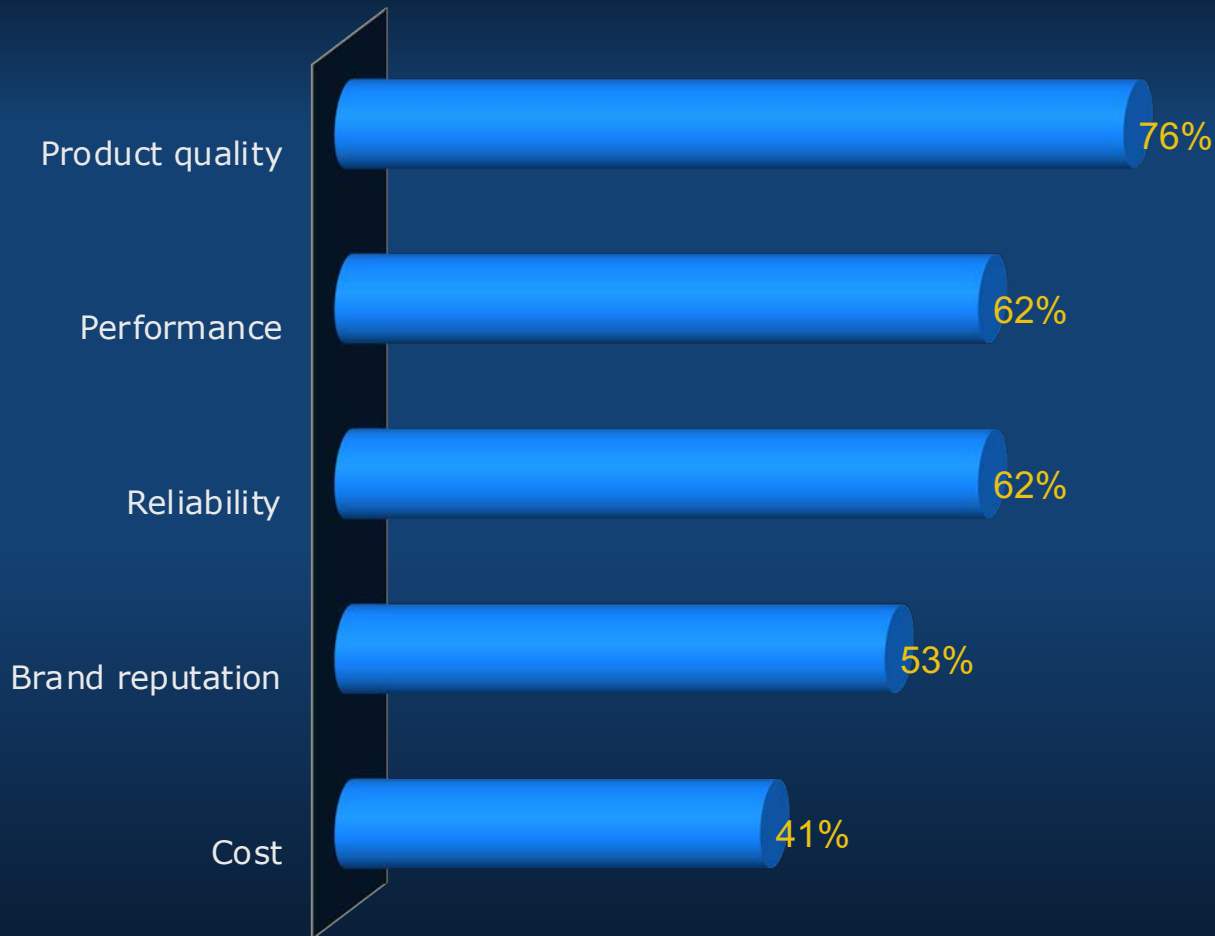


83% of Top Performers say that if design engineers could **collaborate more easily with a simulation expert**, it would help them.

Start with Your Customer

Product quality, performance, and reliability are critical buying criteria.

WHY CUSTOMERS BUY YOUR PRODUCTS



Why Do Customers Buy Your Products?

While engineers strive to engineer the best product possible, customers are the ultimate judge. When we asked companies why customers buy their products, the majority said it was because of product quality, performance, and reliability (see graph). Engineering decisions directly impact these criteria. These qualities also have a significant impact on brand reputation, which is also a critical influencer of customer buying behavior. Another factor, cost, also affects it, yet cost competes directly with quality, performance, and reliability. While cost was considered less important when the data was collected, as the economy suffers, it will likely increase in importance.

Engineers need insight to make appropriate trade-offs to develop the best product possible that will capture market share and boost revenue. The research reveals the best ways to achieve this.

But Design Decisions Have Gotten Harder

Quality Requirements and Time

While engineering decisions are critical for product success, 44% say that the decisions that impact competitiveness have gotten harder. The graph shows the top five reasons why.

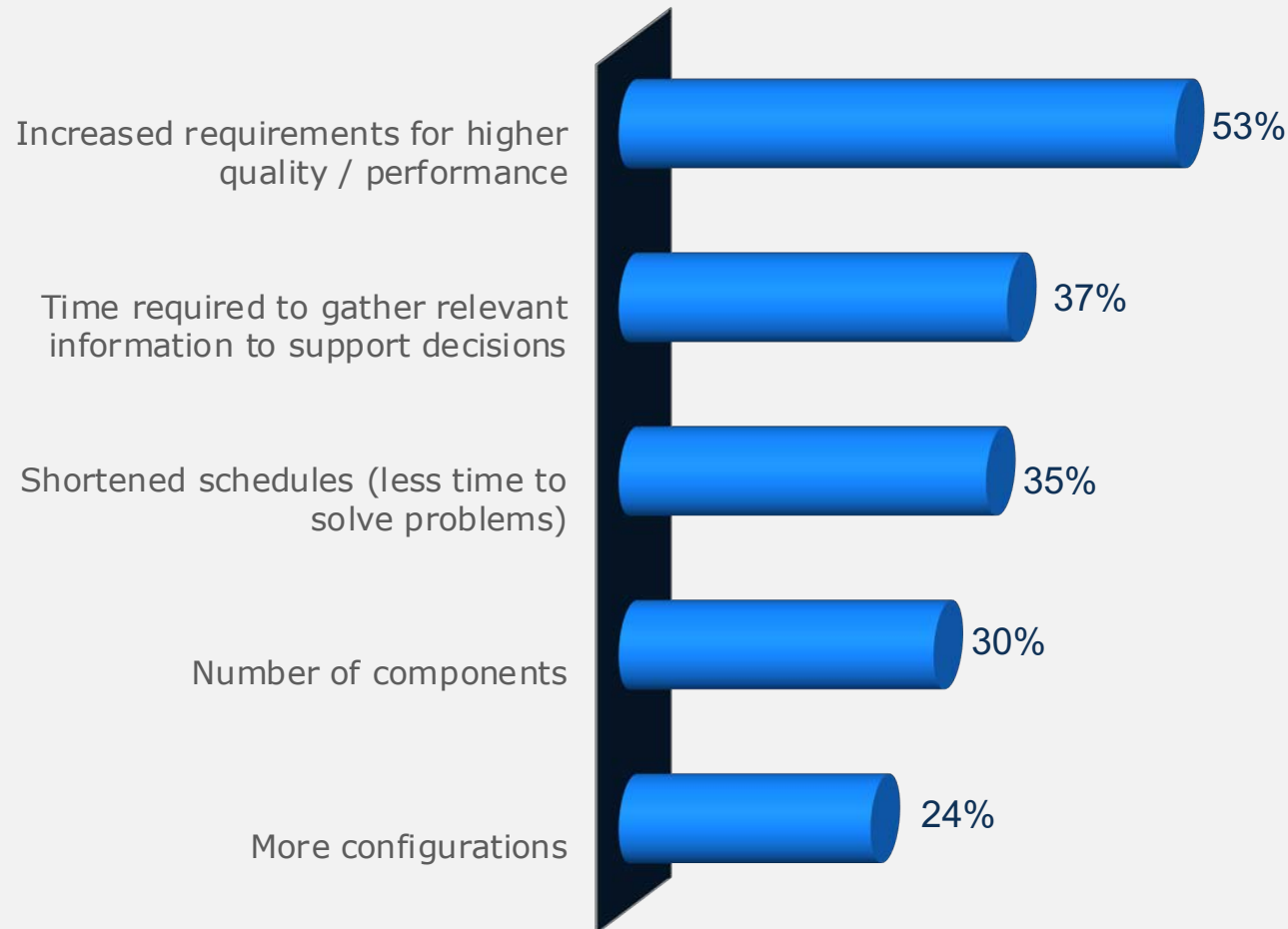
The majority say it is those very requirements that improve competitiveness, increased requirements for higher quality, and performance that have made it harder. Unfortunately, during a recession, if a company cannot meet those requirements, they may not survive. However, it takes additional time to make those decisions as engineers need to gather a lot of information. Yet, shortened development schedules mean engineers have less time to spend on analyzing the impact of their choices. This puts engineers in a nearly impossible situation, continually trading off between quality and time, without driving up product cost. Plus, products themselves are more complicated with additional components and configurations, so there are even more factors to consider.

Better Options Needed

Design engineers need better methods to make the right decisions that impact quality in the most efficient way possible.

Design engineers need **better methods** to make the right decisions.

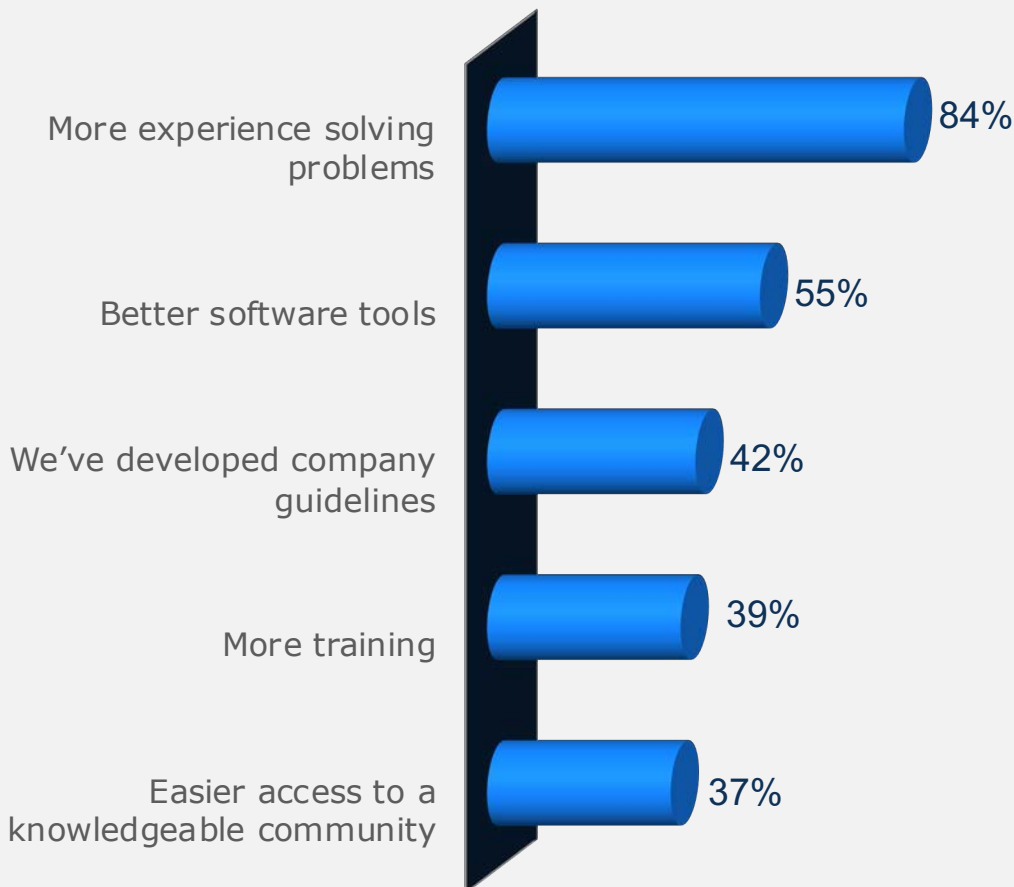
WHY DESIGN DECISIONS ARE MORE DIFFICULT



What Makes Design Decisions Easier

Experience and better software tools have helped engineers make design decisions more easily.

WHAT HAS MADE DESIGN DECISIONS EASIER?



Some Have Found Solutions

While design decisions have gotten harder for many, a smaller group, 22%, says decisions have gotten easier. Why is that? The graph reveals the top five reasons.

Knowledge and Tools Make a Difference

The biggest factor that makes decisions easier is experience. Engineering knowledge is an invaluable resource, but it takes time to develop. The engineering workforce also skews older. For example, in the US, in 2015, 33% of the science and engineering workforce was between 51 and 75.¹ With so many engineers approaching retirement age, unfortunately, many companies will lose that knowledge resource. Further, there are fewer younger engineers to replace them. Plus, as we enter a period of global economic uncertainty, many companies may be forced to reduce their workforce or offer early retirements, which will further limit knowledge resources.

Another factor is that software tools have gotten better. The majority of respondents who have found design decisions have gotten easier, point to better software tools as the reason. Interestingly, software can also help with other issues. The right tools can capture knowledge, best practices, and company guidelines. The software can then guide users through the simulation process.

The right software can also facilitate collaboration to make it easier to connect with each other and experts. As the COVID-19 health crisis proves, the unexpected can happen and it can be painful if you are not prepared. With powerful collaboration capabilities, a company can more easily adapt so that you can continue engineering operations. Whether it is a natural disaster, inclement weather, or something as mundane as an office move, your team can stay connected.

Solving Problems

Challenges Associated with Problem Solving

Digging further into the engineering process, we explored how engineers solve problems. Interestingly, they rely most on the methods used by those who say decisions have gotten easier (see graph below).

To solve problems, engineers depend on their personal experience and simulation software. As previously discussed, it takes a long time to develop expertise, and as many of our most experienced engineers approach retirement, relying on experience may soon become

less of an option. Waiting for physical tests also helps, but it consumes time engineers do not necessarily have. Experts can also be an invaluable resource, but collaboration is often a challenge. Overengineering is safe, but it drives up costs, which will make products either less profitable or less price competitive, something most companies cannot afford during a recession.

Simulation Is the Ideal Method for Problem Solving

Interestingly, when asked about the ideal way to solve challenges, respondents overwhelmingly said, "Use simulation." Clearly, engineers view simulation as an invaluable tool, but some companies get even more value from it than others.

A surprising 18% said they rely on guesswork to solve problems, yet 0% said it was the optimal way. Knowing that nearly a fifth rely on guesswork means there is

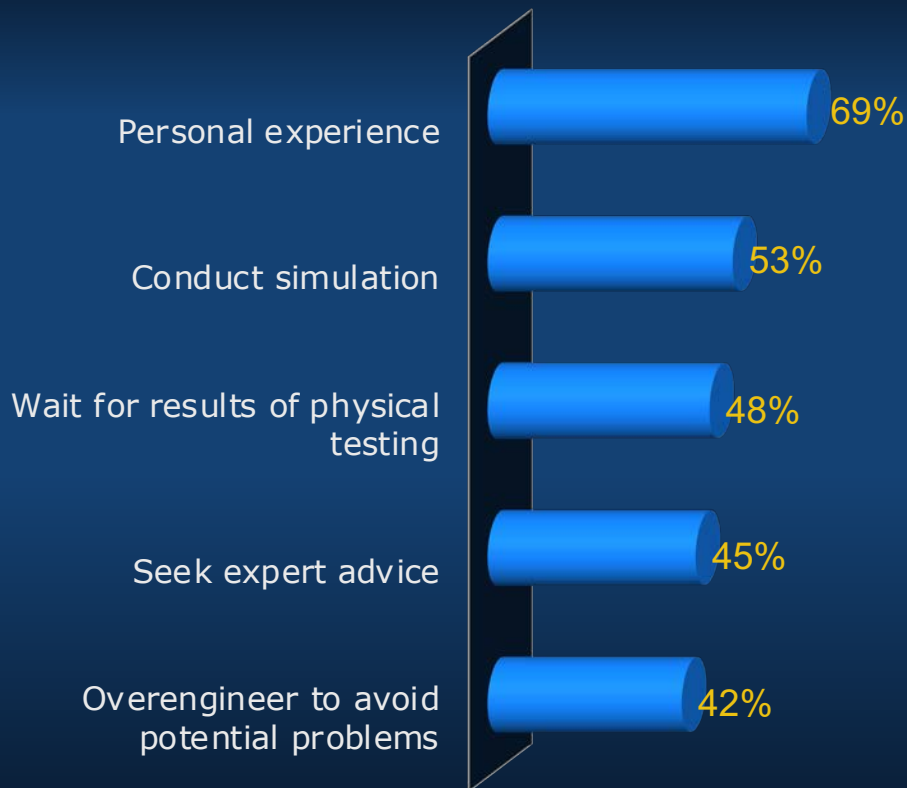
IDEAL WAY TO SOLVE PROBLEMS



high level of uncertainty around design decisions. Considering these decisions impact critical design criteria that will impact a product's success, companies can overcome significant risk by using simulation more.

Let's look at some best practices that can help your company get even more value from simulation.

HOW ENGINEERS SOLVE CHALLENGES



Identifying Best Practices

How Top Performers Were Defined

To determine best practices, Tech-Clarity analyzed the behaviors of Top Performing companies. We defined Top Performers as the top 25% of companies who outperform their competitors in metrics that indicate engineers can make the best design decisions with their ability to develop:

- High quality products
- Innovative products
- Products efficiently
- Products that meet cost targets

We then focused on what Top Performers do, especially what they do differently, to develop recommendations.

The Top Performer Advantage

Top Performers have the right practices in place, so they get better to improve their design decisions. Survey respondents rated how well their company performs from a 5, meaning "Highly Effective" to a 1 for "A Big Problem." Top Performers rated their processes as working better than "Very Effective" while Others rated theirs as "Average." Their practices help Top Performers meet their required design objectives to improve competitiveness (see table).

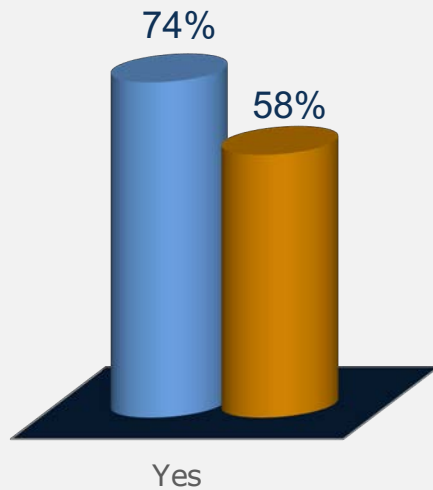


METRIC	TOP PERFORMER	OTHERS
Understand trade-offs	4.4	3.4
Identify problems early during the development process	4.2	3.5
Optimize products	4.6	3.4

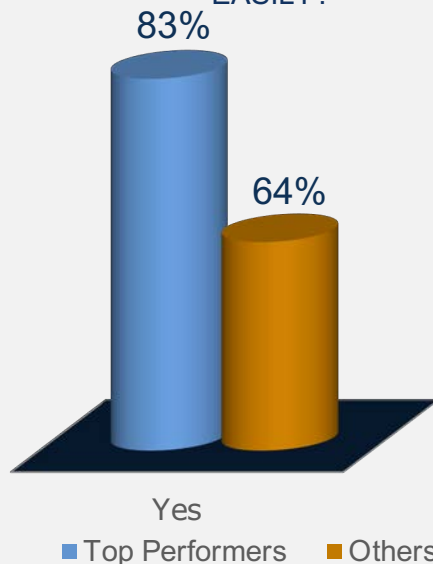


Making Simulation Accessible to Design Engineers

DO DESIGN ENGINEERS USE SIMULATION?



WOULD YOU GET MORE VALUE FROM SIMULATION IF DESIGN ENGINEERS AND ANALYSTS COULD COLLABORATE MORE EASILY?



Design Engineers and Simulation

One way Top Performers differentiate themselves is through their use of simulation. Top Performers are 28% more likely than their peers to empower design engineers with simulation during design.

Collaborate with Analysts

Of those who said design engineers are not using simulation, 50% said more simulation knowledge would help them. They could achieve this by making it easier for design engineers to collaborate with analyst experts. Interestingly, even those who use simulation during design agree, especially Top Performers. An overwhelming 83% of Top Performers say that if design engineers could collaborate more easily with a simulation expert, they would get even more value from simulation.

The question is, what's the best way to collaborate with analysts? The overwhelmingly

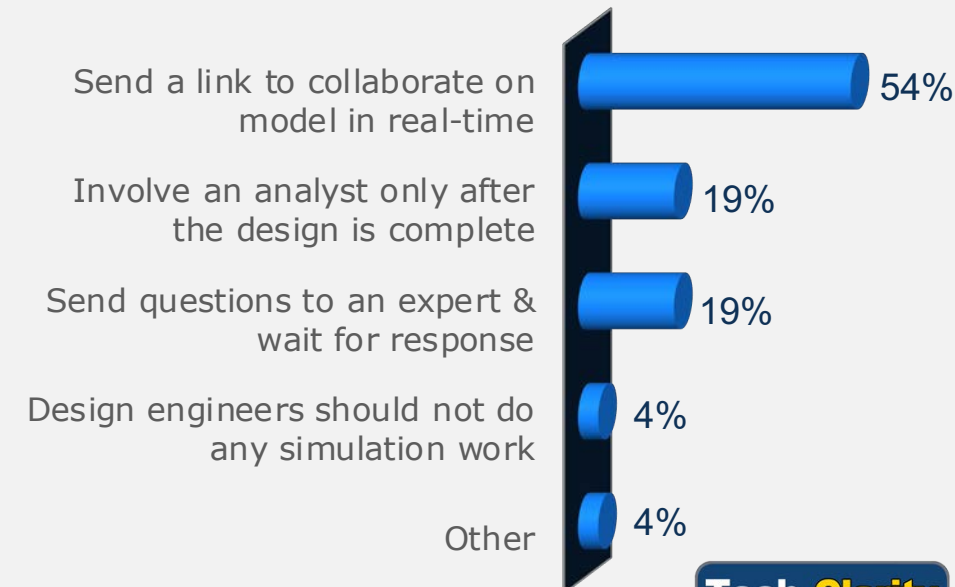
preferred method is for design engineers to send a link to an analyst so they can use the model to collaborate in real-time. This way, the analyst can see precisely what's needed, in context, and provide design engineers with needed guidance.

The Cloud Enables Collaboration

Cloud platforms can provide exactly this collaboration capability. Analysts don't have to worry about installing

additional software since the software is hosted in the cloud. Even better, the cloud supports the infrastructure to connect, so it doesn't matter if the analyst is in the same building, a different country, or at home. This approach can also make it easier to tap into the expertise of third-party design service firms or even semi-retired analysts who continue to consult. Sharing data via the cloud rather than via email, keeps IP secure.

IDEAL WAYS FOR DESIGN ENGINEERS TO COLLABORATE WITH SIMULATION EXPERTS



Using Simulation in the Cloud

The Cloud Increases Adoption

Reasons like this contribute to why Top Performing companies are 3.9 times more likely to use cloud software, including for simulation (see graph on right). Previous Tech-Clarity research

found that the more cloud software a company uses, the more they appreciate the benefits and use it.² This is also likely why so many who use cloud software have also extended it to simulation.

Benefits of the Cloud

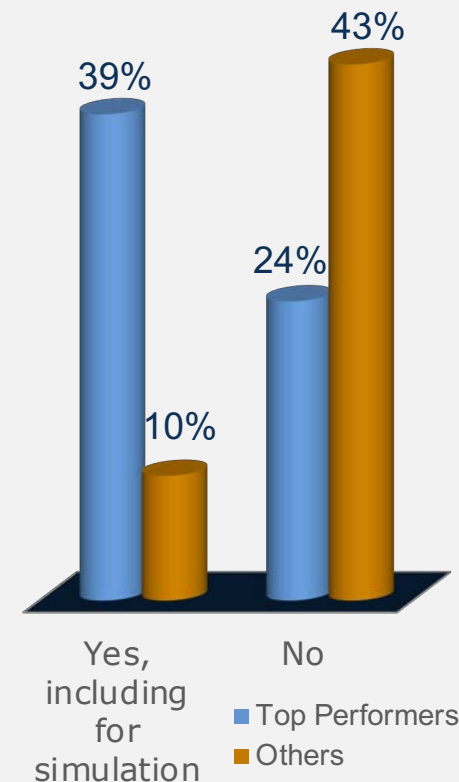
In addition to better and more natural collaboration, the cloud offers other benefits too. The left-hand graph compares the anticipated benefits of those using the cloud for simulation to both those not using it and those using the cloud, but not for simulation.

Interestingly, those using simulation in the cloud are more likely to realize even more benefits than their peers anticipate. This says that once you start using simulation in the cloud, it will likely help you in ways that you may not expect.

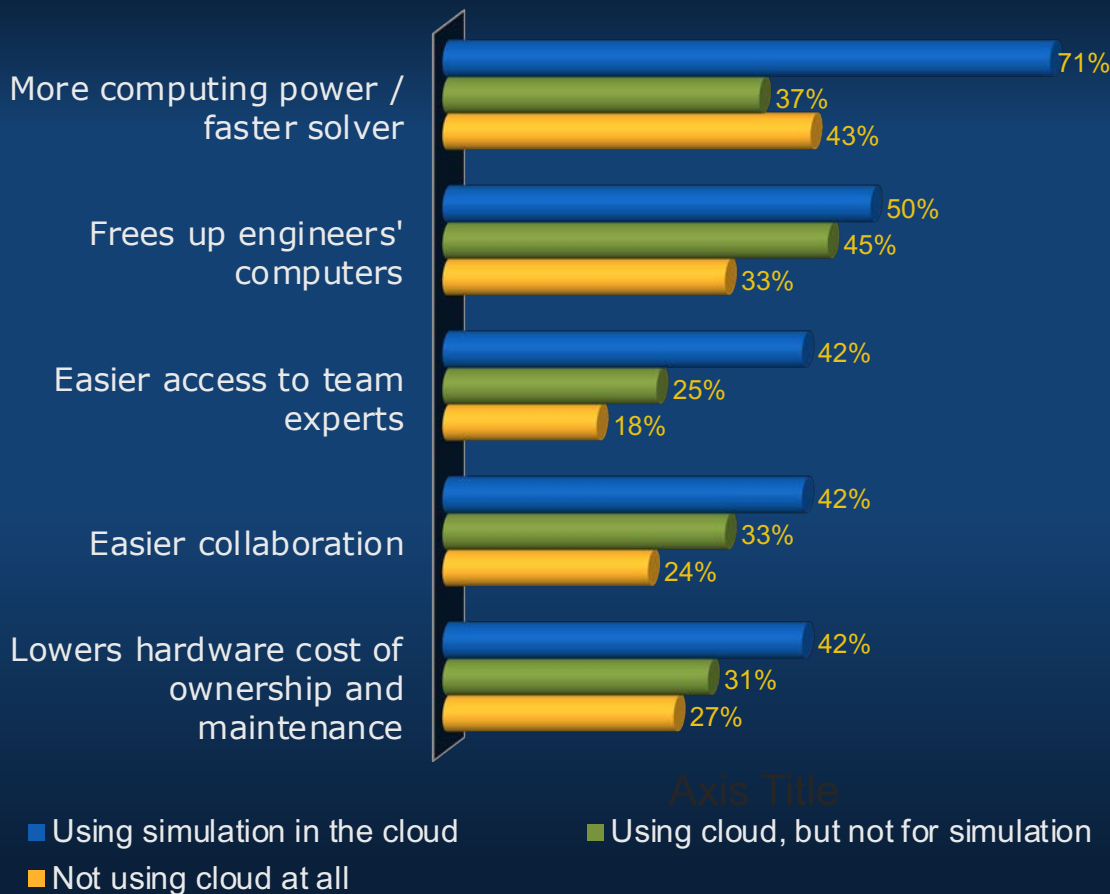
Simulation is particularly computationally intensive, and the access to additional computing power is by far the leading benefit reported by those using simulation in the cloud. Let's explore that idea further.

Top Performing companies are 3.9 times more likely to use cloud software that includes simulation.

DOES YOUR COMPANY USE CLOUD SOFTWARE?



BENEFITS OF SIMULATION IN THE CLOUD



Cloud Computing

Limitations of Non-Cloud Solver Methods

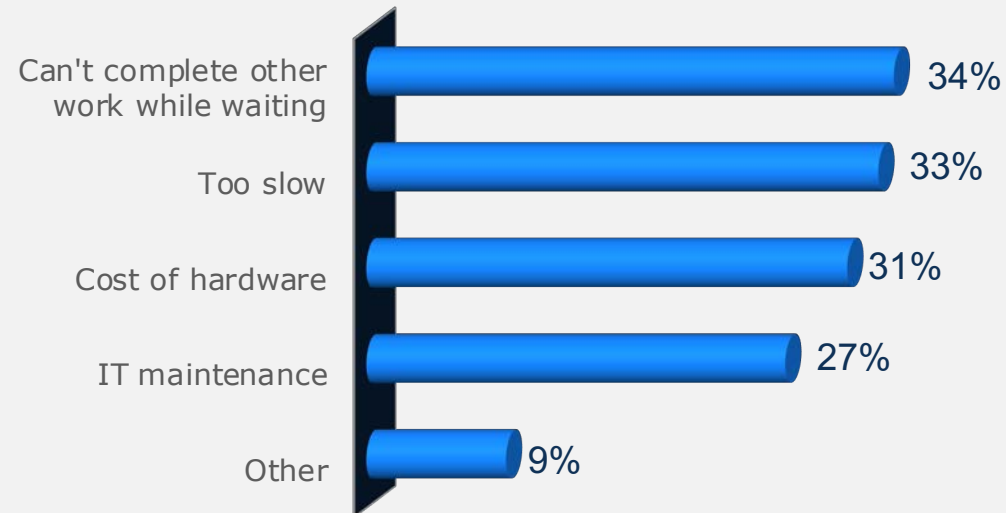
During a simulation, the solver uses significant computational power to process results. Besides cloud computing, this power may come from the engineer's local desktop, or perhaps a high-performance computing (HPC) cluster or grid. While these methods get the job done, they do come with some disadvantages (see graph on the right).

Cloud Computing Benefits

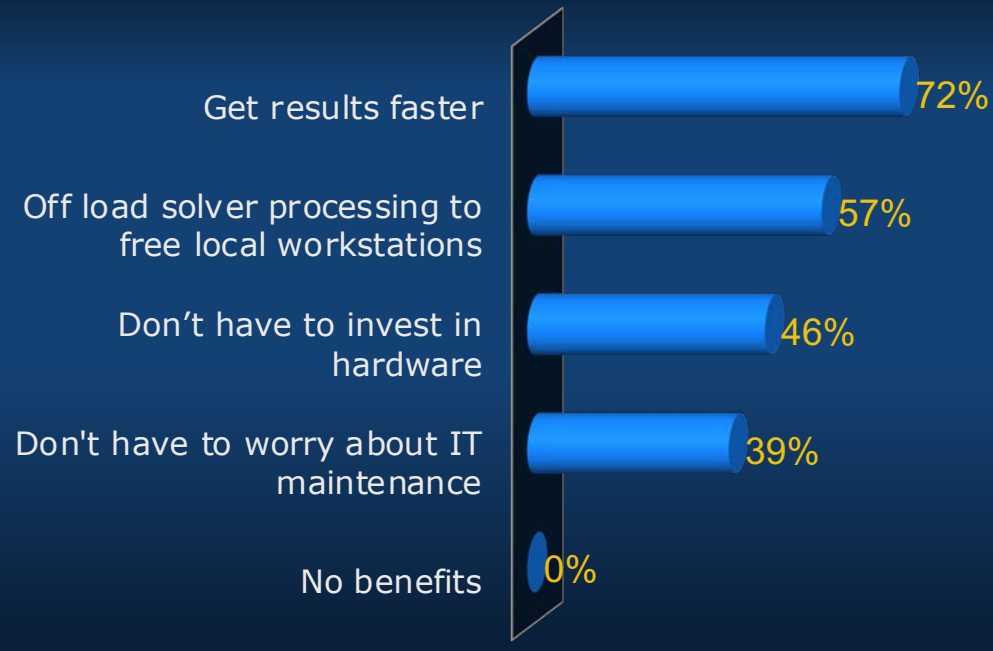
On the other hand, cloud computing offers several benefits. The graph shows the top benefits reported by those using cloud computing. Two things are striking about the results:

- Everyone using cloud computing experiences benefits
- Cloud computing solves the top disadvantages of other processing methods

DISADVANTAGES OF CURRENT SOLVER APPROACH



BENEFITS OF CLOUD COMPUTING



Reduced Hardware Investment

First, with cloud computing, an obvious advantage is that your company can avoid the expense of investing in the high-end hardware infrastructure to support simulation. Plus, no one has to worry about IT maintenance, particularly for HPC or a grid.

Time Savings

Another major benefit respondents value even more than the cost of the hardware is time. It can take a long time to process the results. Plus, if

you are using your local desktop, like 35% of respondents report they do, it can significantly bog down your workstation. This makes it hard to get anything else done. Many engineers queue up simulation jobs for their lunch hour or the end of the day. Then they let them run while they are away from their desk, so they don't disrupt other work. However, this delays getting needed insight. They will also be less likely to leverage simulation as much as they could and, therefore, get less value from it.

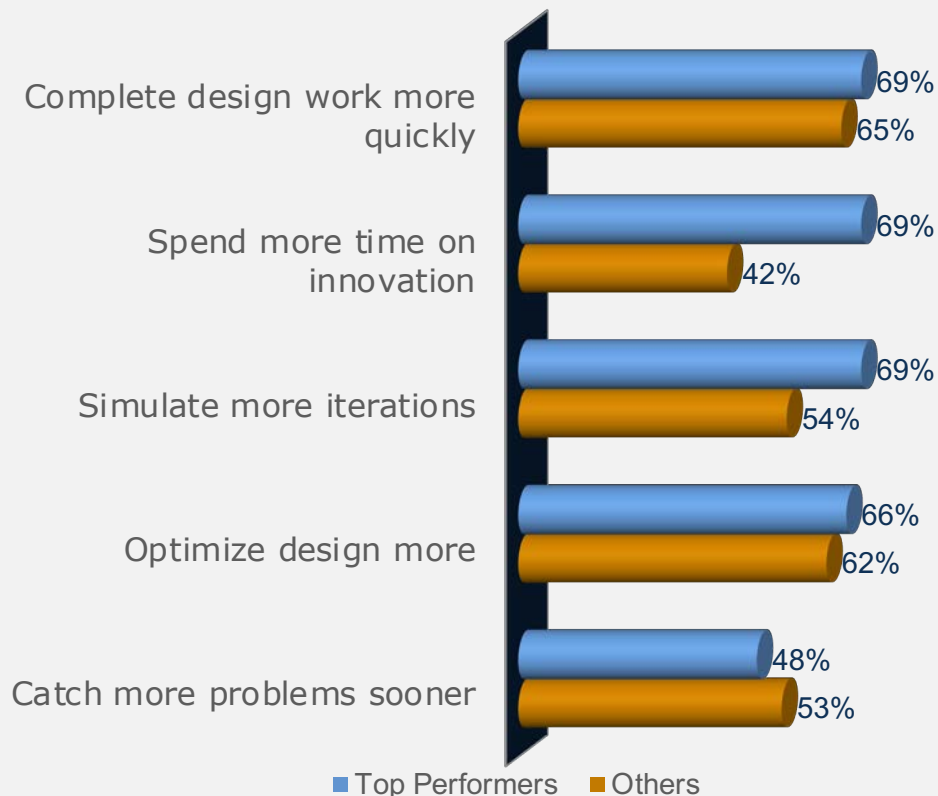
How Faster Results Translates to Business Value

Get Results Faster with the Cloud

Cloud computing can save significant time. The table compares the average time engineers spend waiting for the solver to process results based on the different methods. It shows that those using a public cloud or one provided by a vendor

get their results in significantly less time. Meanwhile, those using a local desktop waste more than twice as much time waiting. Plus, with the cloud, engineers can continue work without the frustrating performance hit on their desktop.

HOW FASTER RESULTS WOULD HELP



Top Performers will use the extra time to innovate and simulate more.

SOLVER PROCESSING METHOD	TIME SPENT WAITING FOR RESULTS
Public cloud / cloud supported through software vendor	4.6 Hours
Private cloud	6.5 Hours
HPC clusters or grid	8.5 Hours
Local desktops	9.5 Hours

Time Savings Can Lead to Better Products

Now, what would you do with that extra time? It is particularly instructive to look at how Top Performers will use it (see graph). While everyone agrees they will complete design work more quickly, Top Performers will

also use the extra time to innovate and simulate more. If you have more time for simulation, you can evaluate more options, which will lead to greater innovation and higher quality. You can also look at trade-offs to help manage costs.

Accessing Required Data to Support Simulation

Data Management Challenges

Tech-Clarity research finds that engineers waste 34% of their time on non-value added work.³ This non-value added work mostly comes from tasks related to searching for information and recreating work you couldn't find.

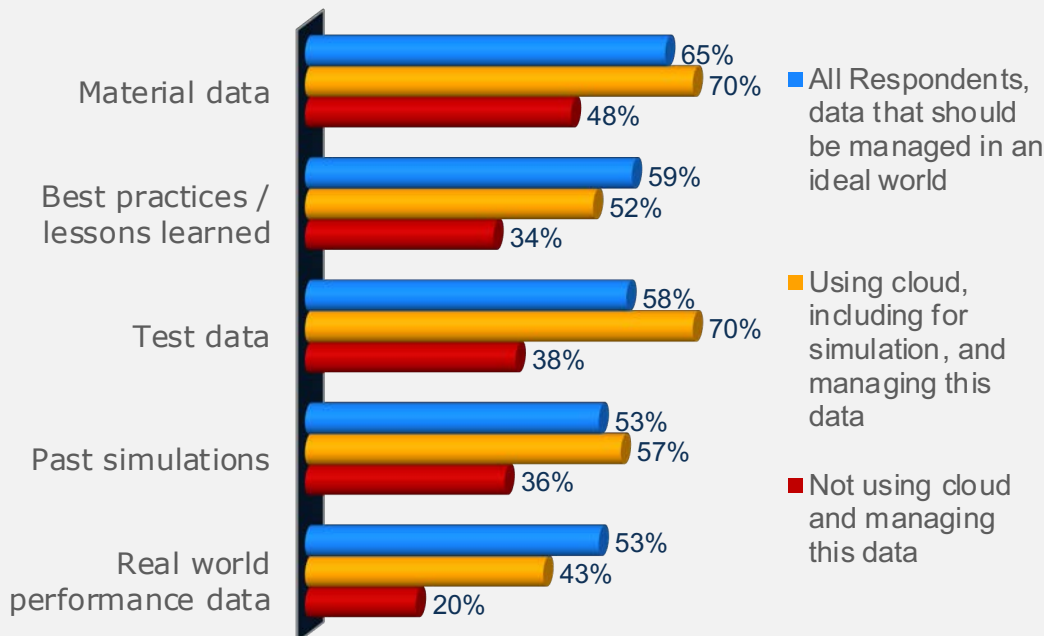
Poor data management practices also impact simulation. Simulation is dependent on accurate model definitions. If you cannot find

the data you need to support the simulation, it will not only slow you down, but it will also impact the quality of your results.

Data Types Needed for Simulation

Many different data types support simulation. The graph below shows the data types respondents agree they should manage in an ideal world. It then compares this to those using the cloud to manage it to those who do not use the cloud.

MANAGING DATA TO SUPPORT SIMULATIONS

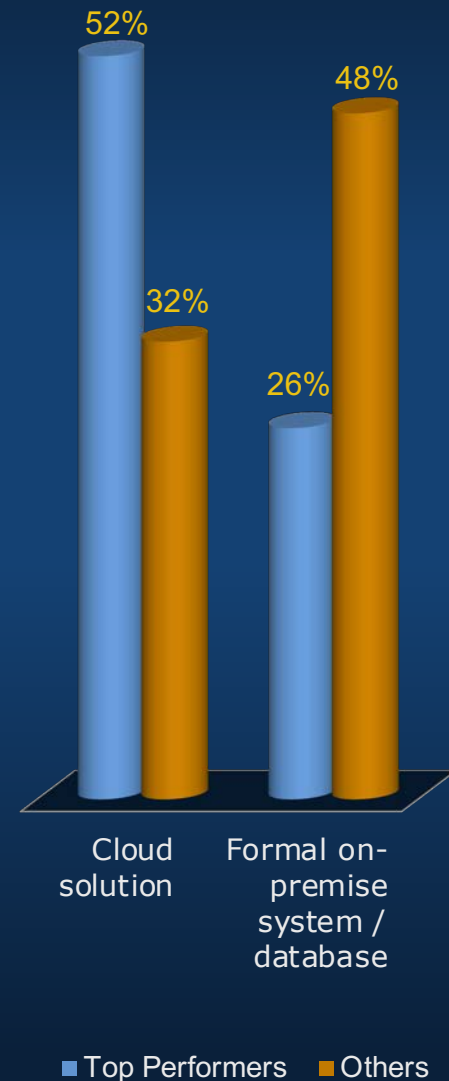


Those Using the Cloud Manage More Data

The results show that those using the cloud are much more likely to manage the ideal data for simulation. Part of the data management challenge is that much of this data comes from a variety of sources, which makes it particularly challenging to manage with a traditional on-premise data management solution. Recognizing this is likely why Top Performing companies are 63% more likely than Others to agree that the cloud is the ideal way to manage the different data types needed to support simulation (graph on right).

This data also helps design engineers access needed knowledge to help them improve their models and make better use of simulation. For example, analysts can define validated methods for repetitive simulations that design engineers can leverage. This is yet another way that supports better collaboration between analysts and design engineers.

THE IDEAL WAY TO MANAGE DATA FOR SIMULATIONS



The Value of an Integrated Platform

Increased Benefits with Complexity

A cloud solution also supports simulation as an integrated platform. The graph shows the many benefits available with an integrated platform. What's interesting is that the more complex a companies' products are, the more likely they are to appreciate the benefit. Considering that 67% of respondents reported that their products have become more complex over the last five years, it is likely that your products will also become, or continue to become, more complex. This graph reveals the benefits you will find useful as your products grow in complexity.

Improved Collaboration

On a platform, it is easier for design engineers and analysts to collaborate. Increased complexity makes this even more valuable. It is also useful to have easy ways to share results with other design engineers, analysts, third-party partners, customers, and management. With greater complexity, more people are likely involved, which complicates collaboration. A cloud platform makes it easier to share information with access-controlled capabilities.

Traceability

When simulation exposes design problems or when you identify an area

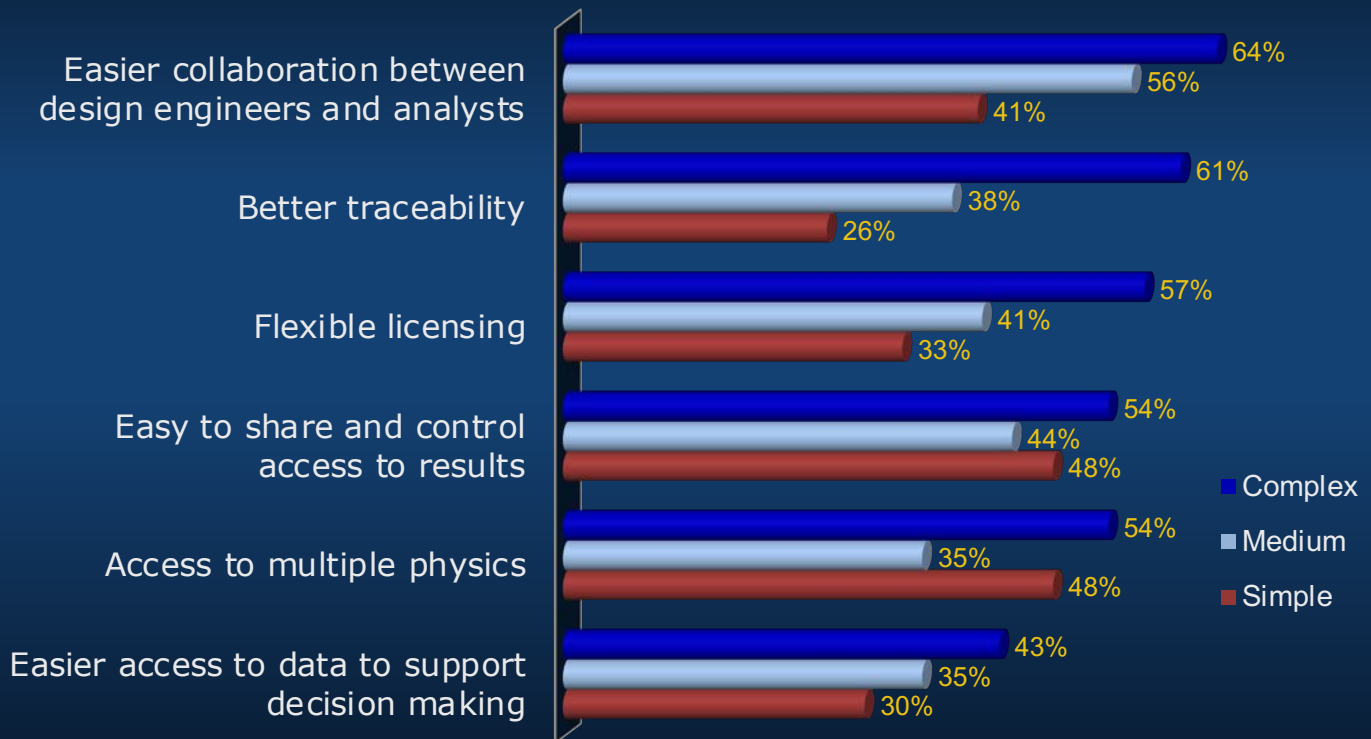
for optimization, there may be an impact on other components. As the design progresses, it can become harder to determine the effect of a change. An integrated platform can provide a single point of access to design information, making it easier to manage dependencies across the design. This can be invaluable when a sudden market change, such as the COVID-19 health crisis, drastically disrupts supply chains, or requires

immediate changes to design requirements.

Scalability

As your products become more complex, you may need access to more functions and more physics. An integrated cloud platform offers the flexibility to use only what you need. You can add additional functionality as desired, and then drop it if and when you find you no longer have use for it.

BENEFITS OF AN INTEGRATED PLATFORM FOR SIMULATION BASED ON PRODUCT COMPLEXITY



Conclusions

Better Decisions with Simulation

Companies looking to develop more competitive products can realize significant benefits by leveraging simulation during design. This can help design engineers make better decisions around critical design criteria that impact quality, performance, and reliability while balancing cost.

Realize Even More Value from Simulation with the Cloud

A cloud platform can help companies extend their use of simulation and empower design engineers to use it more during the design process. It can provide a mechanism to improve collaboration between design engineers and analysts. In this way, design engineers can get better guidance during the simulation and analysis process. The cloud offers significant computational power that allows you to get results even faster. This offers many advantages such as accelerating the design process, freeing up engineers to spend more time on innovation, and allowing them to simulate and evaluate more design options. It also provides a more natural method for managing the many different data types required to support simulation, so that engineers have what they need at their fingertips. Finally, as an integrated platform, companies enjoy benefits such as better collaboration between design engineers and analysts, improved traceability, more flexible licensing options, easier options to share and control access to results, and access to multiple physics.



A **cloud platform** can help companies **extend their use of simulation and empower design engineers** to use it more during the design process.

Recommendations



Recommendations and Next Steps

Based on industry experience and research for this report, Tech-Clarity offers the following recommendations:

- Empower design engineers to use simulation. Cloud simulation offers many advantages that can make that easier.
- To support design engineers, facilitate easy and secure collaboration methods for them to connect with analysts. A cloud platform can support collaboration by merely sending a link to the model for real-time collaboration.
- Accelerate the time to get simulation results with cloud computing.
- Ensure design engineers have easy access to the needed data to support their simulations. Given the variety of different sources of data required to support simulation, the cloud is especially well suited to provide a single access point for the different data types.
- Consider an integrated platform to support simulation. Sudden market changes or supply chain disruptions can require significant changes to requirements. The traceability of an integrated platform to identify impacts, simulate new options, and update the design can be an invaluable way to adapt without hurting time to market.

About the Research

Data Gathering

Tech-Clarity gathered and analyzed responses to a web-based survey from over 272 manufacturers. Survey responses were collected by direct e-mail, social media, and online postings by Tech-Clarity.

Industries

The respondents represent a broad cross-section of industries. 32% were from Industrial Equipment, 29% Automotive, 23% Engineering Services, 15% Aerospace & Defense, 14% High-Tech, 12% Energy, 12% Life Sciences, 11% Consumer Products, and others.*

Company Size

The respondents represent a mix of company sizes, including 33% from less than \$50 million, 22% between \$50 million and less than \$1 billion, and 19% greater than a billion. 26% did not

disclose their company size. Company sizes were reported in US dollar equivalent.

Geographies

Responding companies report doing business in North America (51%), Asia (47%), Western Europe (23%), Middle East (15%), Eastern Europe (14%), Latin America (12%), Australia (9%), and Africa (9%).*

Title

The respondents were comprised of 8% Executive, 7% Directors or VP Level, 21% Manager level, and 64% individual contributors.

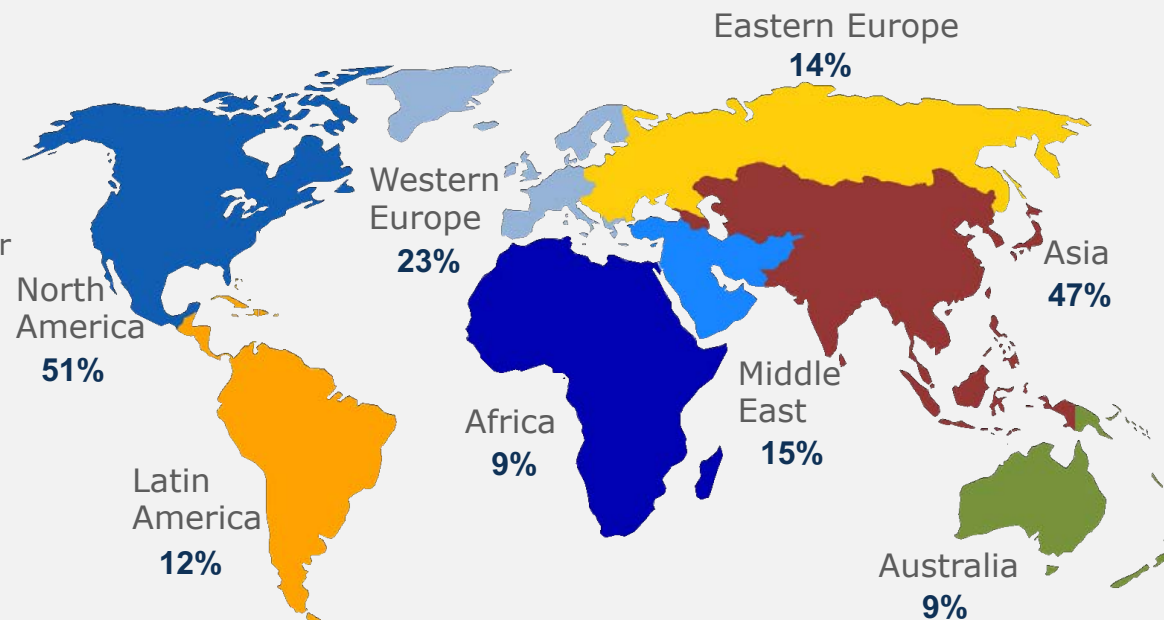
Organizational Function

Of the respondents, 47% were in Product Design/Engineering roles, 25% Manufacturing Engineers, 8% Product / Project / Program

Management, 5% Quality, and the remainder were from a variety of other roles including Industrial Design, Analysts, IT, and more.

* Note that the values may total greater than 100% because companies reported doing business in multiple industries and geographies.

The respondents represented a mix of industries, company sizes, and geographies.



Acknowledgments



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About the Author

Michelle Boucher is the Vice President of Research for Engineering Software for research firm Tech-Clarity. Michelle has spent over 20 years in various roles in engineering, marketing, management, and as an analyst.

Michelle graduated magna cum laude with an MBA from Babson College and earned a BS in Mechanical Engineering, with distinction, from Worcester Polytechnic Institute. She is an experienced researcher and author having benchmarked over 7000 product development professionals and published over 90 reports on product development best practices.



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Tech-Clarity is an independent research firm dedicated to making the business value of technology clear. We analyze how companies improve innovation, product development, design, engineering, manufacturing, and service performance through the use of digital transformation, best practices, software technology, industrial automation, and IT services.

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