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A Look at Simulation and Prototyping Practices Across the Globe

Engineering.com audience survey of simulation vs. prototyping

DASSAULT SYSTEMES

This research has been sponsored by Dassault Systèmes.

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EXECUTIVE SUMMARY

Prototyping and simulation enables engineers to test their designs before creating a physical product. This typically results in cost savings, safer testing and early detection of design flaws. Design testing via simulation and/or physical testing are considered best practice. However, reality and theory often conflict.

In this engineering.com research report, we asked 329 engineers, designers, product managers and other readers to report on simulation and physical testing. We wanted to understand the use of simulation and its place in the whole design cycle, from concept to manufacturing.

We also discovered:

- The top barriers to simulation facing engineers today.
- The top concerns with testing options.
- How a company's size impacts their simulation methods.
- And more.

If you're interested in learning more about simulation, prototyping and how these methods are applied in industry, this report is for you. We would like to thank all of our survey participants for generously sharing their insights, and we hope you find this research useful.

Thanks for reading,

Roopinder Tara
Director of Content
engineering.com

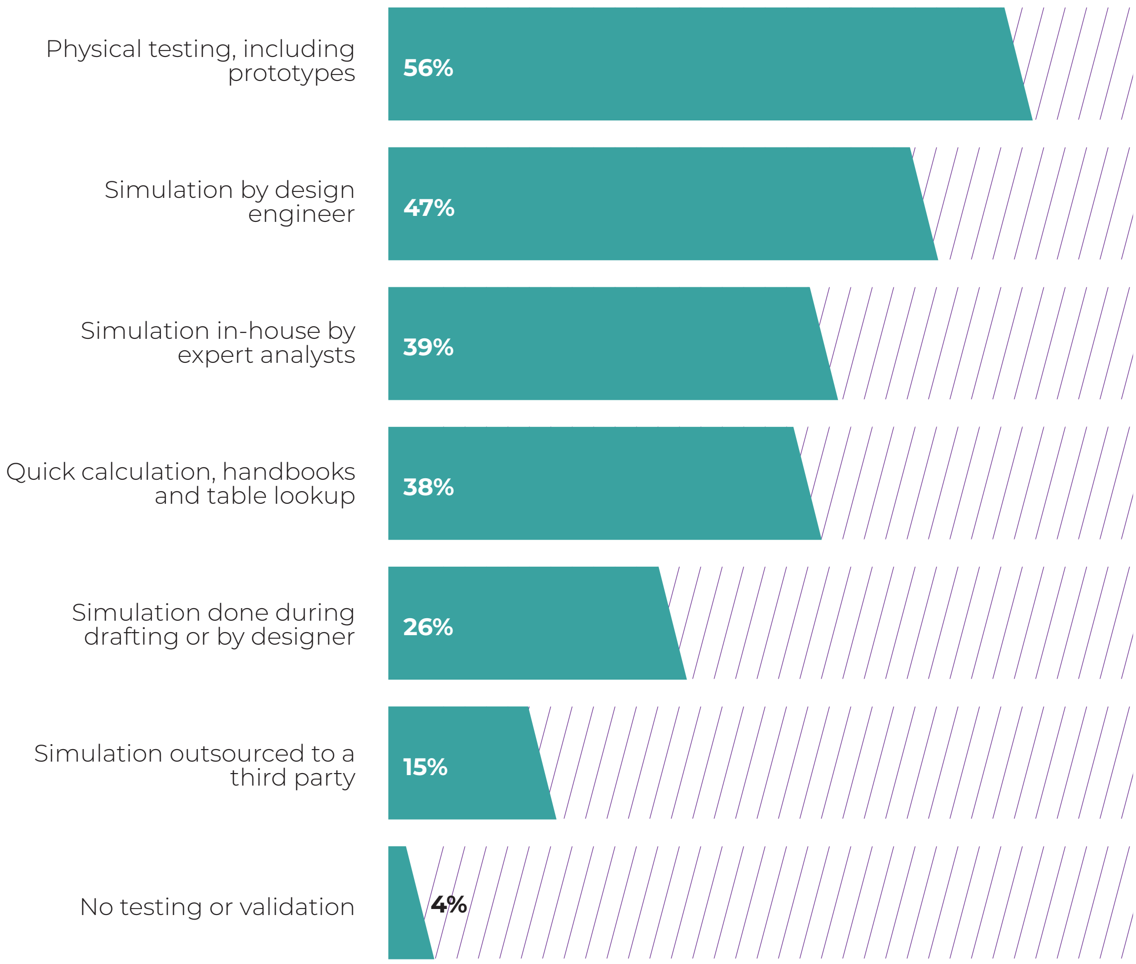
Model Validation and Optimization Practices

HOW DO ENGINEERS VALIDATE THEIR DESIGNS?

We asked survey takers to reveal which testing methods they rely on to validate their designs. The majority (56%) implement physical tests, including prototypes.

That said, simulation is still a popular approach among our audience. Most simulations occur in-house; only 15% of respondents send their designs to a third-party vendor. In-house simulation is completed by both design engineers (47%) and expert analysts (39%).

Some respondents use quick calculations, handbooks and table lookups (38%) to validate their models. Only a small minority (4%) revealed that they neither validate or test their designs.

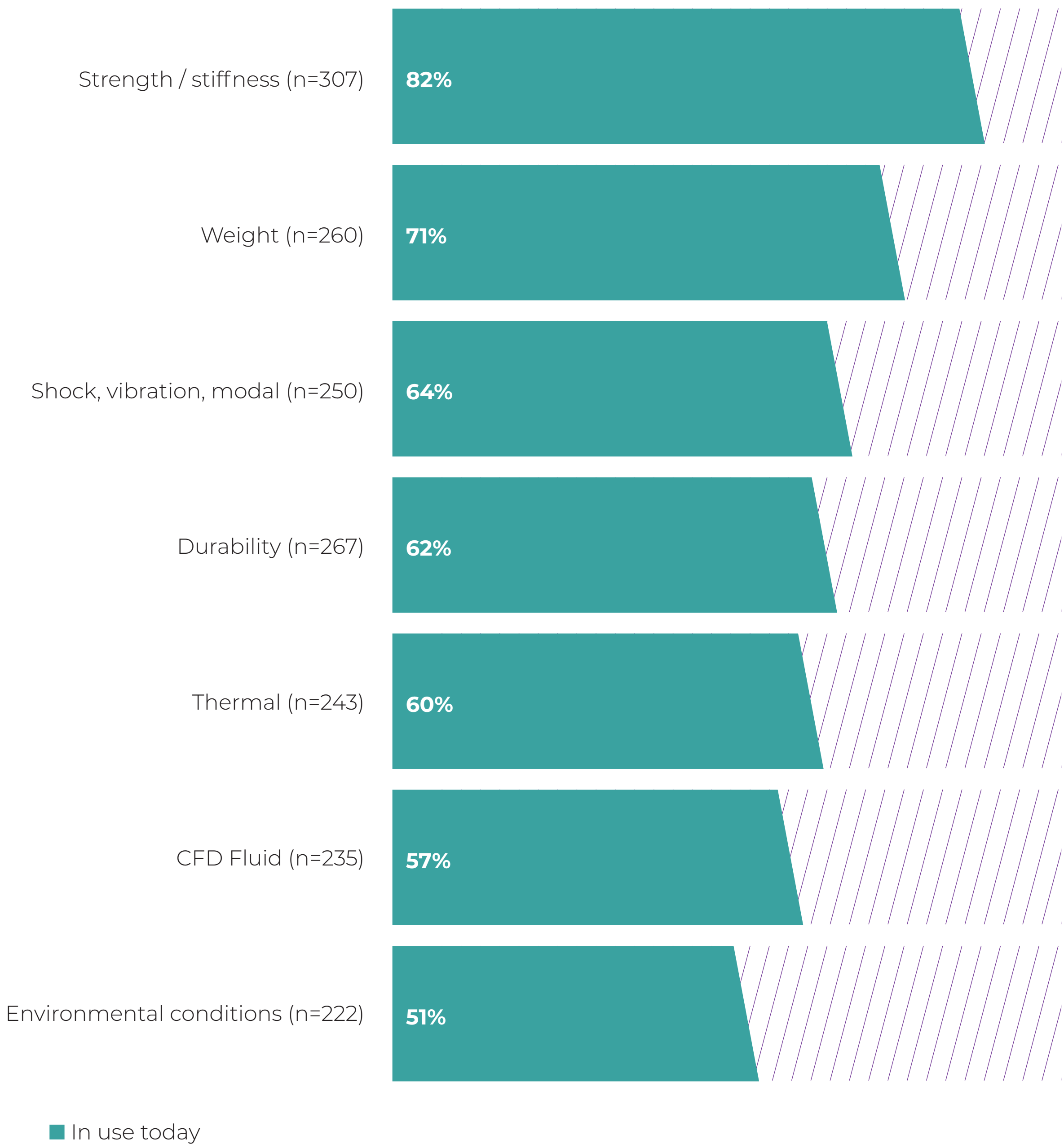


Q: How do you validate your designs? Select all that apply.

N = 329

WHAT OPTIMIZATION STANDARDS DO ENGINEERS FOLLOW TODAY?

Our respondents used several criteria to reach the best design possible. The top 5 design requirements were strength/stiffness (82%), weight (71%,), shock/vibration/modal (64%), durability (62%) and thermal (60%).

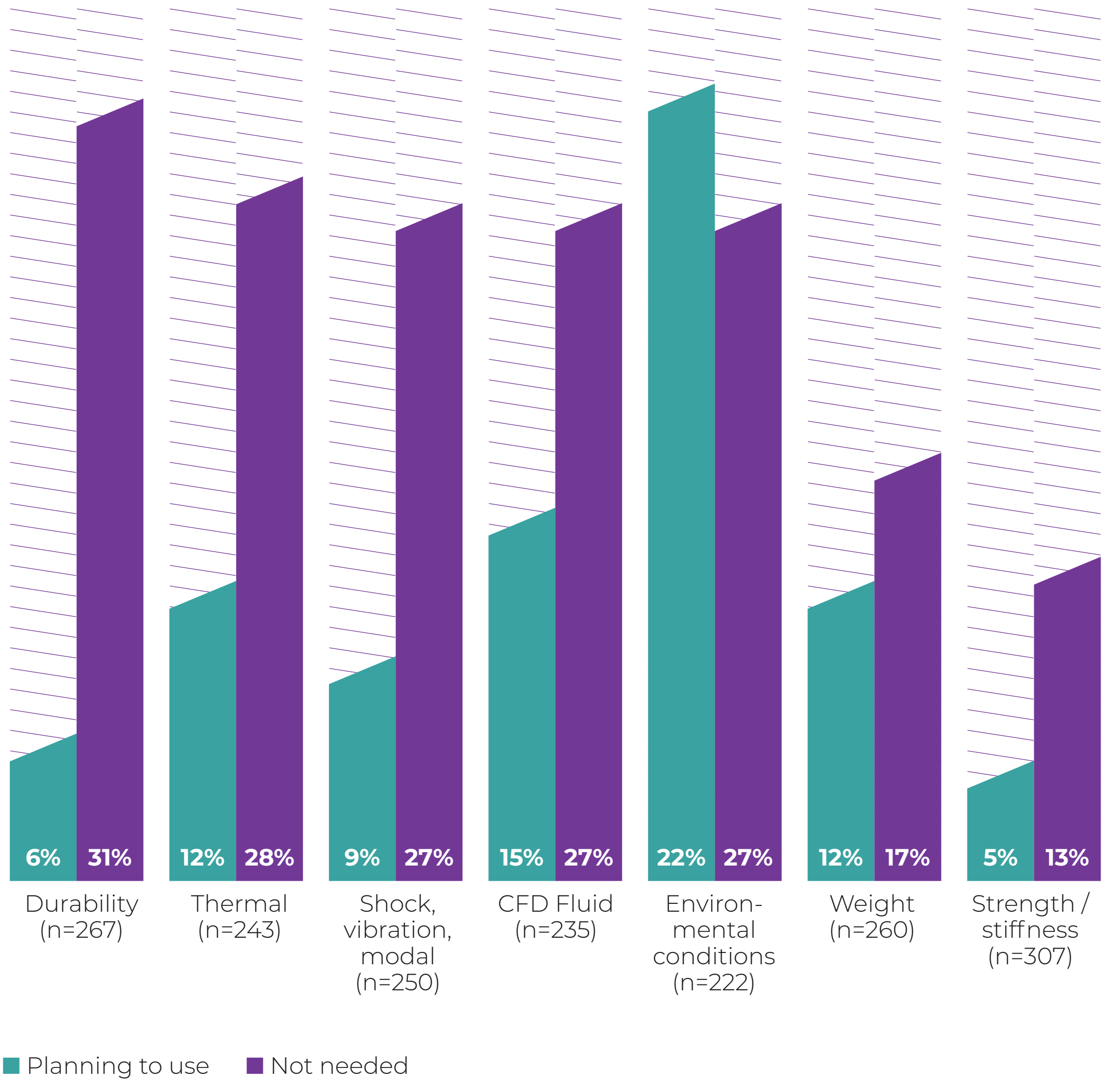


Q: Which requirements do (or should) your design engineering team use to optimize your designs? Showing responses for "IN USE TODAY."

WHAT DESIGN REQUIREMENTS DO ENGINEERS PLAN TO USE, AND WHICH ARE CONSIDERED UNNECESSARY?

Even though durability, thermal and shock/vibration/modal made it to the top five criteria currently in use, some users don't consider these factors at all.

A third (31%) of respondents noted that they plan to incorporate durability in future design optimization, while 6% consider this requirement unnecessary. Thermal and shock are planned future requirements for 28% and 27% of respondents, respectively.



Q: Which requirements do (or should) your design engineering team use to optimize your designs? Responses for "PLAN TO USE" and "NOT NEEDED."

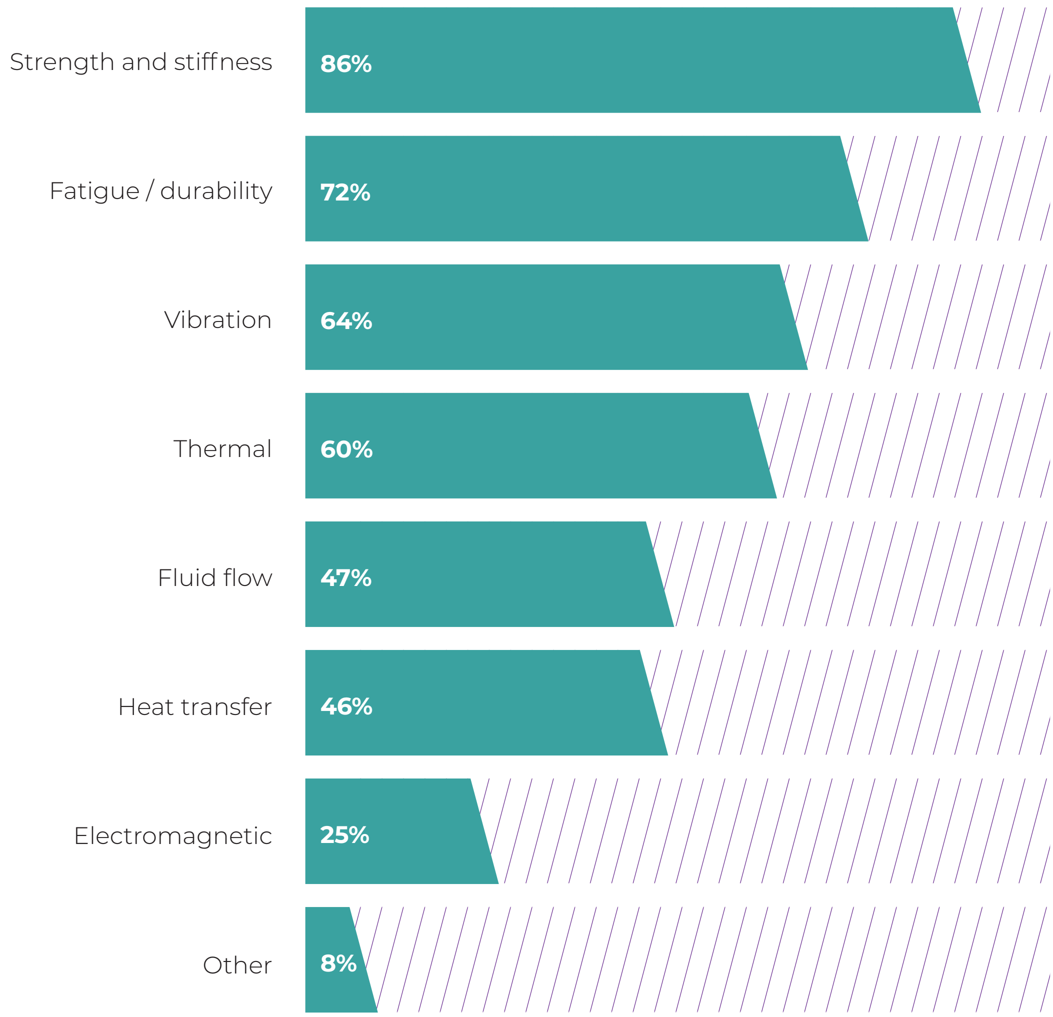
Physical Prototyping Practices

WHICH TESTS ARE USED MOST OFTEN TO VALIDATE DESIGN MODELS?

We asked respondents who use physical prototyping to select the test types that they have to run to validate their models. Strength and stiffness were selected by the majority (86%).

The majority of respondents also use physical prototyping to test for fatigue/ durability (72%), vibration (64%) and thermal (60%).

Less than half of those who use physical testing validate factors like fluid flow (47%), heat transfer (46%) and electromagnetic properties (25%).

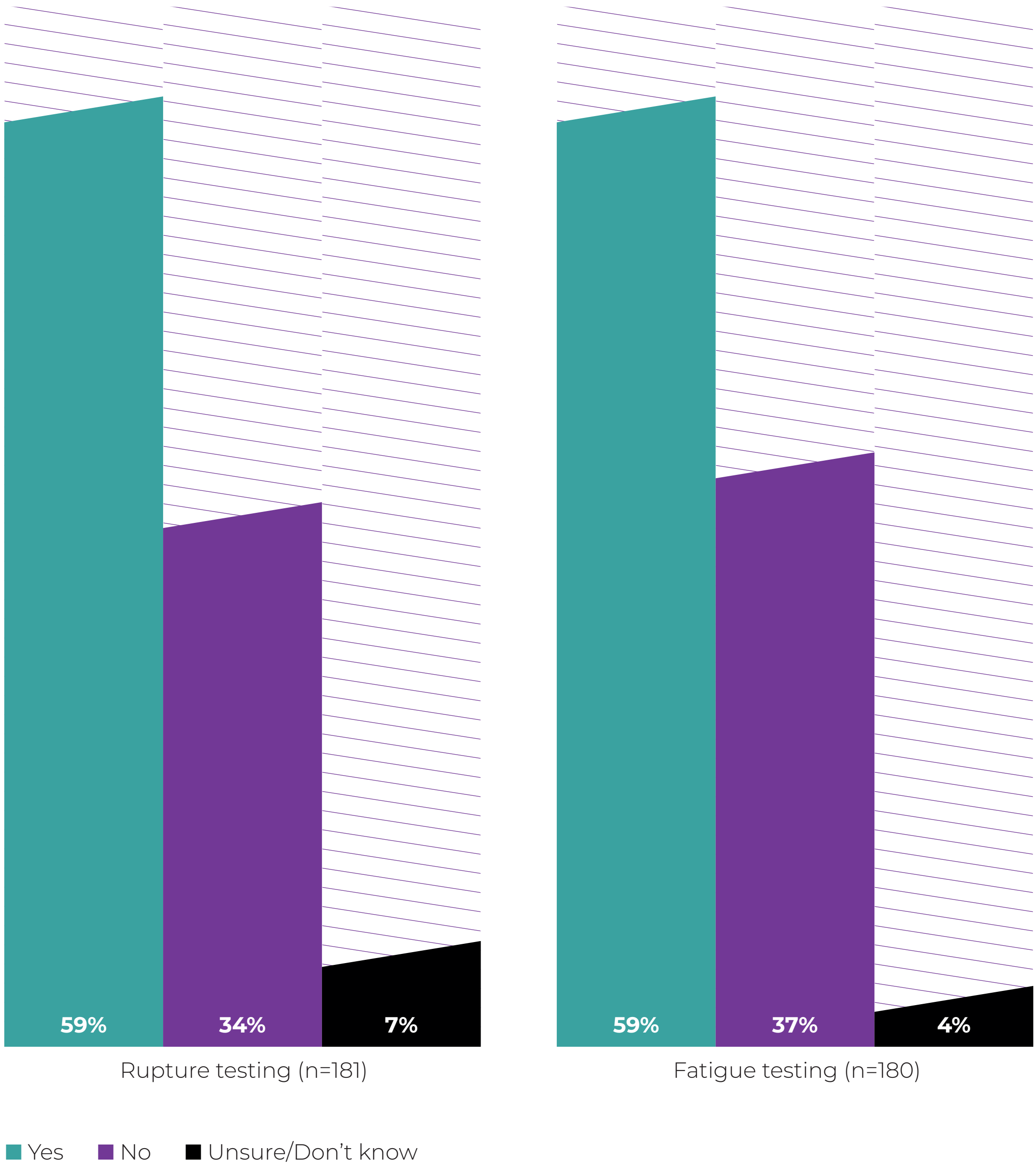


Q: What types of tests are required to validate your models? Select all that apply.

N = 177

DO ENGINEERS TEST FOR FATIGUE AND RUPTURES IN PHYSICAL PROTOTYPES?

The majority (59%) test their prototypes for ruptures and fatigue.

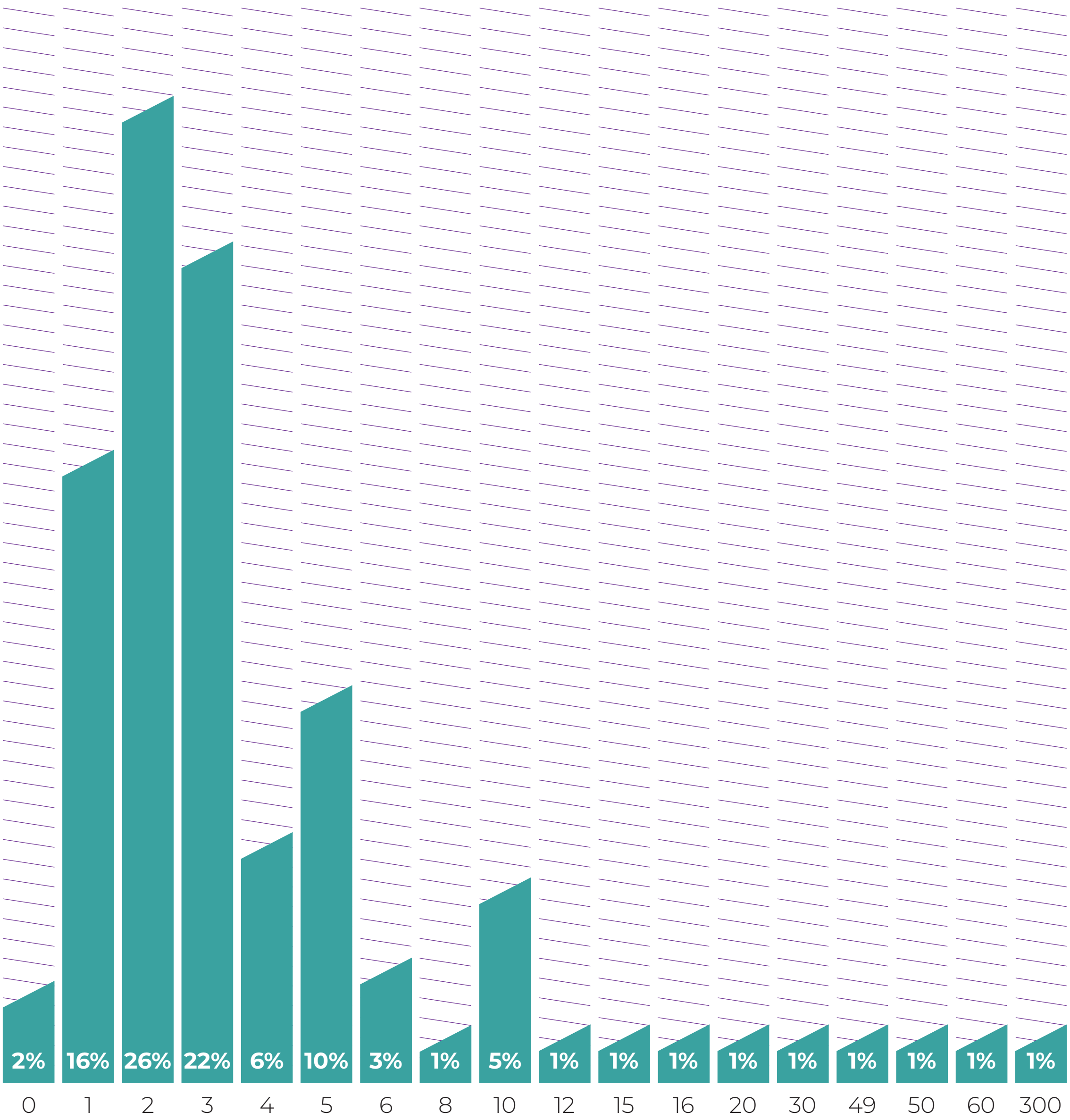


Qs: Do you test for ruptures in your physical prototypes?
Do you test for fatigue in your physical prototypes?

HOW MANY PHYSICAL PROTOTYPES ARE CREATED ON AVERAGE?

We asked respondents to estimate the number of physical prototypes they typically create before finalizing the product design.

On average, engineers created nine physical prototypes before finalizing their product designs.



Q: How many physical prototypes do you typically create before finalizing the product design [open text]

N = 159

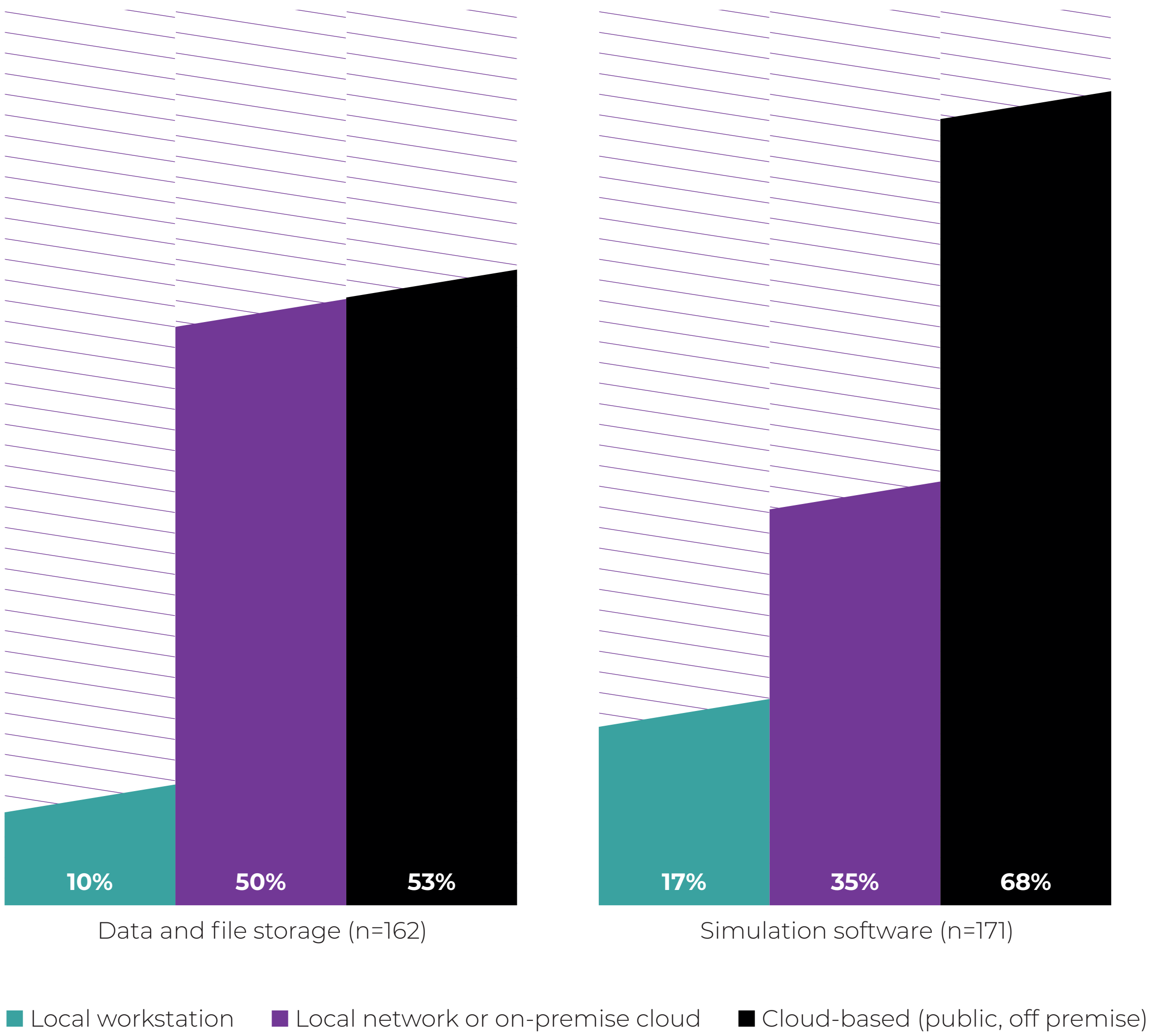
Virtual Simulation Practices

WHAT HARDWARE/SOFTWARE ENVIRONMENTS DO ENGINEERS USE TO RUN SIMULATIONS?

Most respondents use local hardware/software for simulation and testing. There is a nearly equal split between local workstations (50%) and local networks (53%) for data and file storage.

The majority (68%) of those using simulation software rely on local workstations or a local network (35%).

Cloud-based computing is the least popular hardware/software environment.

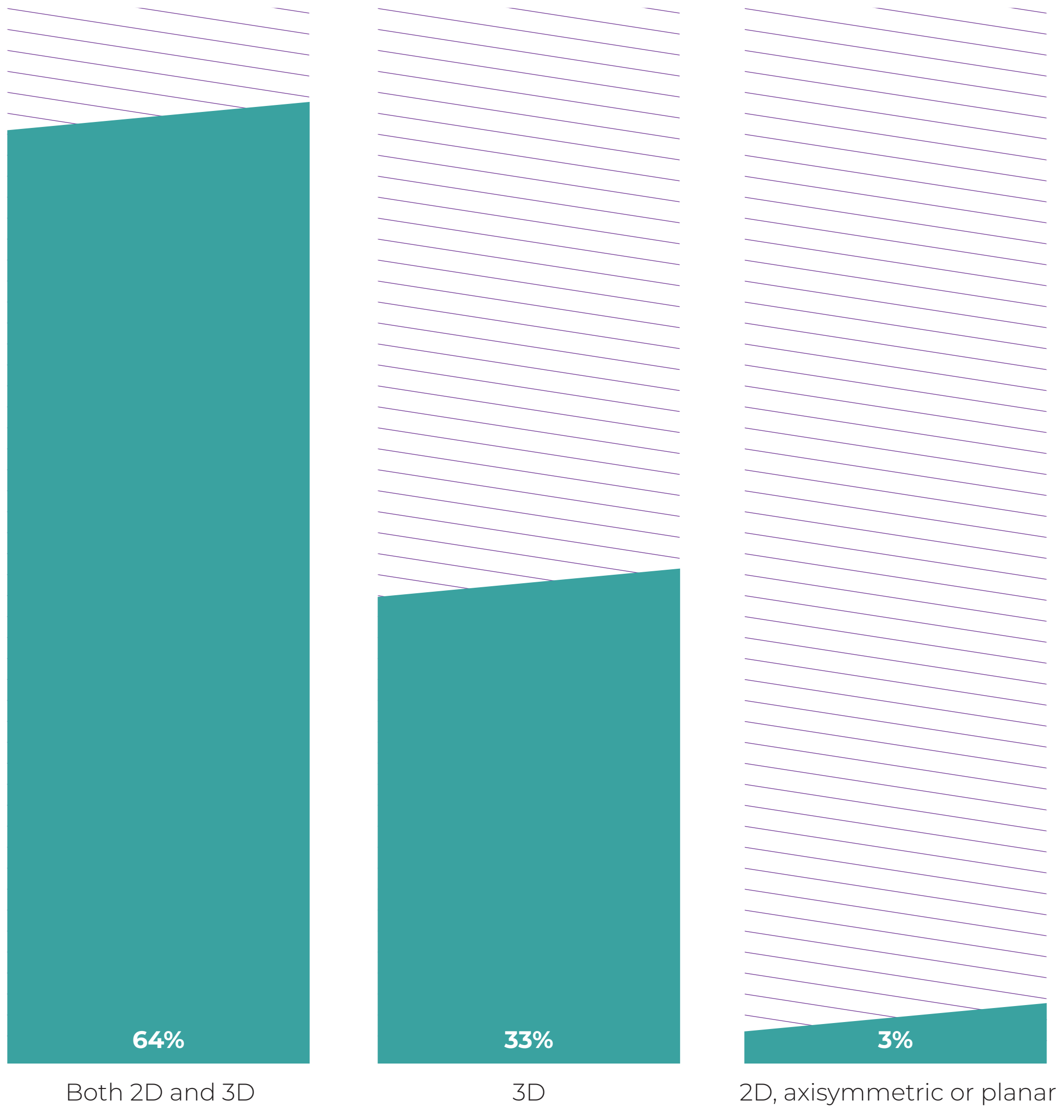


Q: What hardware/software environment do you use?

ARE 2D OR 3D SIMULATIONS MORE POPULAR?

The majority (64%) of survey takers create simulation models in both 2D and 3D.

Those who work with one over the other appear to favor 3D models (33%). A very small percentage (3%) rely solely on 2D, axisymmetric or planar models.



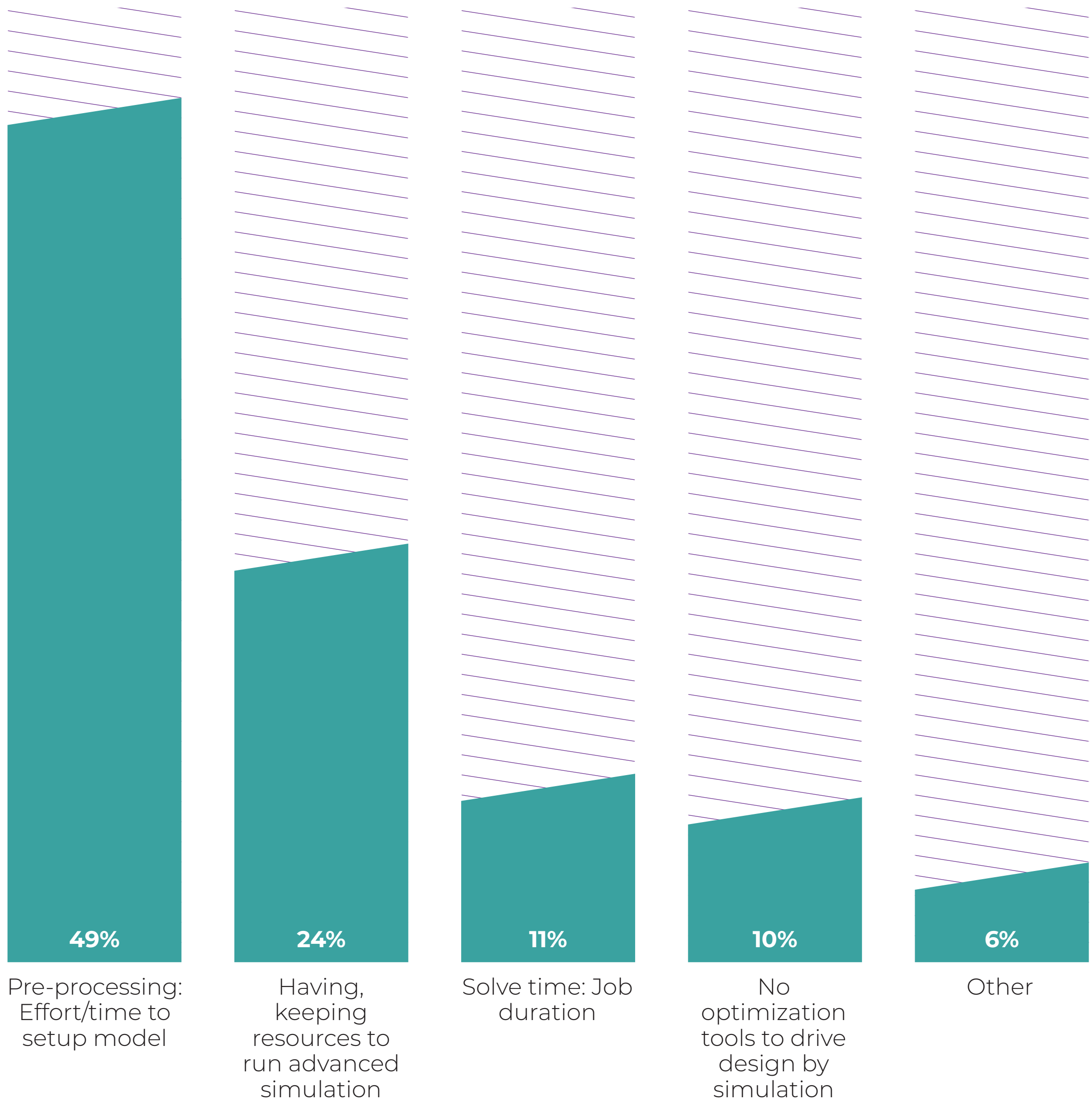
Q: What type of simulation models do you make?

N = 248

WHAT MAKES SIMULATION WORK CHALLENGING?

Running simulations is not an effortless endeavor. Almost half (49%) of respondents struggle with the amount of time and effort required to set up the model in the pre-processing phase. Some (24%) found it hard to maintain adequate resources for advanced simulations.

Other challenges were the time required to run the simulation (11%), and not having the right tools (10%).



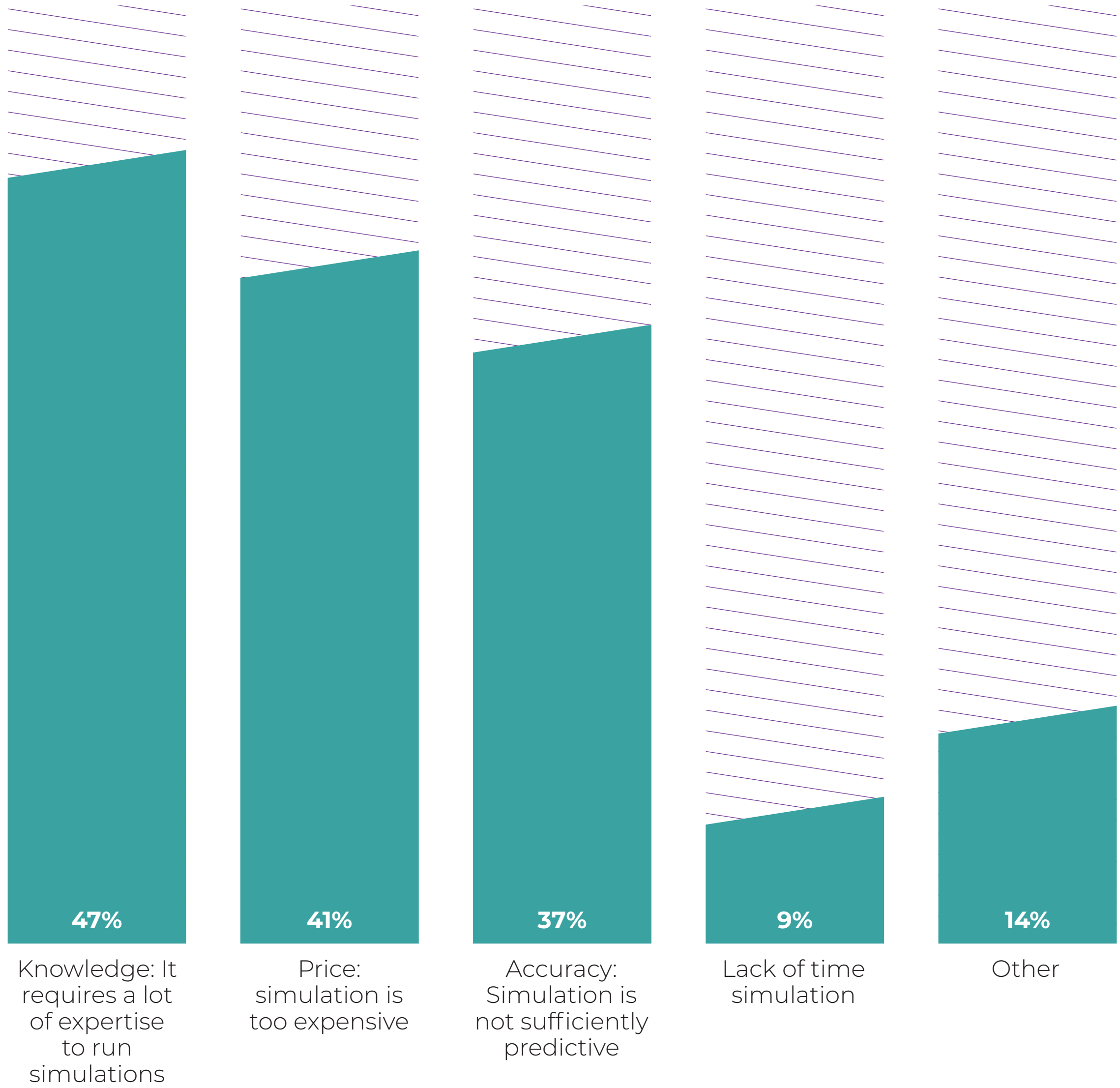
Q: What is the most challenging aspect of simulation work?

N = 246

WHAT KEEPS ENGINEERS FROM RUNNING SIMULATIONS MORE FREQUENTLY?

Respondents identified three main barriers preventing engineers from running simulations more often: a lack of knowledge (47%), the expense (41%) and a lack of trust in the results (37%). Lack of time (9%) was another barrier.

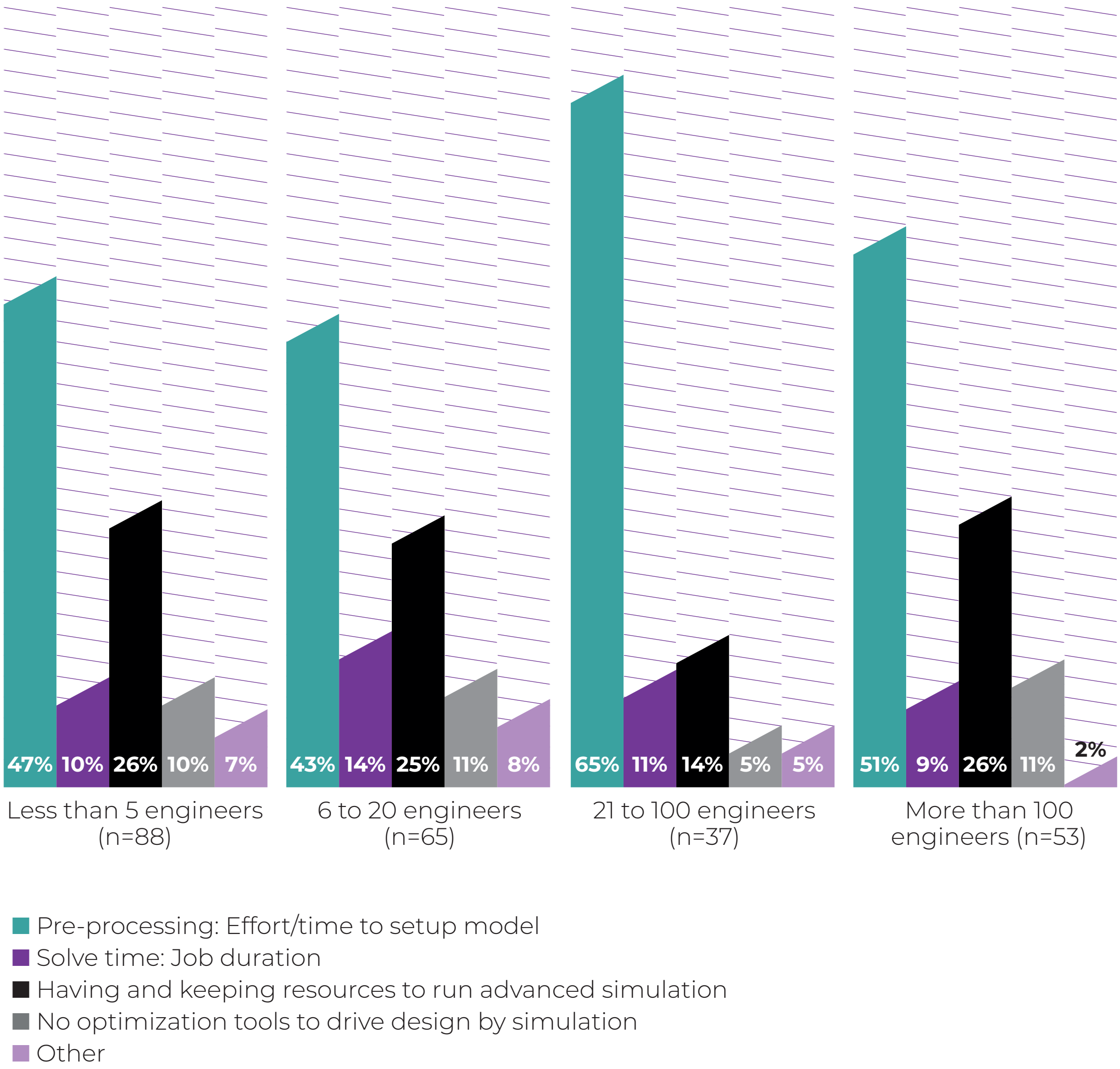
These factors will need to be overcome if we are to see higher simulation rates in the future.



Q: What keeps you from running simulations more often? Select all that apply. N = 176

WHEN WORKING WITH SIMULATIONS, DO SMALLER ENGINEERING FIRMS HAVE AN ADVANTAGE OR DISADVANTAGE?

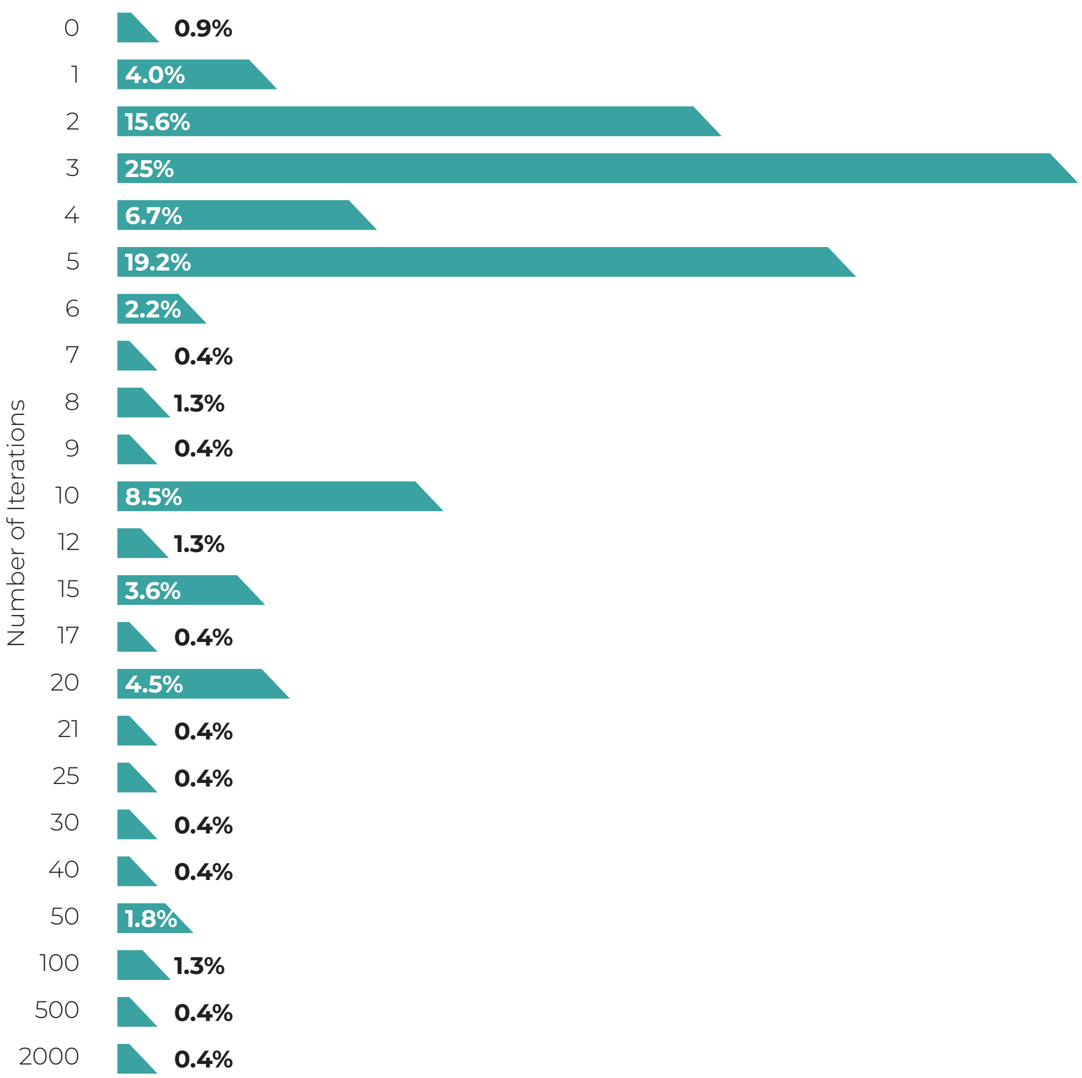
Pre-processing appears to be the greatest challenge for most engineering companies, but this problem is pronounced for mid-size companies with 21 to 100 engineers (65%). Interestingly, these companies seem to be at an advantage in maintaining resources for advanced simulation—14% consider this a big challenge compared to around a quarter for all other companies.



Qs: What is the size of your engineering office?
What is the most challenging aspect of simulation work?

HOW DO ENGINEERS FEEL ABOUT THE IDEAL VS. ACTUAL NUMBER OF ITERATIONS REQUIRED PRIOR TO PRODUCTION?

We asked survey takers to estimate how many design-virtual simulation iterations they complete before producing the first part or prototype. On average, respondents indicated that they go through 19 iterations of the cycle before producing the first part or prototype.

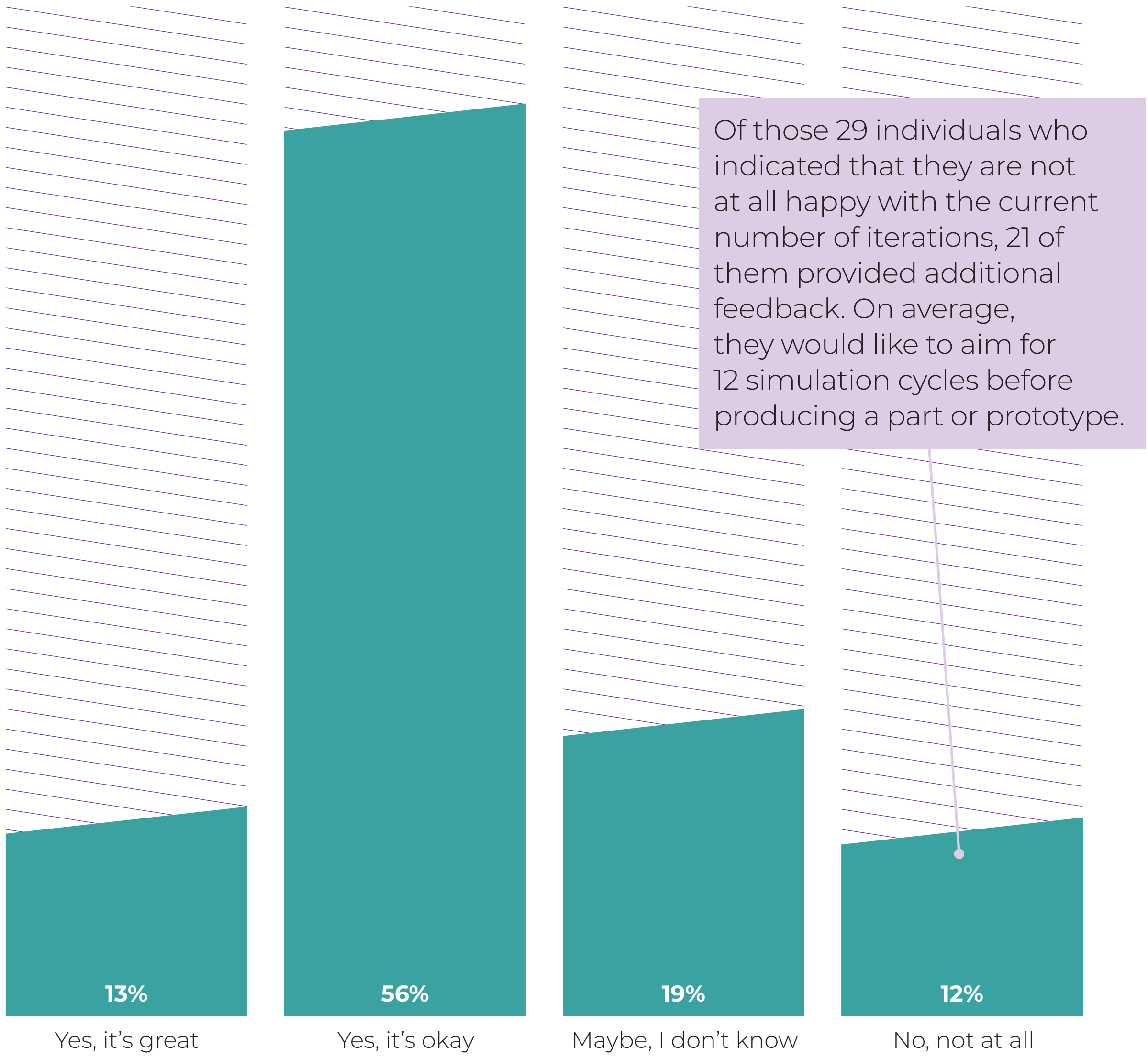


Q: On average, how many iterations through the design-virtual simulation cycle do you use before producing the first part or prototype?

N = 224

HOW DO ENGINEERS FEEL ABOUT THE IDEAL VS. ACTUAL NUMBER OF ITERATIONS REQUIRED PRIOR TO PRODUCTION?

The majority (69%) are happy or okay with the current number of iterations, but some (12%) are not.



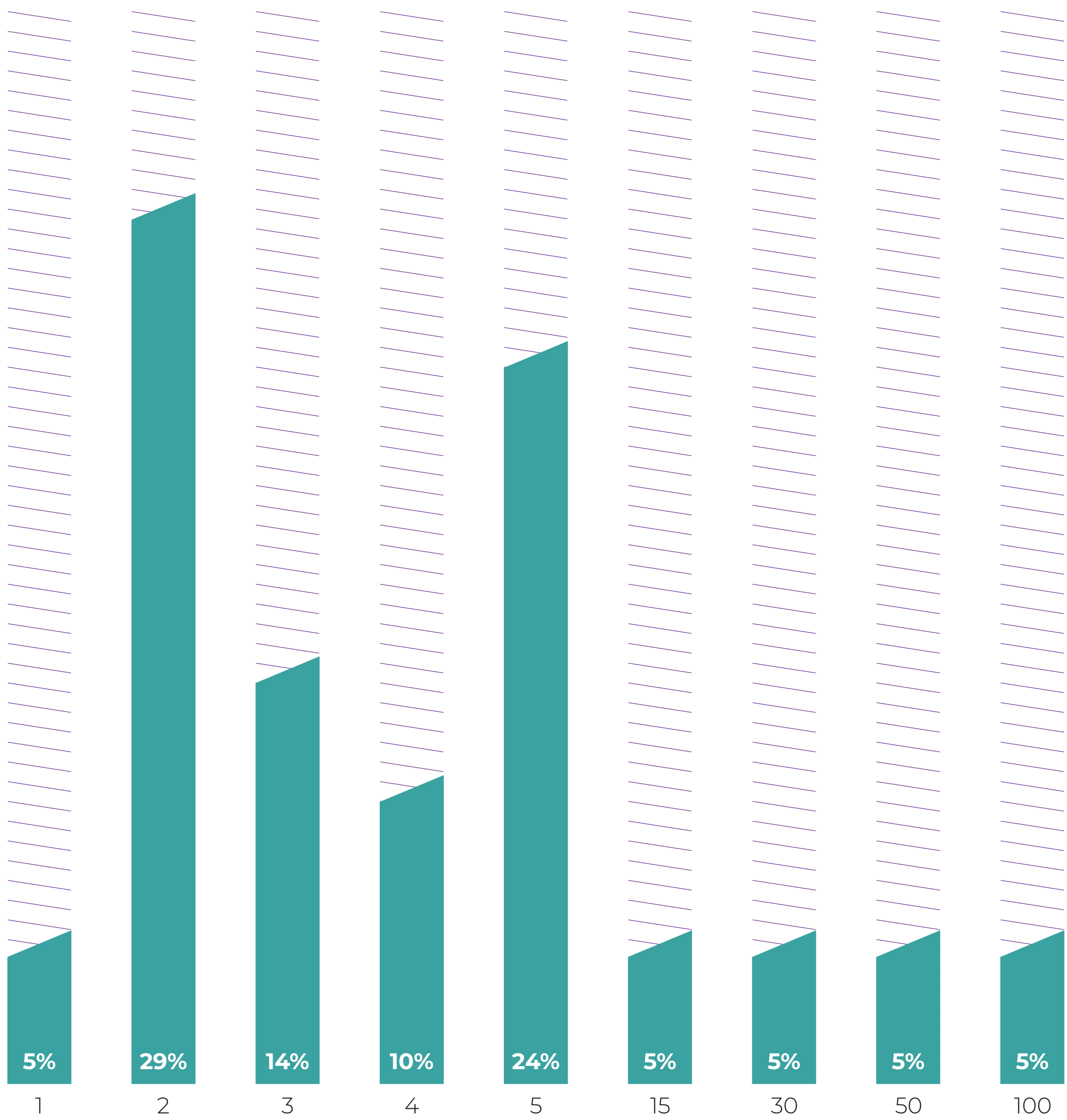
Q: Are you satisfied with the average number of iterations of the simulation cycle in your organization? N = 248

If not, what is your target number of iterations? [open text] N = 21

WHAT DO ENGINEERS CONSIDER TO BE THE IDEAL NUMBER OF ITERATIONS REQUIRED PRIOR TO PRODUCTION?

Of those 29 individuals who indicated that they are not at all happy with the current number of iterations, 21 of them provided additional feedback.

On average, they would like to aim for 12 simulation cycles before producing a part or prototype.



Q: If not, what is your target number of iterations? [open text]

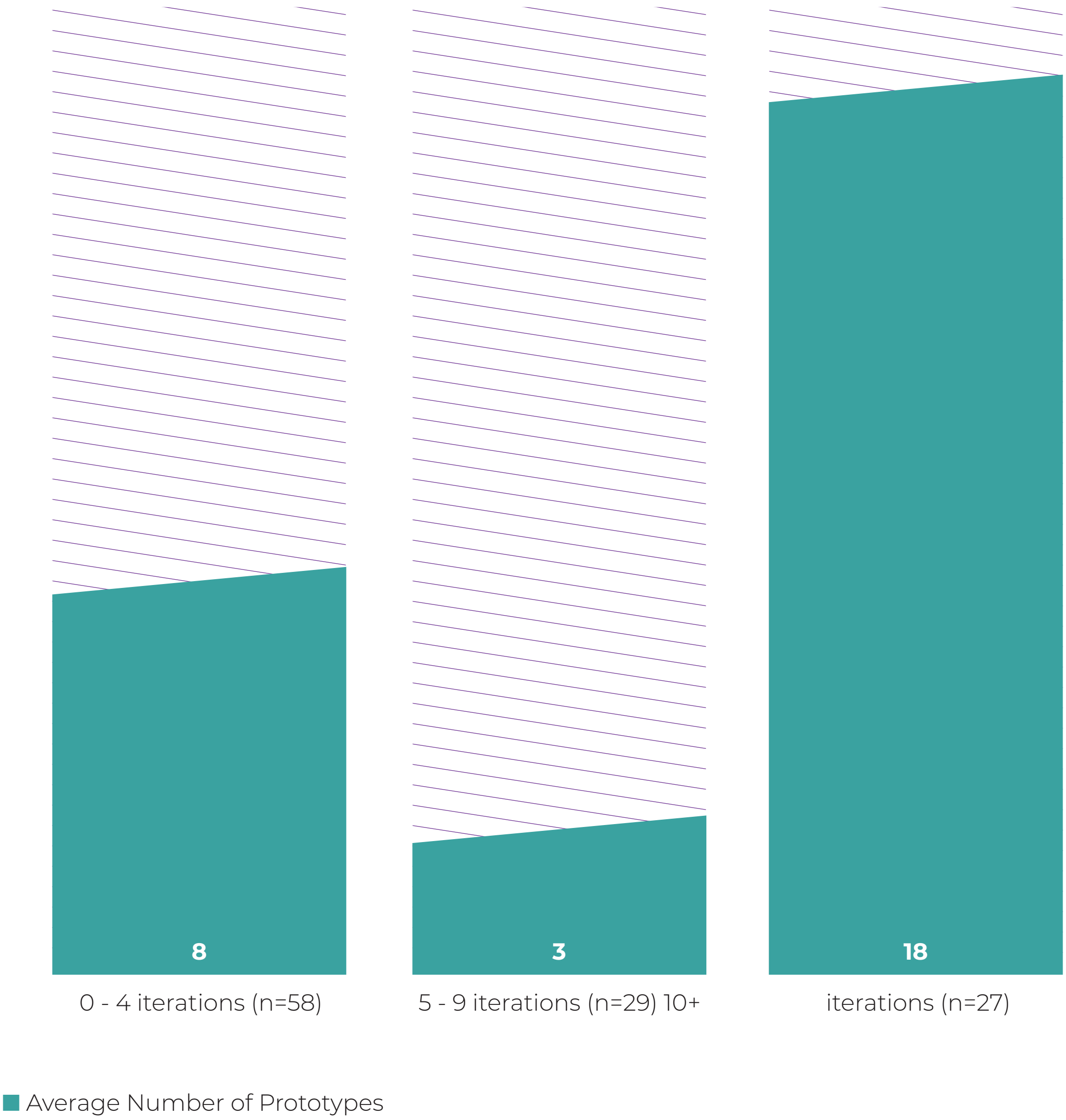
N = 21

HOW DO ENGINEERS COMBINE SIMULATION WITH PHYSICAL TESTING?

At the 0 – 4 iteration range, engineers created an average of eight physical prototypes prior to finalizing the product's design.

At 5 – 9 iterations, the average number of prototypes dropped down to three.

Those who run 10 or more iterations are also averaging 18 prototypes.

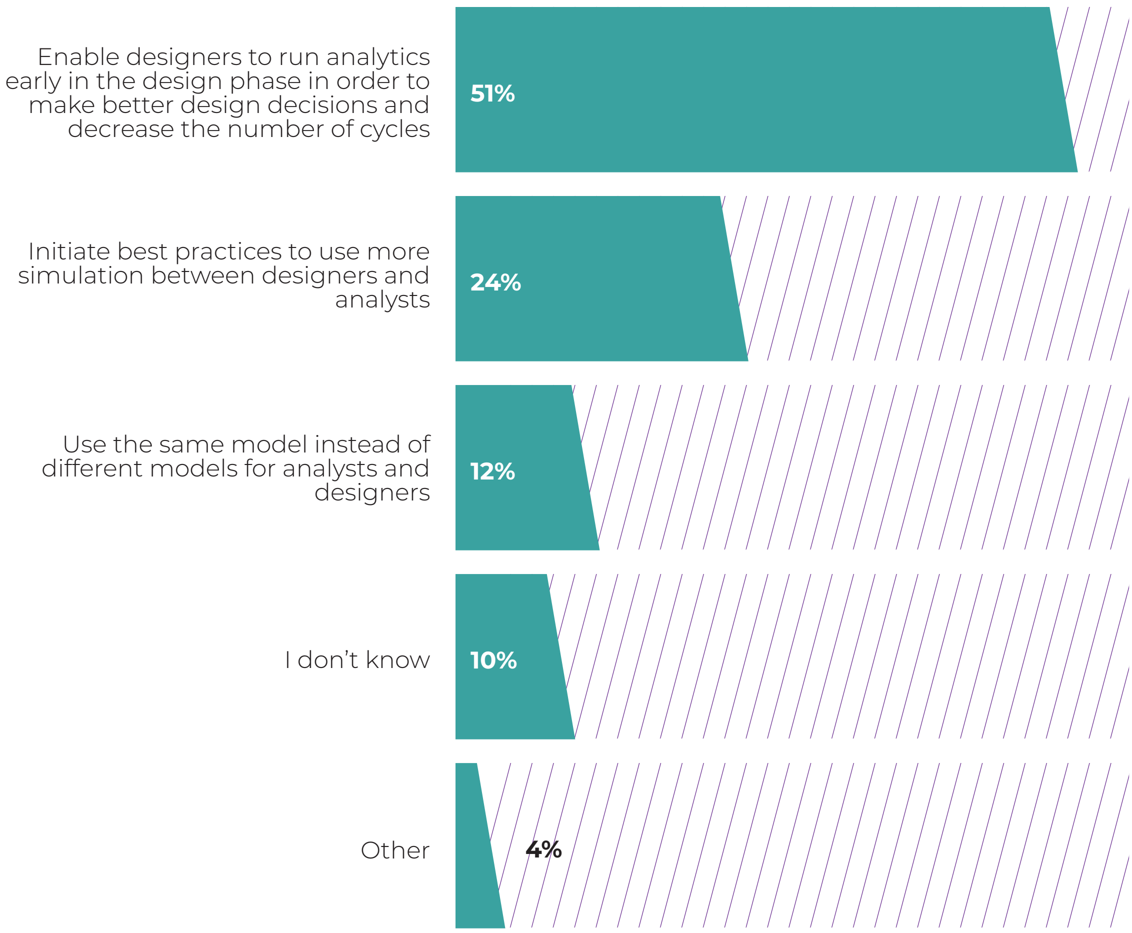


Q: How many physical prototypes do you typically create before finalizing the product design? [open text]
On average, how many iterations through the design-virtual simulation cycle do you use before producing the first part or prototype? [open text]

WHAT WOULD ENGINEERS CHANGE TO STREAMLINE DESIGN-SIMULATION CYCLES?

Our survey respondents recognized that the design-simulation cycle could be better. The majority (51%) would enable designers to run analytics themselves much earlier in the design phase; they saw this as a strategy to lower the number of cycles.

Some (24%) would use best practices to encourage more collaboration between designers and analysts. A small group (12%) would use a consistent model for analysts and designers.



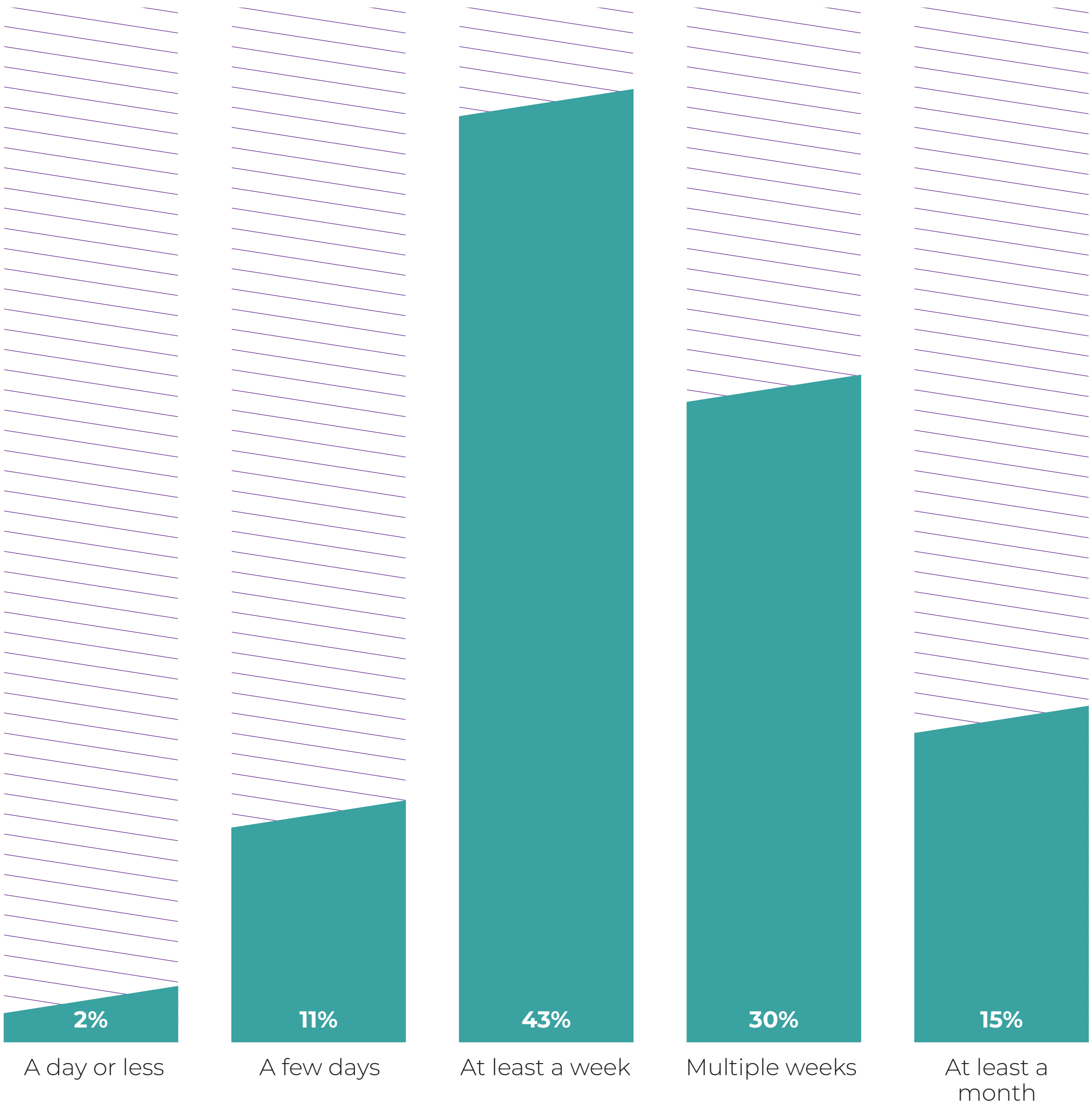
Q: What can you do to better streamline design - simulation cycles?

N = 246

HOW LONG DOES IT TAKE TO OUTSOURCE SIMULATION WORK?

While outsourcing can free up engineers' time and provide a much-needed third-party perspective, don't expect a quick turnaround. Feedback from those who outsourced indicated that for 43%, it could take at least a week, if not multiple weeks (30%) or even a month (15%) to receive the results.

Only 13% of third-party analysts turned around results within a few days.



Q: If you are outsourcing your simulation projects, how long does it take to obtain the results you need?

N = 47

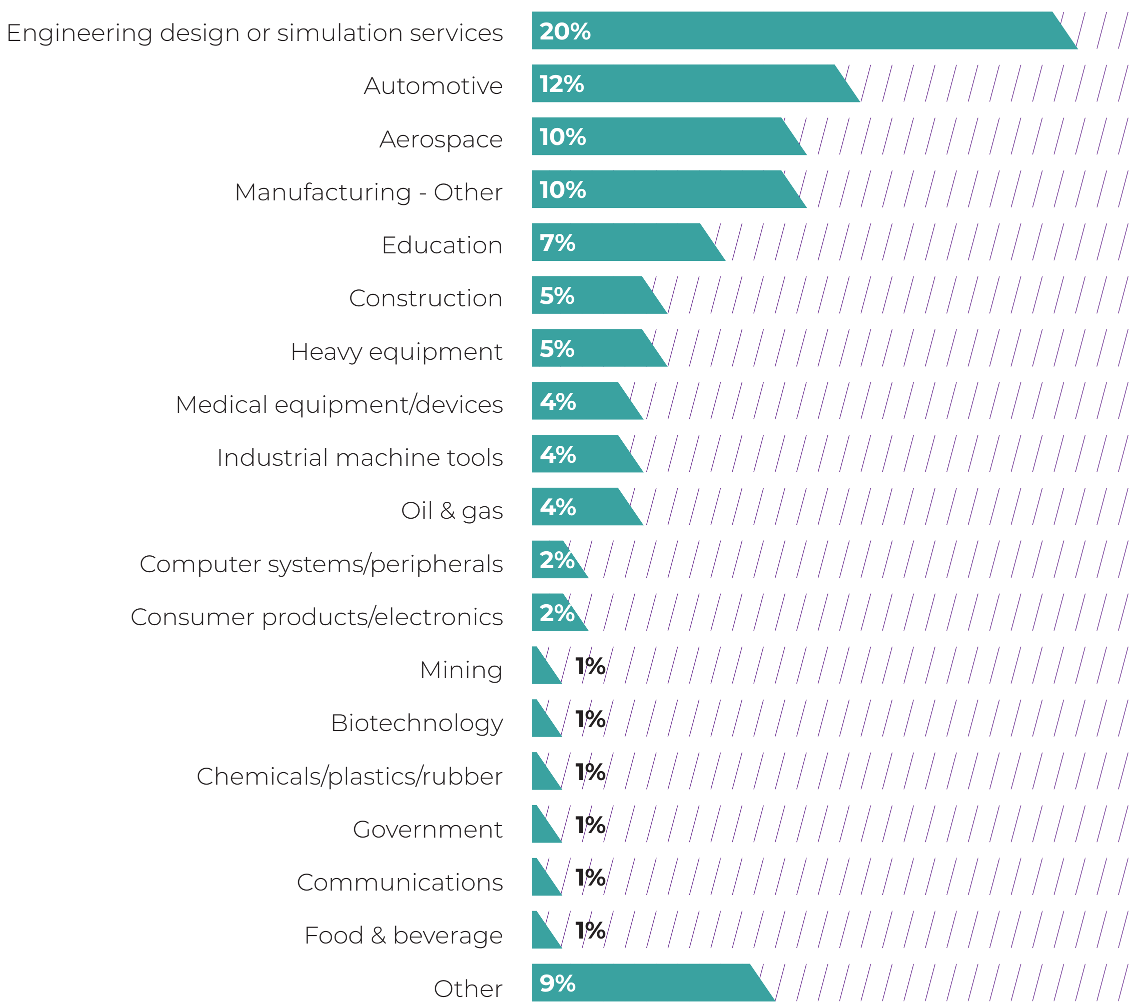
Demographics

INDUSTRIES REPRESENTED

Though respondents work in a diverse range of industries, the largest industries represented here are engineering design or simulation services (20%), automotive (12%), aerospace (10%) and manufacturing (10%). There was also moderate representation from those working in education (7%), construction (5%) and heavy equipment (5%).

The remainder were spread across various other industries. The other industries had less than 5% of respondents each:

- Each covering 4% of respondents: Medical equipment/devices, Industrial machine tools, oil and gas
- Each covering 2% of respondents: Computer systems/peripherals, consumer products/electronics
- Each covering 1% of respondents: Mining, biotechnology, chemicals/plastics/rubber, government, communications, food and beverage



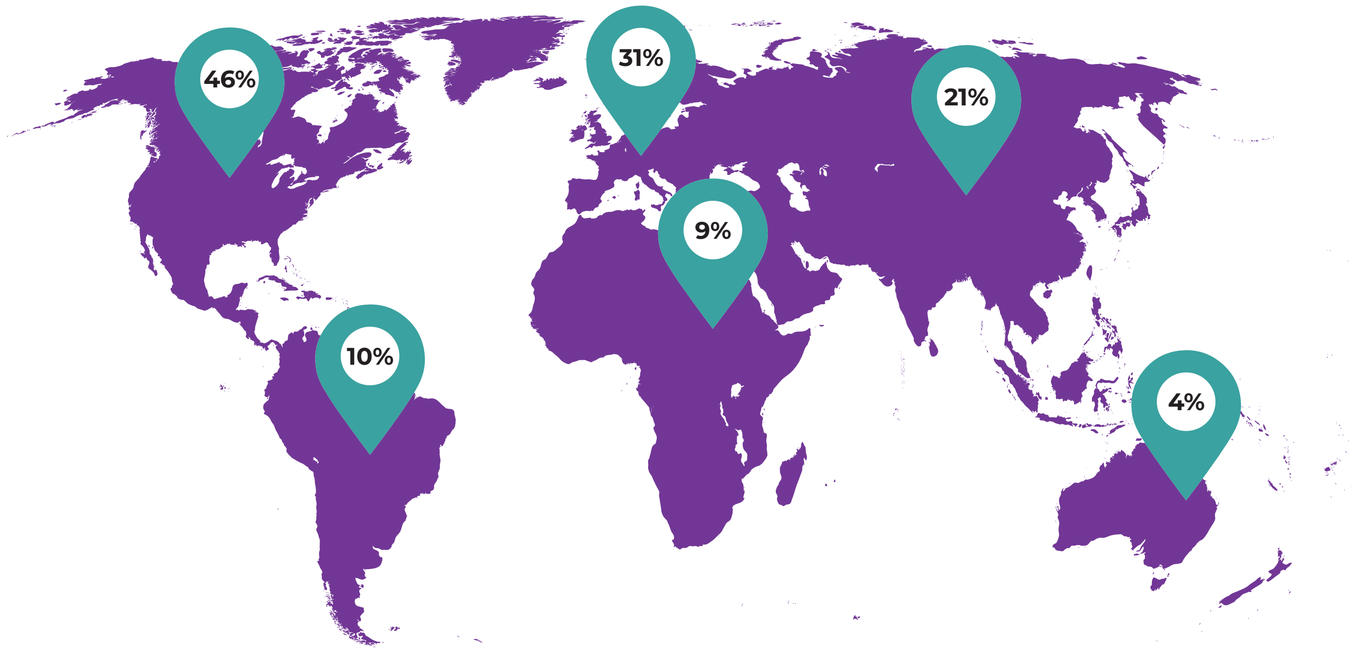
Q: What industry do you work in?

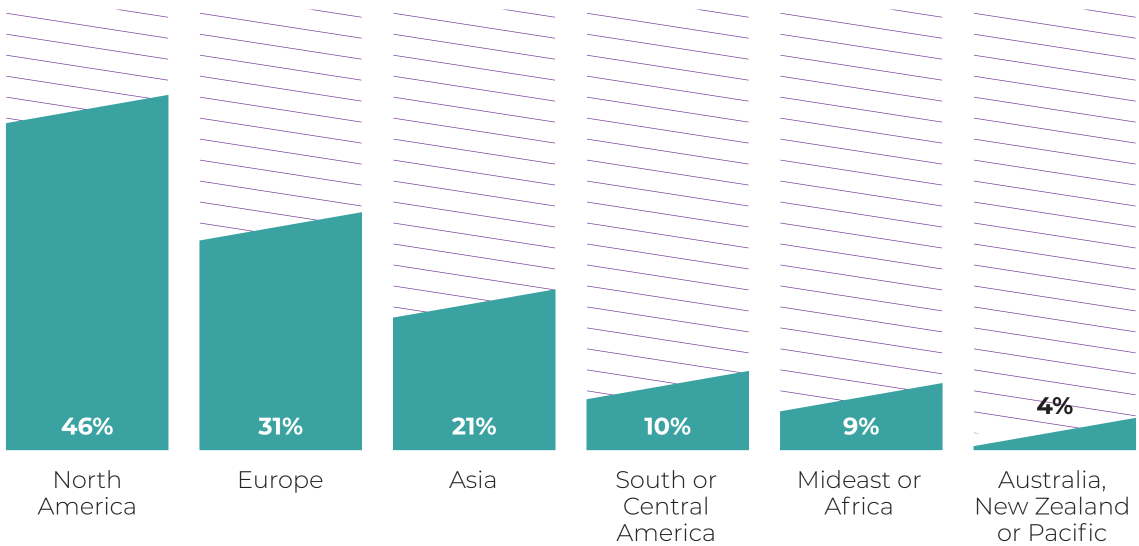
N = 329

GEOGRAPHIC SPREAD

The survey had good representation from an international audience.

Most respondents (46%) had an engineering office in North America, followed by Europe (31%), Asia (21%), South or Central America (10%) and in the Mideast region or Africa (9%). A small percentage (4%) of engineers had offices in Australia.





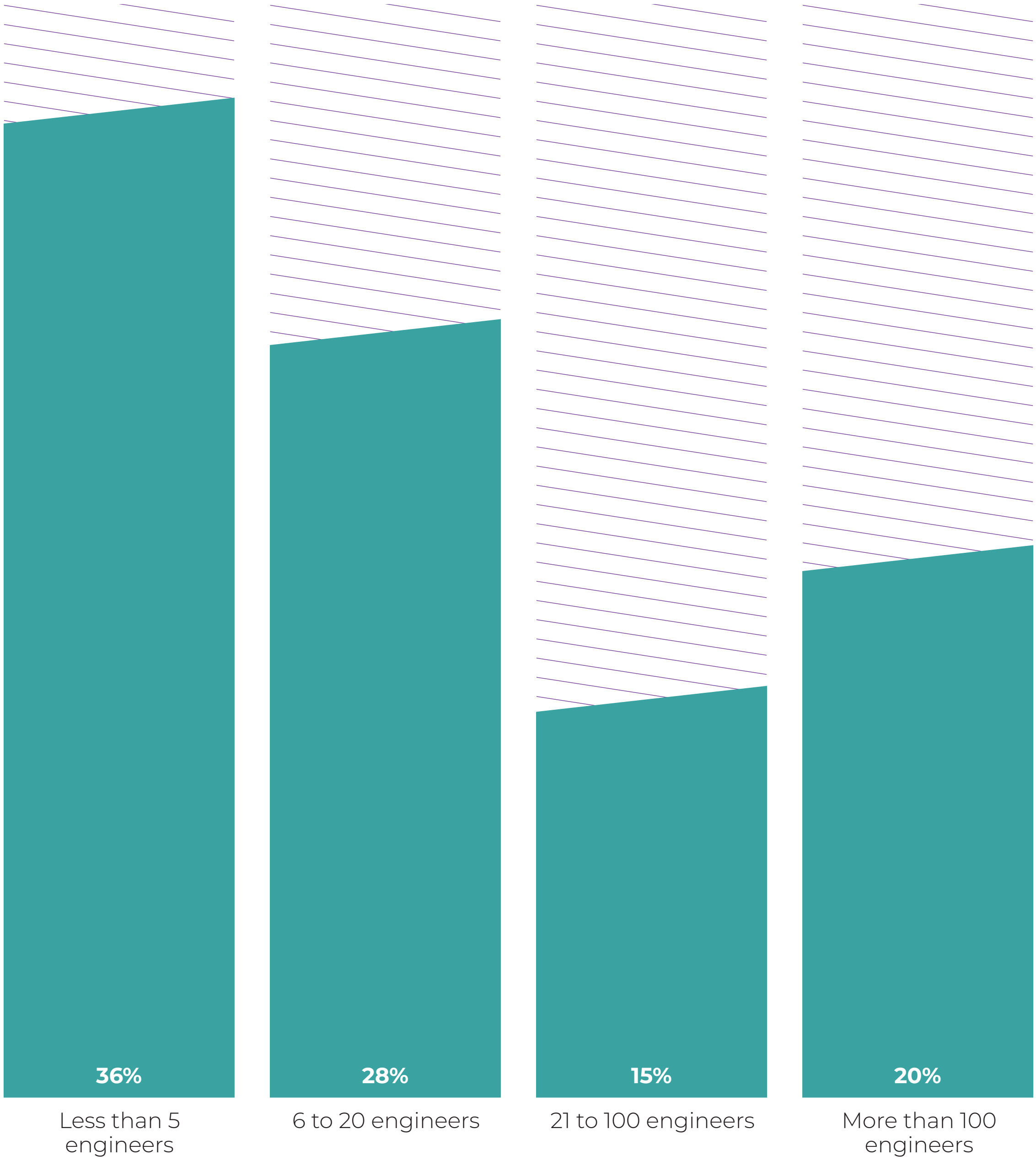
Q: Where are your engineering office(s) located? Select all that apply.

N = 320

OFFICE SIZE

Survey participants represented large and small engineering firms. Most worked for smaller firms (64%) with 20 or fewer engineers.

However, there was representation from midsize (15%) to large (20%) firms, as well.



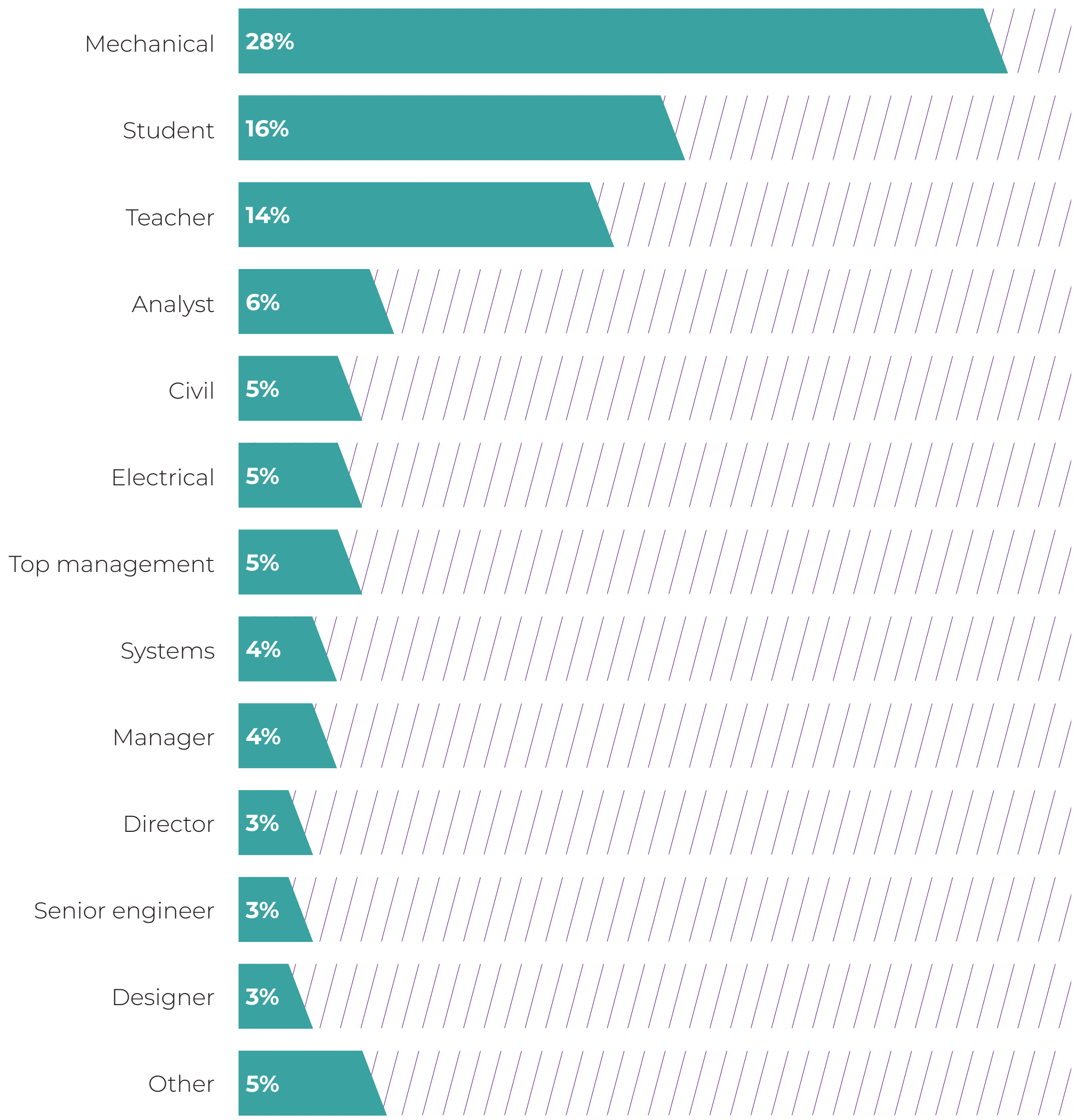
Q: What is the size of your engineering office?

N = 324

JOB ROLES REPRESENTED

Despite a low number of designers (3%), the survey was completed by respondents in a range of different roles. The highest representation came from mechanical engineers (28%). A third held academic roles (16% students and 14% teachers) and 15% were in some form of leadership—a senior engineer or other formal management role.

Analysts (6%), and civil (5%), electrical (5%) and systems (4%) engineers contributed as well.



Q: What is your job role?

N = 328

CLOSING COMMENTS

We conducted this research to better understand the use of simulation and its place in the whole design cycle, from concept to manufacturing. We found that engineers across industries are incorporating simulation at all levels. However, it's clear that there is room to improve. There are barriers in both using simulation software as well as retaining simulation resources.

Interesting results include:

- Our respondents used several criteria to reach the best design possible. The top five criteria were strength/stiffness (82%) and weight (71%) followed by shock/vibration/modal (64%), durability (62%) and thermal (60%).[1]
- Because simulation prior to production is ideal, we wanted to discover what prevents engineers from running simulations more often. We discovered three main barriers—a lack of knowledge (47%), the expense (41%) and a lack of trust in the results (37%). [2]
- On average, engineers go through 19 iterations of the design-virtual simulation cycle before producing the first part or prototype. The majority (69%) are happy or okay with that, but some (12%) are not. Those who indicated that they are not at all happy with the current number of iterations, on average, responded they would like to aim for 12 cycles before producing a part or prototype. [3]
- Respondents recognized that the design-simulation cycle could be better. The majority (51%) would enable designers to run analytics themselves much earlier in the design phase; they saw this as a strategy to lower the number of cycles. [4]

Engineering.com would like to thank the participants of this study. By sharing their knowledge and allowing others to see how they compare, they have enriched the entire engineering community.

Thanks for reading,

Roopinder Tara
Director of Content
engineering.com

RESPONSE FROM SPONSOR

1. A multidisciplinary approach based on a common user-interface could ease access to new domains and increase the range and value of simulation-driven design activities.
2. Integrated workflows with simulation knowledge built into the designer interface can increase efficiency and volume of simulation, and build trust in the process.
3. Stronger integration of simulation technology into the design environment, coupled with guided simulation workflows, can improve efficiency and outcomes and further decrease the overall time needed for simulation-based design.
4. Delivering powerful, yet designer-oriented simulation tools on the cloud, within the designer's familiar environment, is a key to breaking this log jam and shortening design cycles.

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