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What's the State of Nonlinear Simulation?

Engineering.com audience survey of nonlinear simulation practices

ALTAIR

This research has been sponsored by Altair.

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EXECUTIVE SUMMARY

Nonlinear simulation is necessary for analyses that go beyond the limits of a linear approach. For complex behavior, such as large deformations, changes in stiffness or failure, nonlinear simulation is the best way to an accurate result. However, it comes with a price: longer solver run times, more computational resources and more complex pre-processing than linear simulation.

We set out to determine how engineers incorporate nonlinear simulation into their work, and how they rate the software that they have available for this work. We wanted to understand how nonlinear simulation is really used across various industries.

In this engineering.com research report, we present the results of a survey in which we asked over 100 engineers, designers, product managers and executives about the use of nonlinear simulation within their companies. We determined what the most popular software is, who's using it and what they're using it for.

You'll also find out:

- What kind of simulation work is most prevalent today
- Which industries use nonlinear simulation the most
- Which software is most popular among power users
- Whether your license complement is comparable to other organizations
- The common pain points with nonlinear simulation applications
- And more

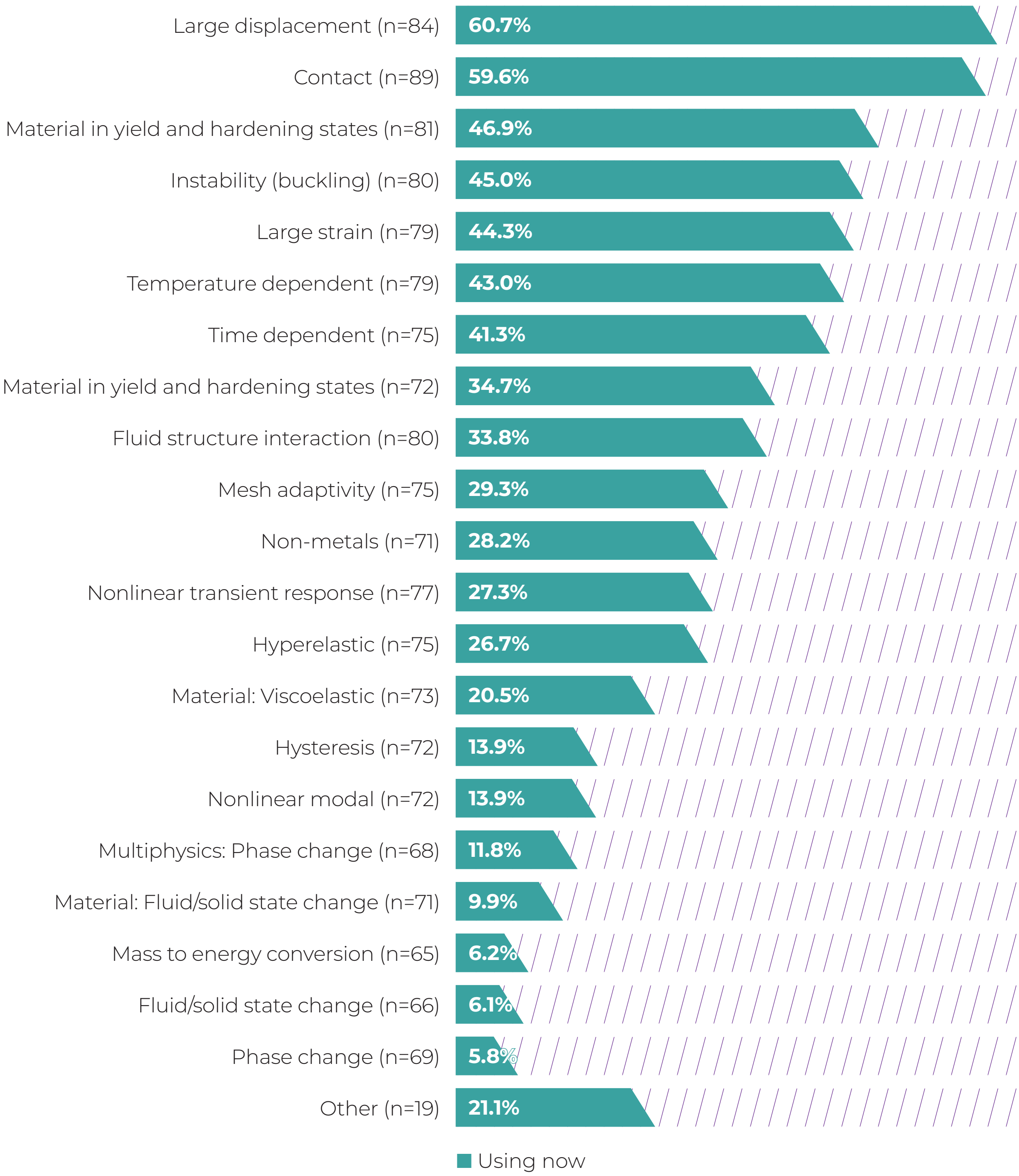
Thanks for reading,

Roopinder Tara
Director of Content, engineering.com

What kind of simulation work is most prevalent today?

LARGE DISPLACEMENTS ARE MOST COMMONLY ANALYZED.

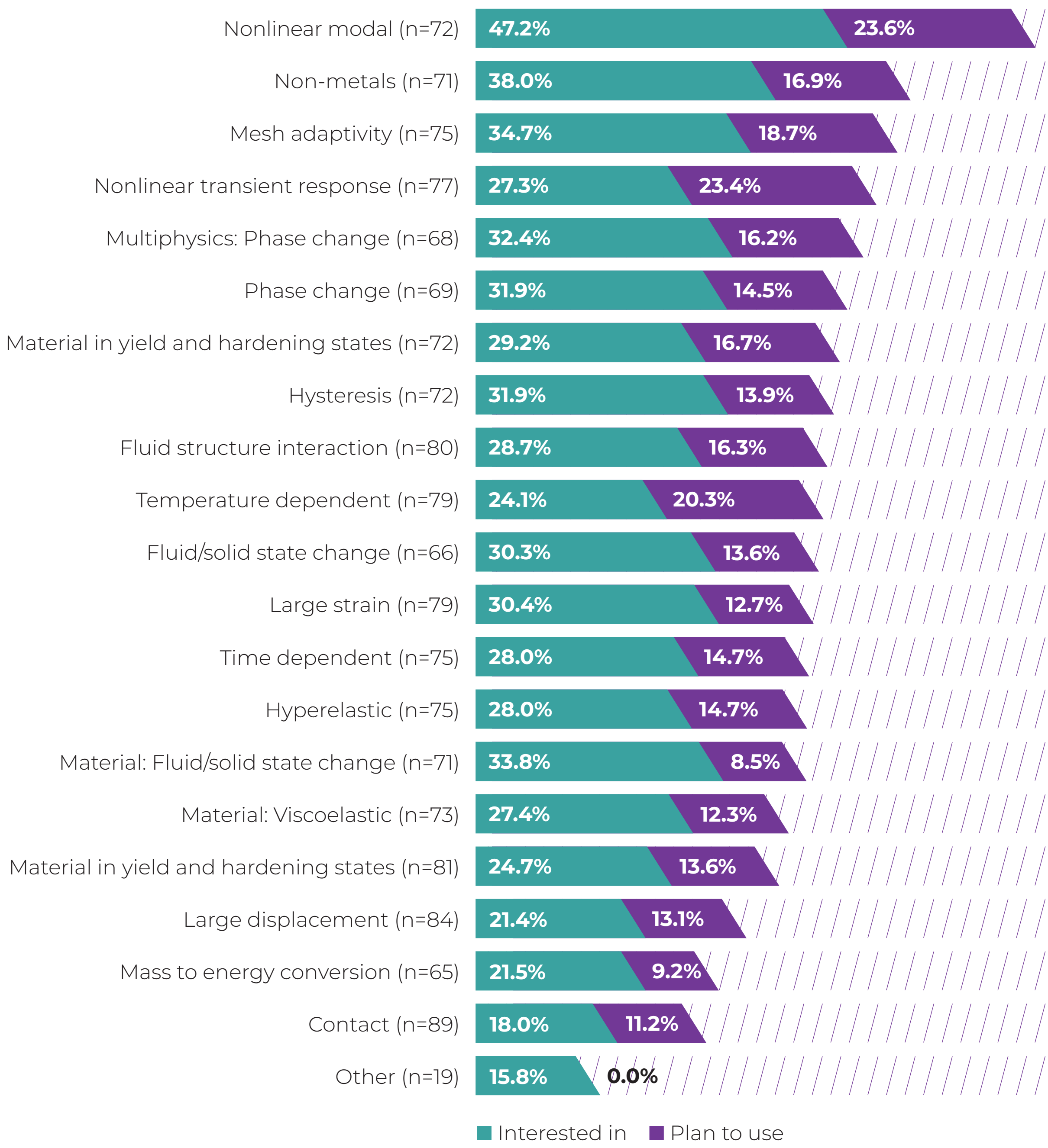
Over half of respondents rely on nonlinear simulation to analyze large displacements (61%) and contacts (60%).



Q: What kind of nonlinear simulations do you or your company use or plan to use?

NONLINEAR MODAL SIMULATIONS ARE TRENDING.

Nonlinear modal (70.8%), non-metals (54.9%) and mesh adaptivity (53.4%) are the top analyses that survey takers are interested in or plan to start using in the near future.

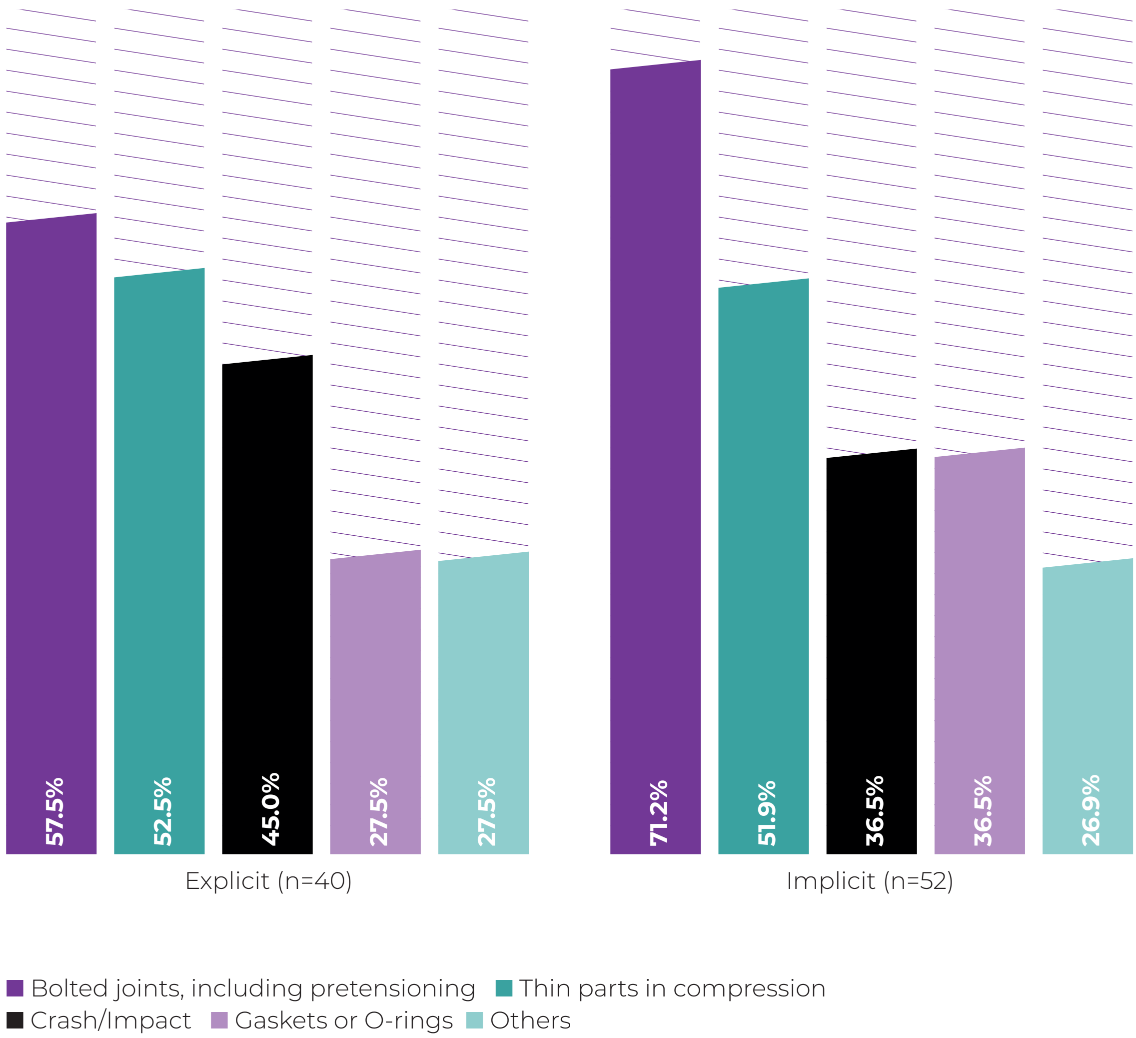


Q: What kind of nonlinear simulations do you or your company use or plan to use?

WHAT KIND OF PARTS OR PROBLEMS ARE BEING SOLVED?

There is a nearly equal split between users of implicit and explicit nonlinear simulation. The majority (55%) of respondents indicated that they typically complete implicit nonlinear analysis, compared to the 45% that typically perform explicit nonlinear analysis.

When comparing explicit versus implicit types, users across both categories are called in most often to analyze bolted joints (56% explicit / 71% implicit) and thin parts in compression (53% explicit / 52% implicit). Those who typically perform explicit analysis appear to be called on to simulate crashes/impacts (45%) more than their counterparts.



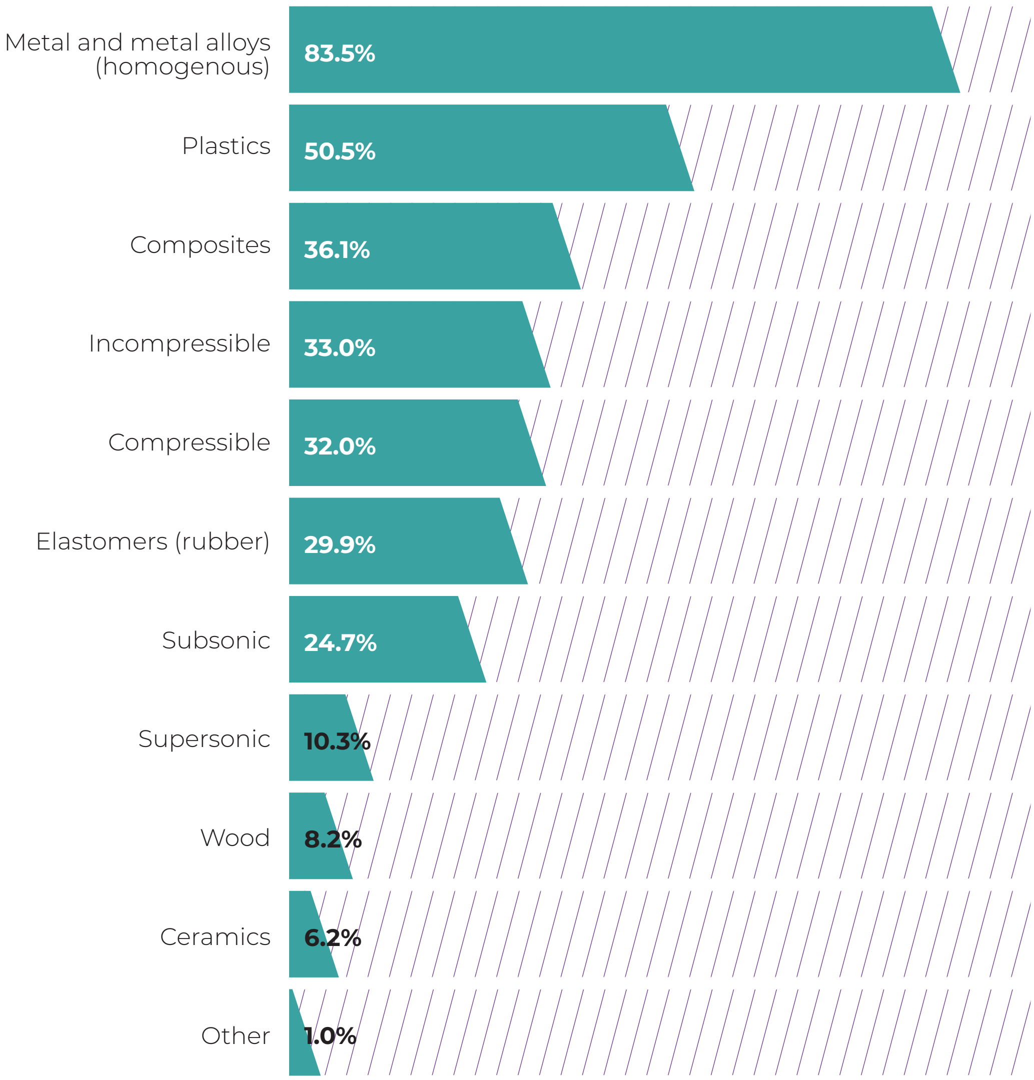
Q: What kind of parts or problems are you asked to solve? Check all that apply.
What is the primary type of nonlinear analysis you perform?

METALS AND HOMOGENEOUS METAL ALLOYS ARE THE MOST COMMON MATERIALS EXAMINED.

Most survey takers are looking at metal and homogenous metal alloys (84%) and/or plastics (51%).

The next most popular materials are composites (36%), incompressible (33%) and compressible (32%) materials, as well as elastomers (30%).

Based on the responses received, few users are running nonlinear simulations with ceramics (6%) and wood (8%).



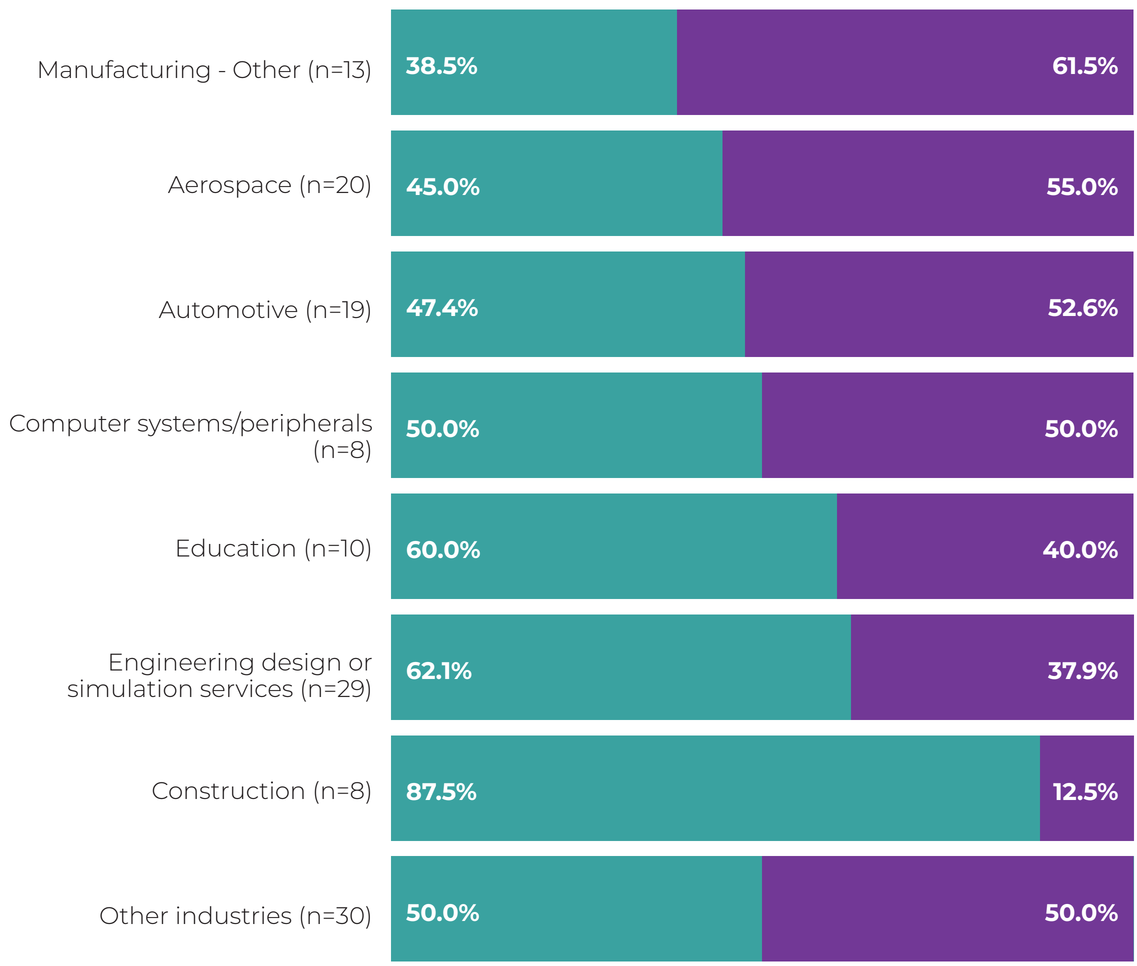
Q: What material(s) do you typically analyze? Check all that apply. N = 97

Which industries are engaging in nonlinear the most?

MOST SURVEY TAKERS ARE NOT DOING NONLINEAR SIMULATION AS A CORE FUNCTION OF THEIR ROLE.

Of the 137 respondents who shared how often they do simulation work, we discovered that practices range from not at all or very little (53%) to moderate usage (31%). Only a small portion of survey takers do nonlinear simulation work as a core function of their jobs (16%).

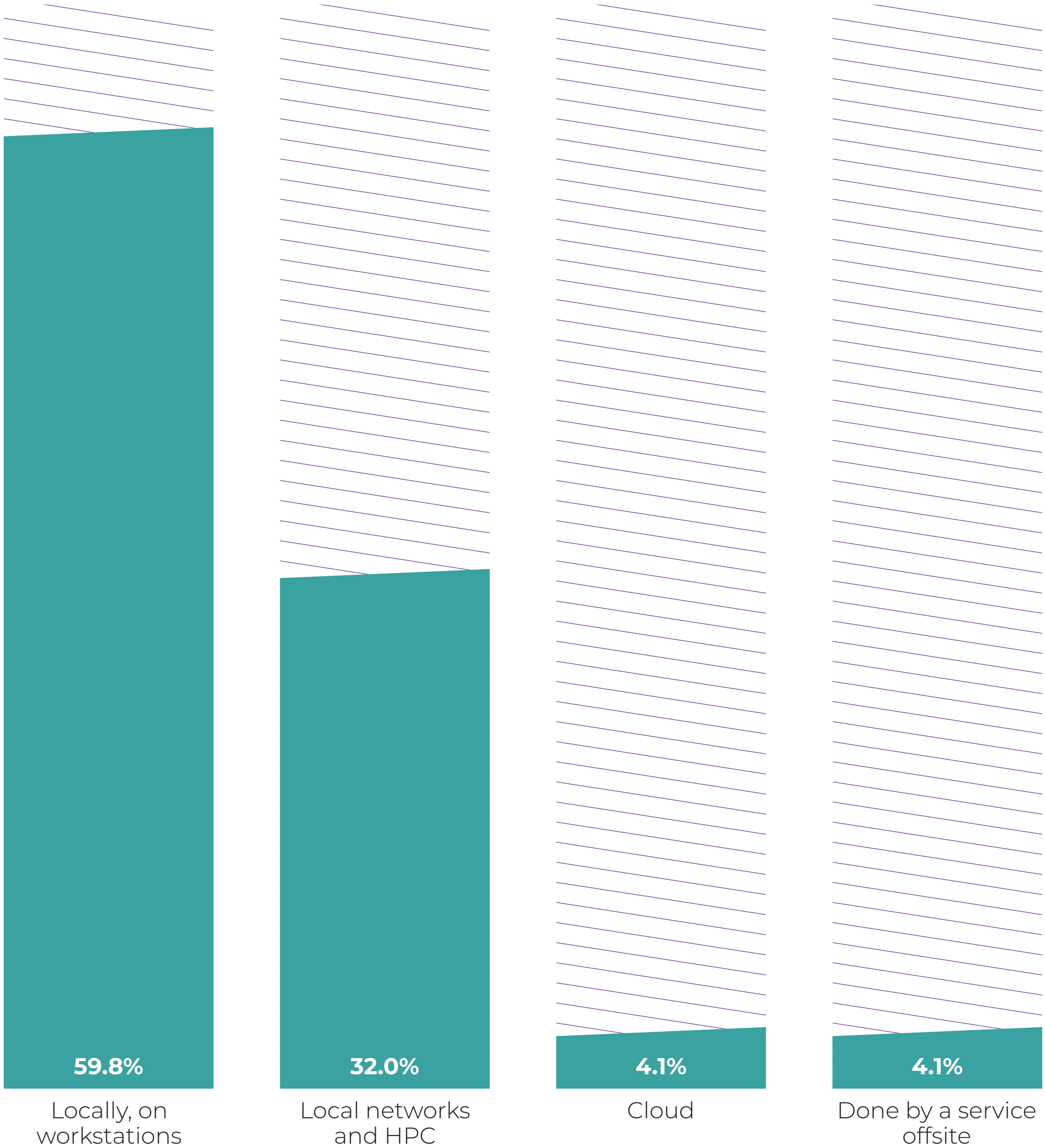
Exploring simulation practices by industry gives us more information. Though group sizes are fairly small, available data suggests that those in manufacturing (62%), aerospace (55%) and automotive (53%) may be doing nonlinear simulation work more often than their counterparts in construction (13%), engineering design or simulation services (38%) and education (40%).



Q: What industry do you work in? How much nonlinear simulation do you do?

LOCAL WORKSTATIONS ARE THE GO-TO OPTION FOR SIMULATION WORK.

The majority (60%) of survey respondents noted that they run nonlinear simulations on a local workstation. Not many are sending this work out to an offsite service (4%) or relying on a cloud-based solution (4%).



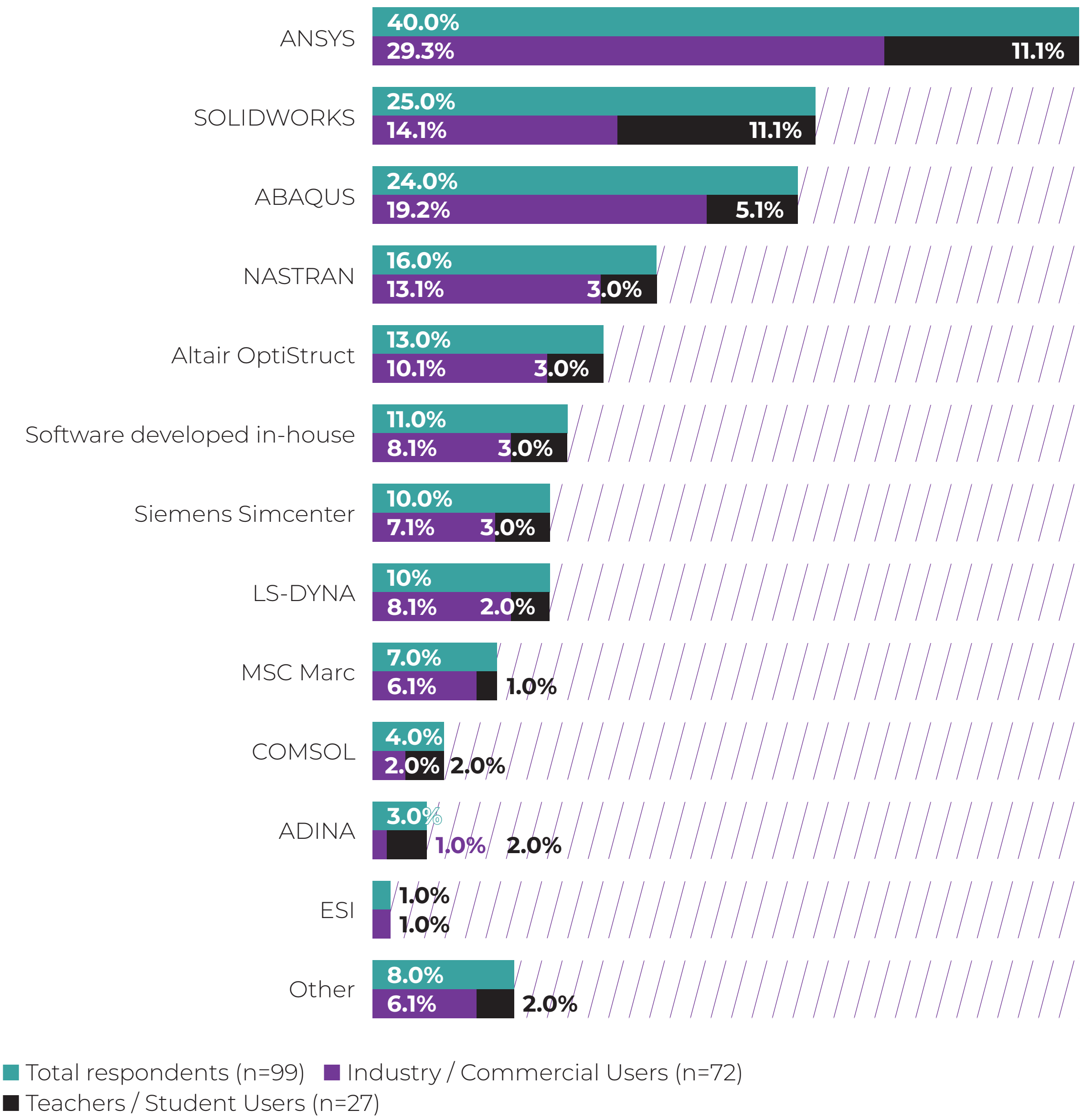
Q: Where does your nonlinear simulation solution take place?

N = 97

Which software applications do power users rely on most?

WHICH SOFTWARE APPLICATIONS ARE MOST POPULAR?

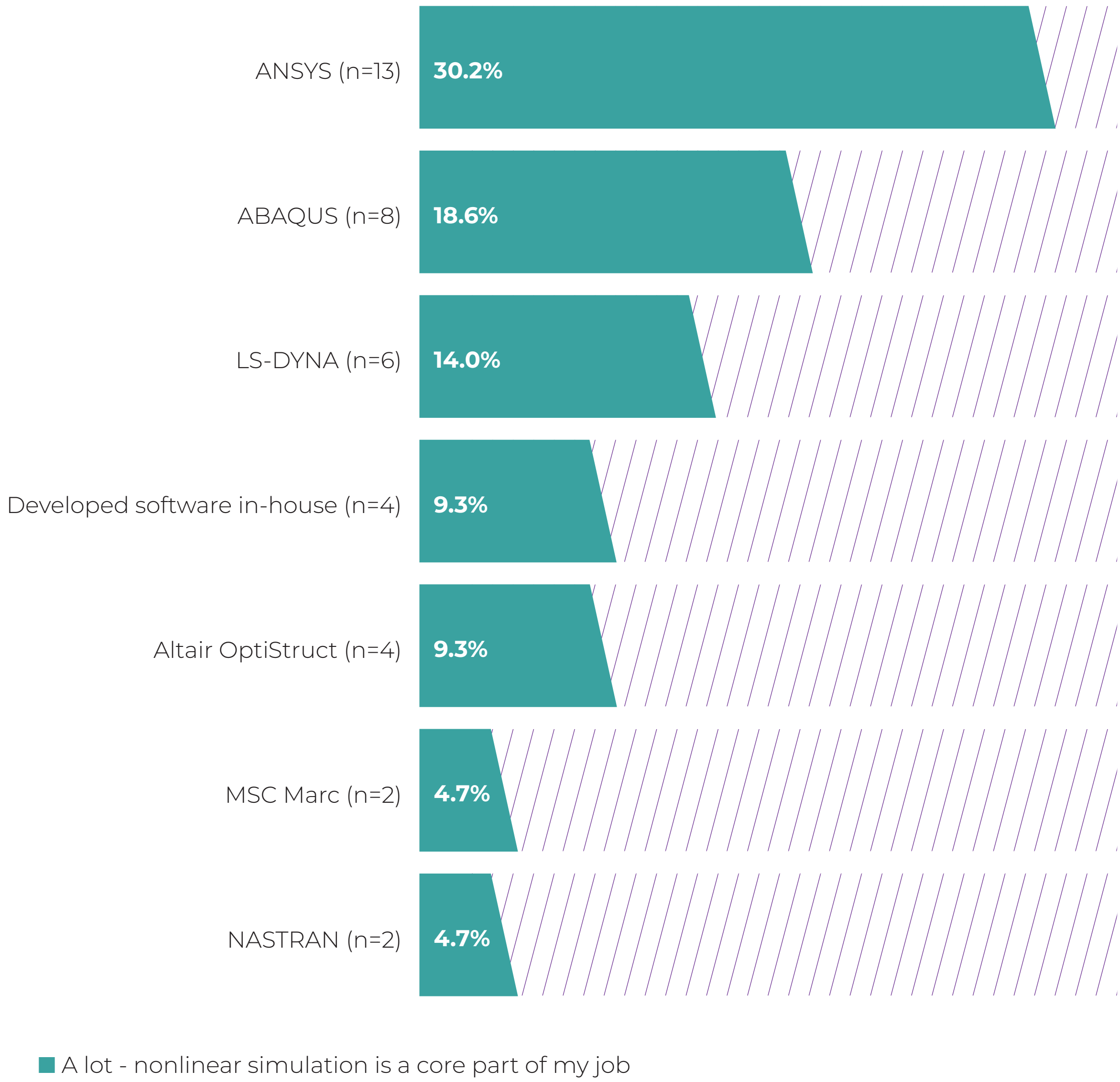
Some of the more popular nonlinear simulation applications include ANSYS (40%), SOLIDWORKS (25%), ABAQUS (24%), NASTRAN (16%) and Altair OptiStruct (13%). Of the 99 users who shared which software they use, only a small percentage use applications like COMSOL (4%), ADINA (3%) and/or ESI (1%). When considering the type of user for the most popular application (i.e., ANSYS), we found that 29% of ANSYS users have commercial / corporate roles, whereas 11% are in academia.



Q: What software do you use for nonlinear analysis? Check all that apply.
What is your job role?

WHAT SOFTWARE IS USED PRIMARILY BY POWER USERS (THOSE WHO PERFORM NONLINEAR SIMULATION AS A CORE FUNCTION OF THEIR ROLES)?

We asked power users to share which software application(s) they use to do nonlinear simulation. Applications used most include ANSYS (30%), ABAQUS (19%), LS-DYNA (14%) and Altair OptiStruct (9%).

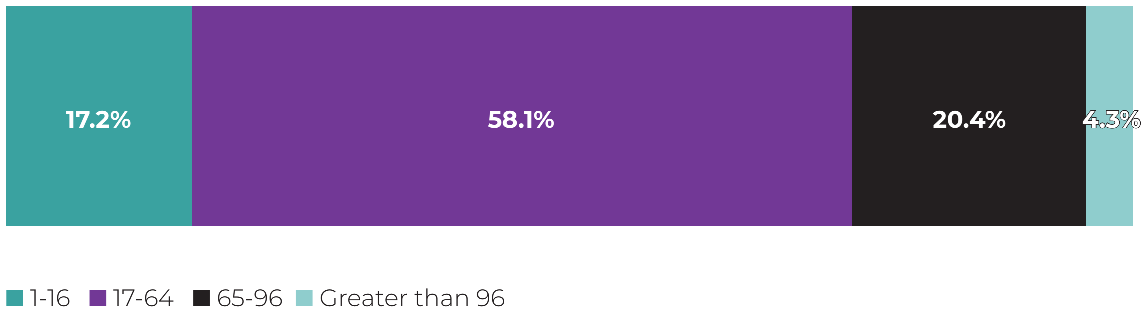


Q: How much nonlinear simulation do you do?
What software do you use for nonlinear analysis? Check all that apply.

Let’s look at the details: Iterations and validations

HOW MANY DESIGN ITERATIONS DO USERS PERFORM ON AVERAGE?

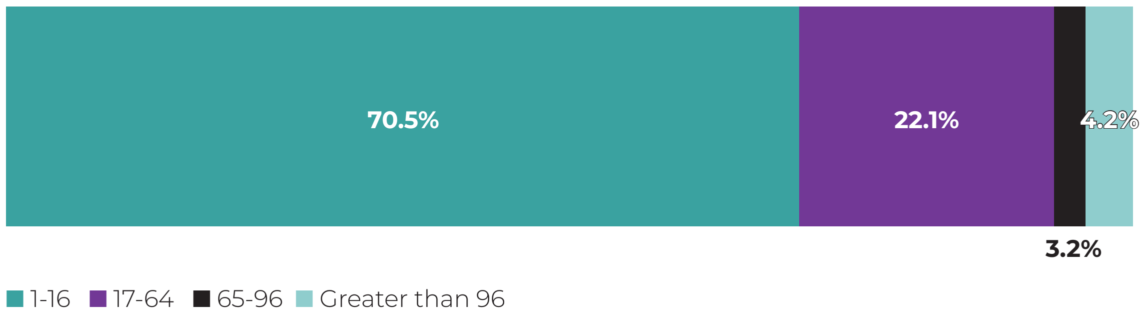
Over half (58%) of the 93 respondents who do at least a little nonlinear simulation indicated that they average 3 – 4 passes before accepting a solution.



Q: On average, how many passes, or design iterations, are analyzed before a model is approved?

HOW MANY CORES ARE USED IN A TYPICAL NONLINEAR ANALYSIS JOB?

The majority (71%) of the 95 respondents who do at least a little nonlinear simulation work indicated that they use 1 – 16 cores to run a typical nonlinear analysis job.

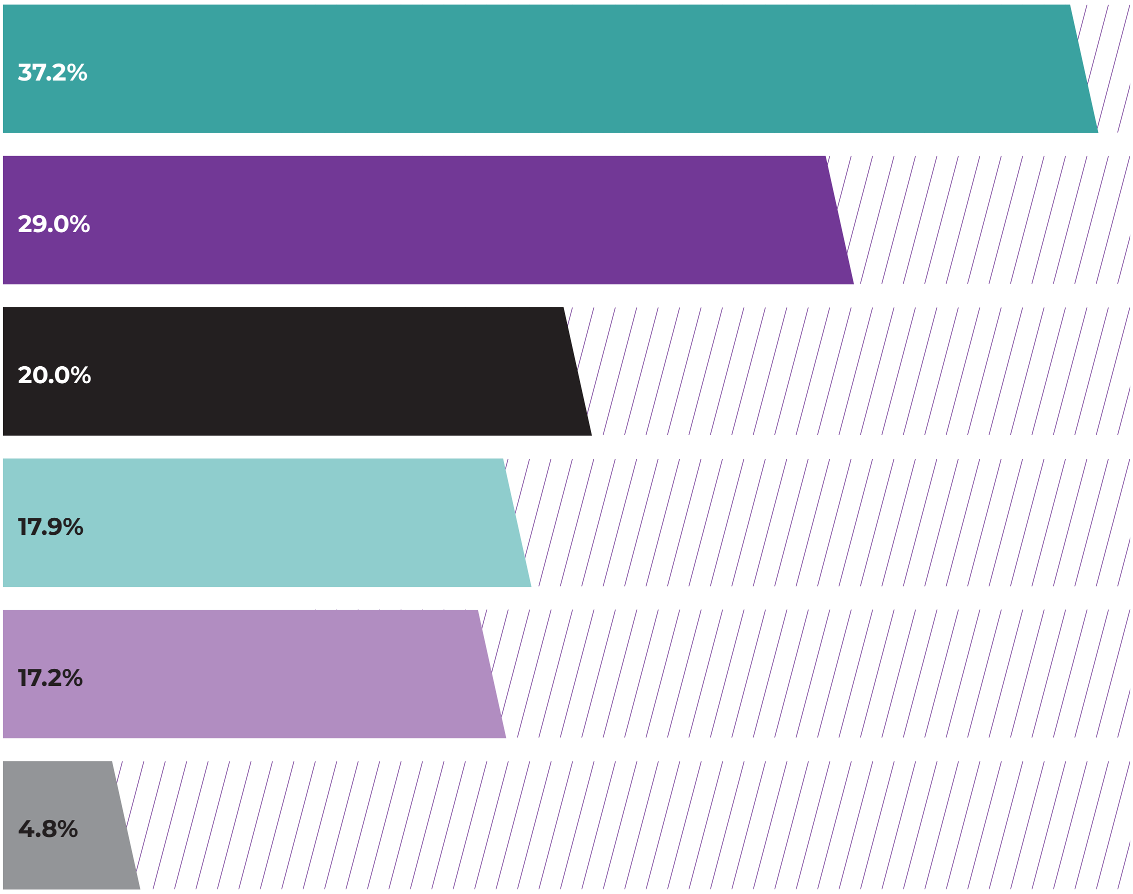


Q: How many cores do you use to run a typical nonlinear analysis job?

HOW ARE NONLINEAR SIMULATIONS TYPICALLY VALIDATED?

Of the 94 respondents who do at least a little nonlinear simulation work, 37% indicated that they use laboratory tests to validate their simulations.

Other popular methods of validation include checking the convergence of results (29%) and referencing a handbook (20%). A significant number of users (17%) rely on experience as their method of validation, while a small minority (4%) perform an alternate nonlinear simulation.



- Using laboratory tests (strain gauges, for example) to gain confidence in model and results
- By convergence (results show little change with increase in elements, time, etc.)
- Handbook
- Back of the envelope calculation
- None (includes reliance on experience)
- Alternate nonlinear simulation method

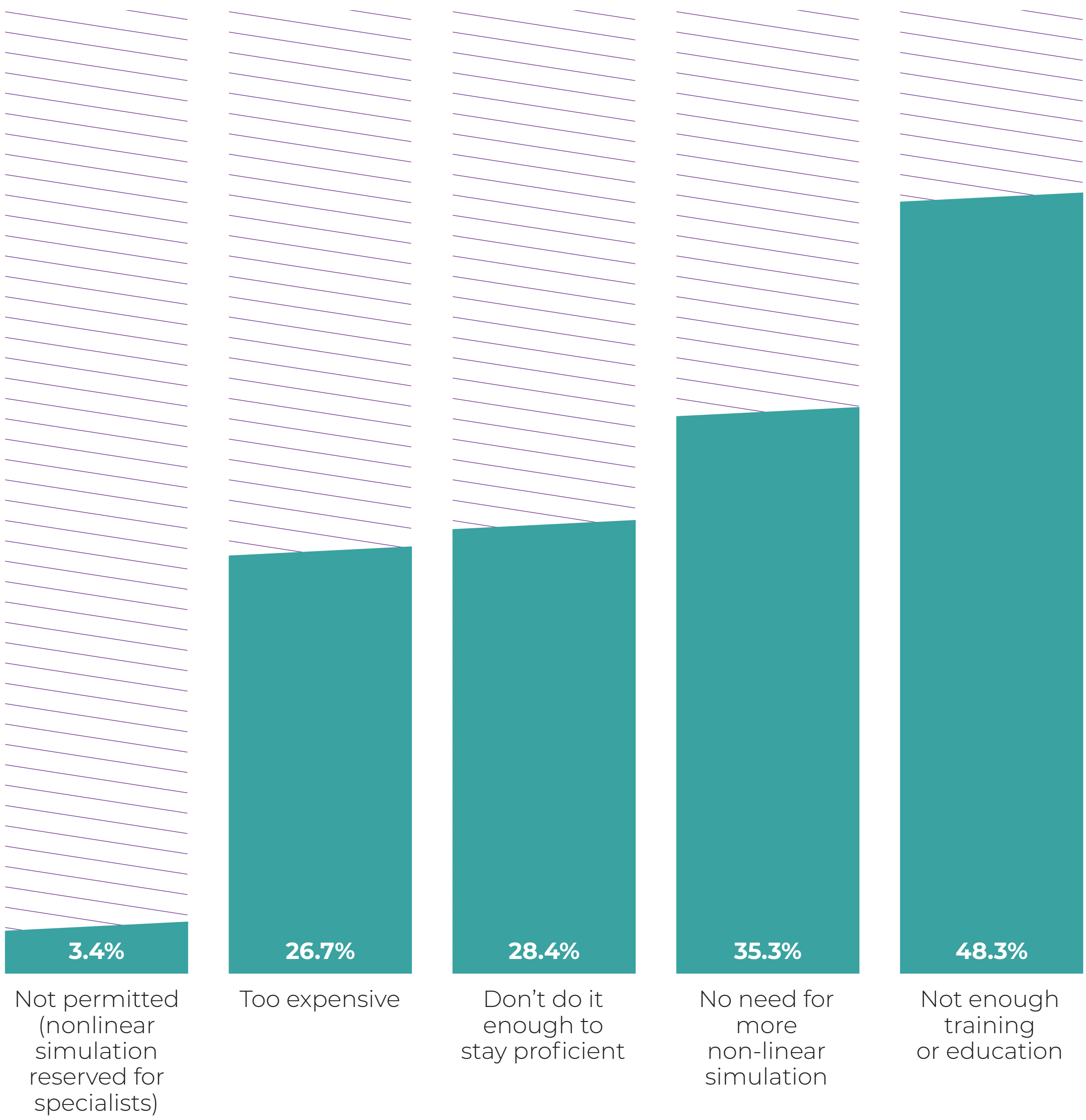
Q: What method(s) do you use (if any) to validate your nonlinear simulations? Check all that apply. Filtered by: How much nonlinear simulation do you do? Answer is not: 'None at all' N=94

What are the biggest frustrations with nonlinear applications?

LACK OF TRAINING IS STILL A BARRIER TO NONLINEAR SIMULATIONS.

As it stands, almost half (48%) of respondents to this survey selected 'not enough training or education' as a key barrier to completing more nonlinear simulations.

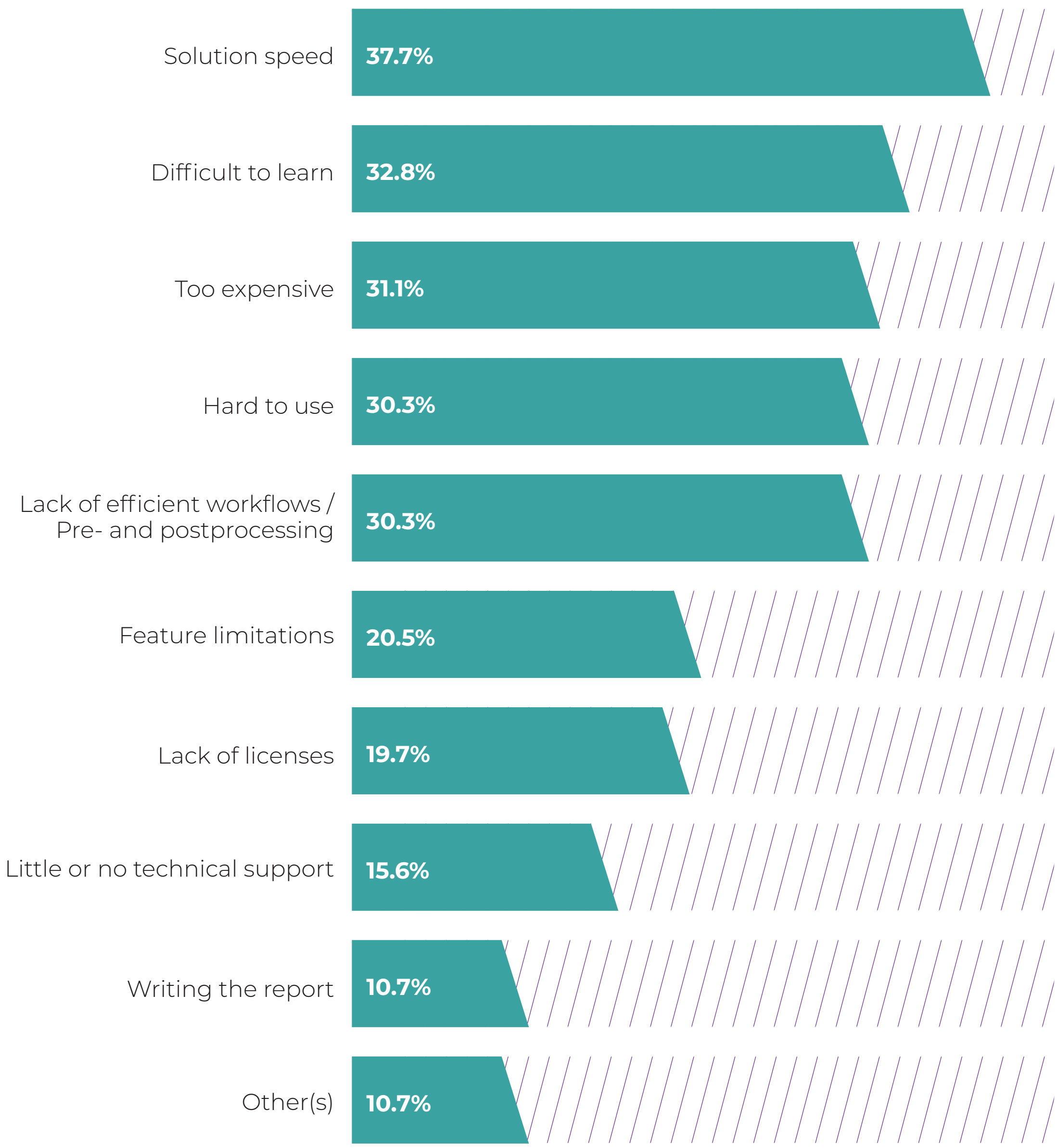
Other barriers included lack of practice to maintain proficiency (28%) and cost (27%). Over a third (35%) had no need for more simulations, and 3% of respondents were unable to do nonlinear simulations because they're reserved for specialists in their organization.



Q: What prevents you from completing more nonlinear simulations? Check all that apply. N=116

WHICH ASPECTS OF NONLINEAR SIMULATION SOFTWARE ARE MOST PROBLEMATIC?

Frustrations with nonlinear simulation software include solution speed (38%), how hard it is to learn the software (33%), expense (31%) and complexity of the software (30%).



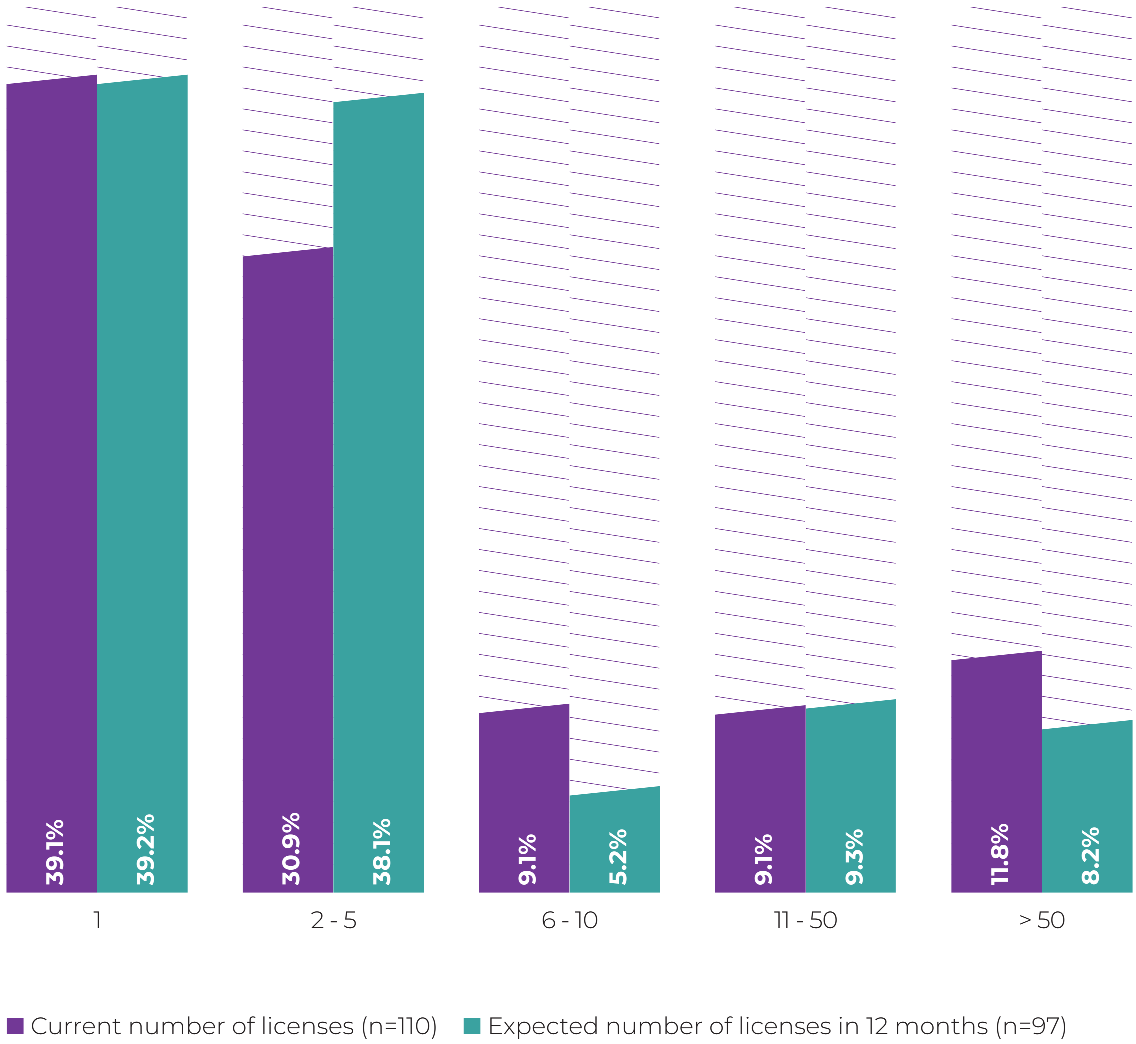
Q: What are your pain points when using nonlinear analysis software? Check all that apply. N=122

How many software licenses do companies have or plan to purchase?

HOW MANY LICENSES DO COMPANIES HAVE NOW AND HOW MANY DO THEY WANT?

We asked respondents to share how many software licenses their organizations have now versus what they expect to have in the next 12 months.

Most (39%) revealed that they have a single license for nonlinear simulation software. This number is not expected to change in the next year. 31% of users have 2 – 5 licenses, though this number will grow to 38% in the next year. This bolstering may come from users with 6 – 10 licenses (9%) and over 50 licenses (12%), as each of these groups plan to reduce their seats in the near future.



Q: How many licenses of nonlinear simulation software does your company have now? How many do you plan to have in the next 12 months?

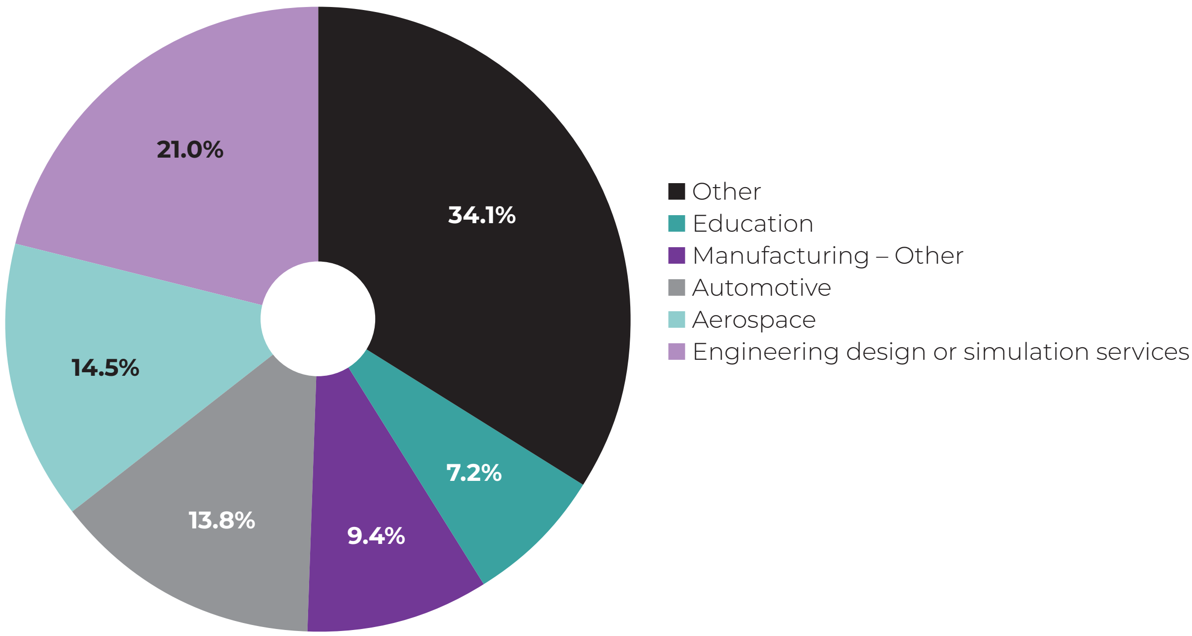
Demographics

INDUSTRIES REPRESENTED

Respondents work in a diverse range of industries. The largest industries represented here are engineering design or simulation services (21%), aerospace (15%), the automotive industry (14%), other manufacturing (9%) and education (7%). Note that engineering students and teachers often identify themselves in industries outside of education (see results on next page).

34% of respondents were spread across various other industries. The other industries had less than 10 respondents each:

- Construction (6%)
- Computer systems/peripherals (6%)
- Heavy equipment (4%)
- Medical equipment/devices (4%)
- Consumer products/electronics (2%)
- Each covering 1% of respondents: Oil & gas, Communications, Mining, Industrial machine tools, Biotechnology and Food & beverage



Q: What industry do you work in?

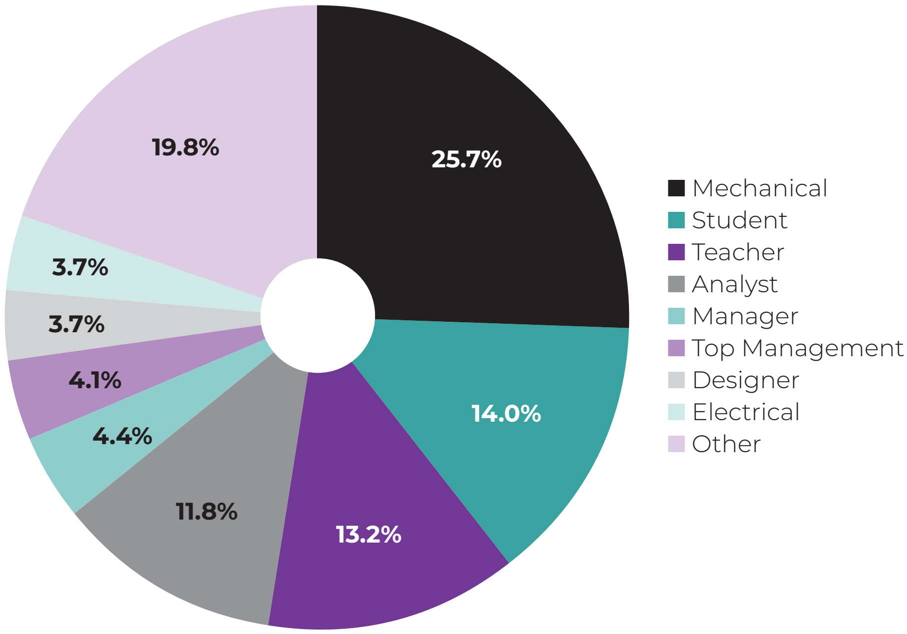
N = 138

JOB ROLES REPRESENTED

The majority of respondents are mechanical engineers (26%). There is good representation from academia as well: 14% are students and 13% are in a teaching role.

Other roles include:

- Managers, directors and executives (11%)
- Electrical engineer (4%)
- Designers (4%)
- Each covering 2% of respondents: Civil engineer, Senior engineer, Consultant and Systems engineer
- Each covering 1% of respondents: Software engineer and Technician



Q: What is your job role?

N = 136

CLOSING COMMENTS

We conducted this survey to determine how companies today are using nonlinear simulation. One of the major findings of the survey was that for most, nonlinear simulation is not a core function of their role. Few fell into the power user category. The top pain points that users have with nonlinear simulation applications include solution speed, difficulty in learning or using the application and cost.

Here are a few other key takeaways from the survey:

- Most respondents use FEA software for nonlinear simulation (74.3%). The most popular nonlinear simulation software was ANSYS (40.4%), followed by SOLIDWORKS (25.3%), ABAQUS (24.2%), NASTRAN (16%) and Altair OptiStruct (13%).
- The industries that rely on nonlinear simulation the most are manufacturing (61.5%), aerospace (55%) and automotive (53%). Construction uses nonlinear simulation the least (12.5%).
- Most users (53%) perform 3 – 4 design iterations using nonlinear simulation. Very few (5%) exceed 10 iterations.
- Many users (48%) cite too little training as the reason they don't use nonlinear simulation more often.
- The most common number of licenses of nonlinear simulation software is 1 (39%). The number of companies with a single license which will remain unchanged in 12 months is 39%. The number of companies with 2 – 5 licenses (31%) will increase within 12 months is 38%.
- Power users (those who use nonlinear simulation software as a core part of their job) most often validate their results with laboratory tests (42%) and checking convergence of results (29%).

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

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