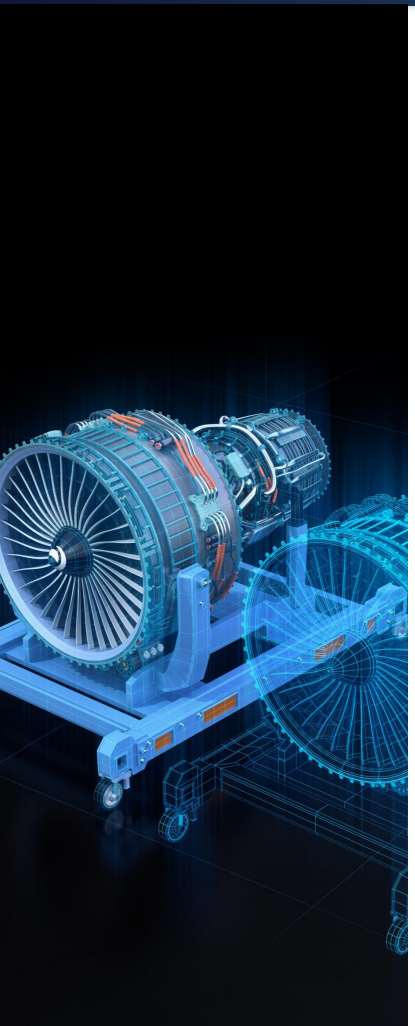
rescale

2022 State of Computational Engineering Report

Insights, statistics, and sentiments from practitioners of compute-driven innovation



Foreword

In the last decade, cloud has transformed software development by removing constraints. Today, cloud is removing the same constraints in physical product development, and the disruption will be just as significant. Rescale has the privilege of working closely with companies leading this next wave of innovation. Each are employing computational science & engineering to commercialize unprecedented engineered products - from personalized medicine, to commercial supersonic transport, to fusion power.

This report has two goals. First, to help technology professionals understand the state of this fast-evolving discipline. Second, to celebrate the contributions of scientists and engineers pioneering new discoveries powered by high performance computing (HPC).

Our survey of 233 engineers, scientists, and high performance computing professionals found some key trends. First, organizations are aggressively using computing to explore new product possibilities. Second, engineering teams with easy access to compute are far more likely to have successful projects. Third, for many organizations, HPC automation plays a central role in their R&D transformation strategy.

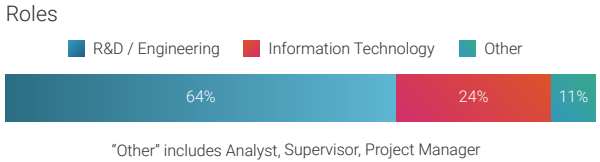
Decades after the the dawn of computer-aided design (CAD) and computer-aided engineering (CAE), computing today is used not only to validate designs, but also to help identify the frontiers of what's possible. Rescale is in service to our science and engineering users, who are pushing these boundaries to solve the world's biggest challenges.

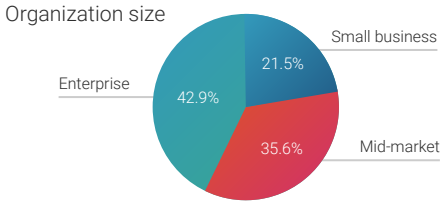
We hope you enjoy this report.

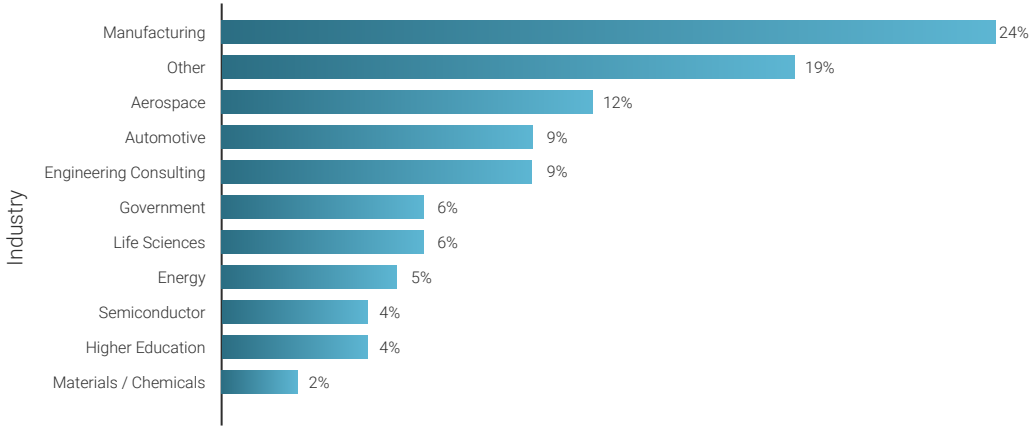
Edward Hsu,
Chief Product Officer, Rescale

Report Sections & Methodology

233 survey respondents span a wide range of industries, from aerospace to life sciences.







1 Computational Science & Engineering Milestones

2 The State of Practice

3 How Computing Impacts Innovation Velocity

4 Practitioner Sentiment

5 Future of Computational Engineering

Computational Science & Engineering Milestones

- Digital transformation begins in science & engineering
- Milestones toward Computational Science & Engineering (CSE)
- Defining our terms in the CSE space

Profiles in Innovation

Exponent®

Solving the most complex engineering challenges impacting the safety and performance of tomorrow's products

"Technological complexity in our clients needs is growing so we need to have the computational capabilities to support them."

Zach Owens
Managing Engineer

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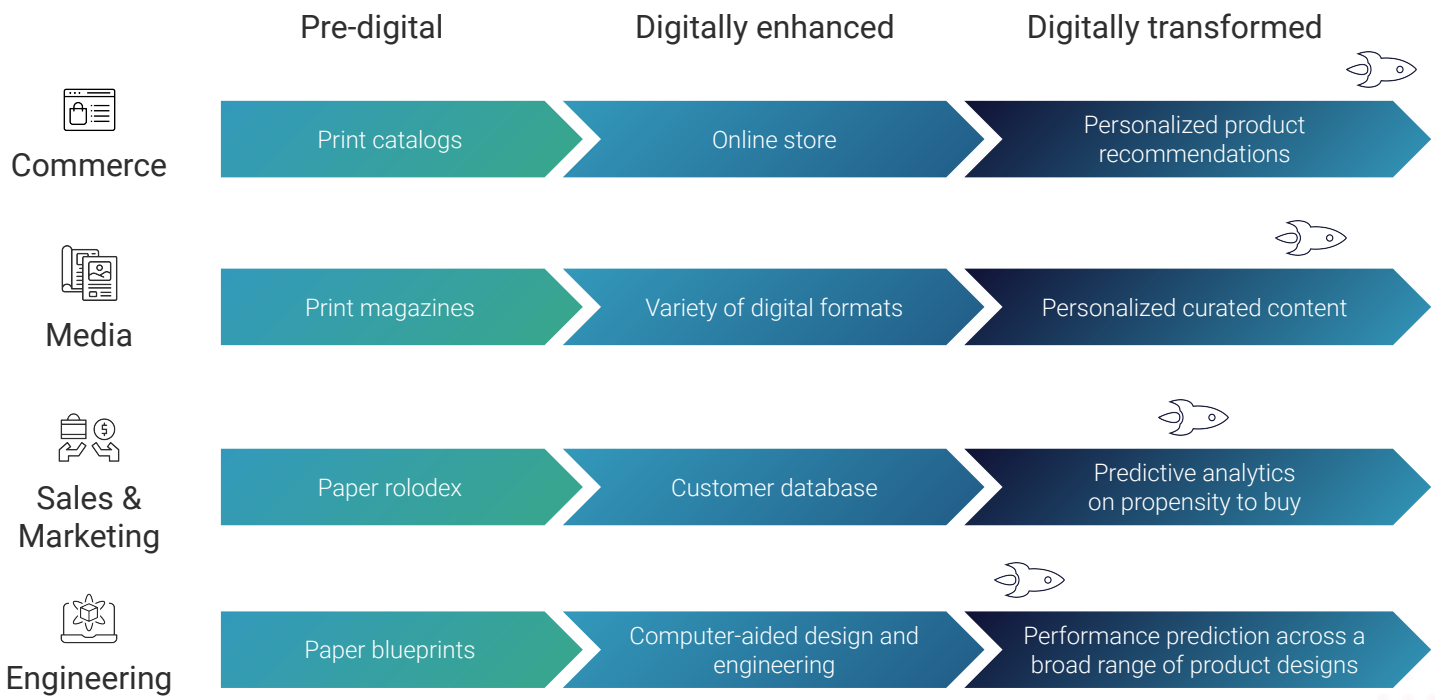
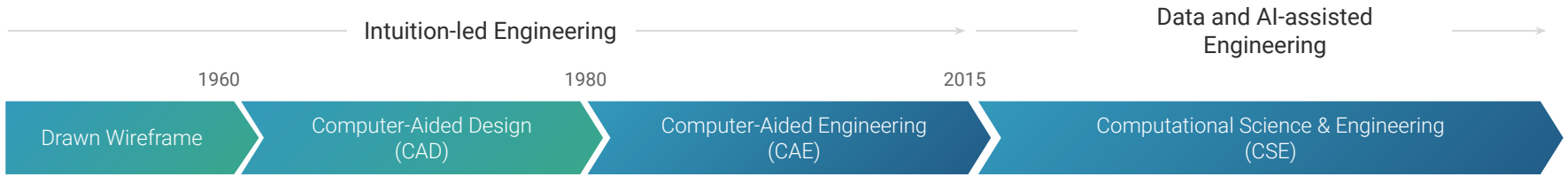
Digital Transformation Across Industries



While many industries and business functions have been transformed by digital processes, engineering is only recently experiencing this shift.

Milestones Towards Computational Science & Engineering



2D, low fidelity drawn or printed representation of 3D objects

CAD improves productivity for 3D and high fidelity design, improves collaboration, and leads to precise manufacturing.

CAE enables simulations of real-world performance of product designs, and leads to a reduction of development costs, as well as improvement of product quality.

Leading universities establish computational science & engineering centers and programs

CSE adds high performance computing (HPC) for breakthrough speed in high-fidelity simulations, enabling mainstream adoption of data and computationally intensive methods:

- **Multiphysics simulation** (e.g., evaluating physical stress, temperature, and airflow simultaneously)
- **Design space exploration & generative design** (i.e., identifying how a product may perform in a broad range of design decisions by running design of experiments, and optimizing the design based on goals)
- **Machine learning-enabled surrogate models** (i.e., fully modeling the process by which a product interacts with its environment – gaining insights from simulation by combining multiphysics, design space exploration and data analytics)
- **Multi-modal AI** (i.e. combining ML-enabled surrogate models with other modalities such as ML models on sensor data or autonomous algorithms, to optimize the overall performance of intelligent products)

Defining Our Terms

Computational science & engineering (CSE) - using computational models, simulations and high performance computing (HPC) to understand natural phenomena (e.g., weather, quantum mechanics) or behavior of engineered products (e.g., aerodynamics, crashes).

Computer engineering - building computers, from hardware to software. May involve developing chips, microcontrollers, sensors, firmware and user software.

High performance computing (HPC) - aggregating computing power across machines to enable parallel processing of computational science & engineering problems. HPC is the modern and commercial descendant of supercomputing.

Computer science - the study of algorithms, data structures, and information theory. Foundation for cryptography, computer graphics, and programming languages.

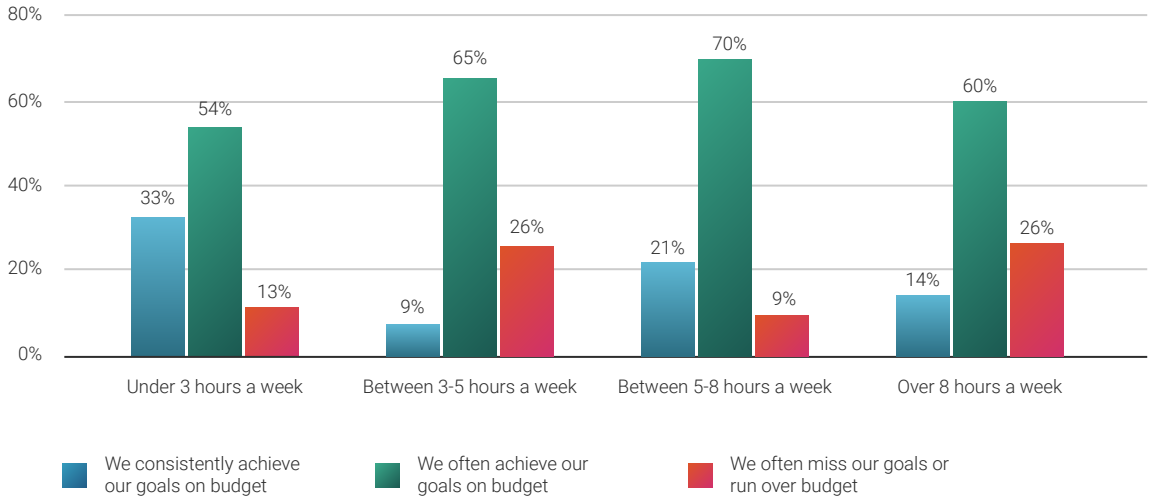
Supercomputing - using the resources of a supercomputer to solve computational science & engineering problems. Supercomputers are typically owned and operated by large government research institutions, given their cost.

As a new discipline, “Computational Science & Engineering” (CSE) can sometimes be confused with other terms describing very different concepts.

Here is a non-exhaustive set of terms that are related to (but are different from) CSE.

Collaboration & automation tools facilitate innovation velocity

Project success probability based on research time spent on non-R&D tasks



R&D leaders know that researchers spend a significant fraction of their time on non-research related tasks (e.g., finding lost files, setting up infrastructures). But the impact of this non-R&D time on project success is not well understood.

Organizations that can help researchers focus their time on R&D are more than twice as likely to achieve project goals consistently.

The State of Practice

- Computational science & engineering is being conducted in nearly every major industry
- While most workloads remain on premises, most organizations are also consistently using cloud
- Organizations employing computational science & engineering typically use several different software providers

Profiles in Innovation

VERTICAL

Pioneering urban air mobility with a focus on sustainability and efficiency

"Our Investments in digital R&D partners like Rescale ultimately helped us produce an aircraft that is 100x safer, 100x quieter, and at a fifth of the cost from what was previously possible."

Madhu Bhabuta
CIO, Vertical Aerospace

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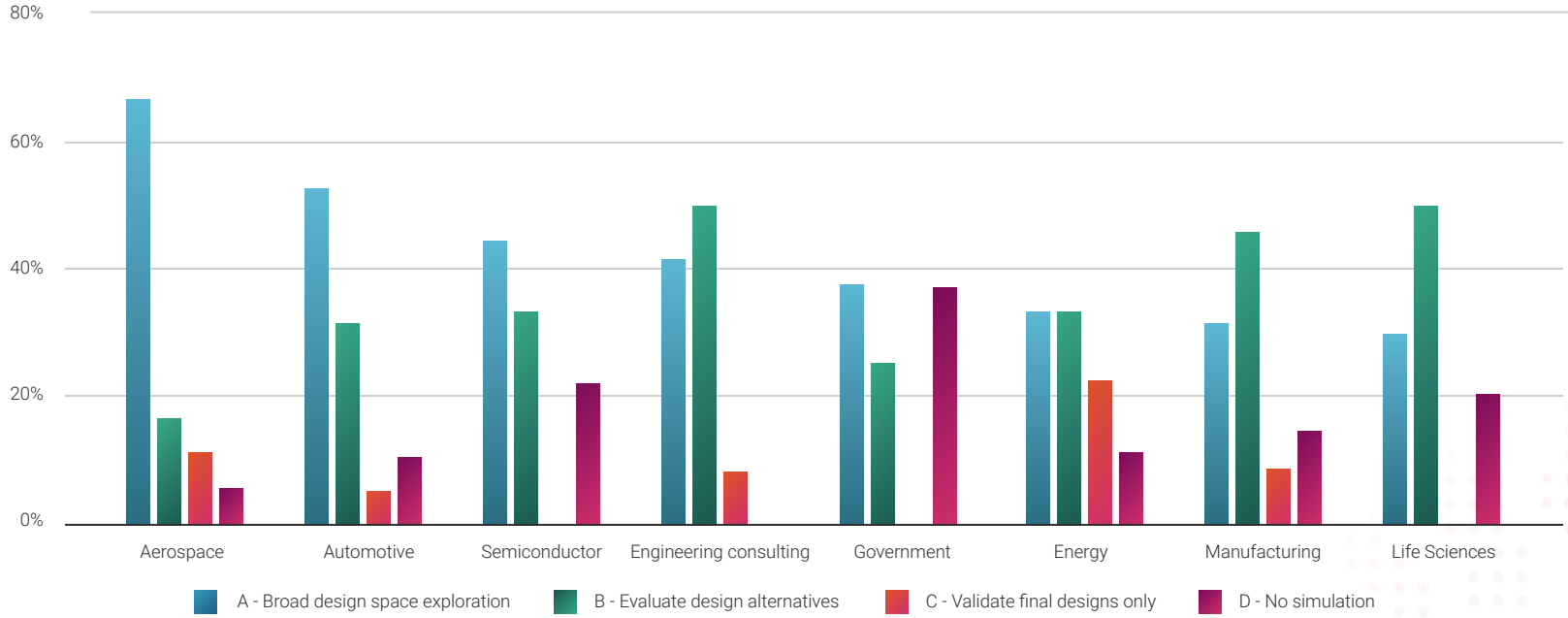
Computational engineering used in all industries, with varying degree

Aerospace and automotive industries lead in the use of computational engineering for full design space exploration (DSE). DSE is computing-intensive, but enables a comprehensive evaluation of a broad range of engineering design decisions.



Practitioner Sentiment

- As IT struggles to keep pace with R&D, both believe cloud is better suited to meet R&D demands
- As R&D transitions to an increasingly distributed working model, most believe improved automation would lead to better products
- Engineers believe collaboration tools and faster computing power are essential to their productivity

Profiles in Innovation

BENCHMARK space systems

Powering next-gen in-space mobility to service vehicles in orbit with safety, reliability, and efficiency

"With the Rescale platform, we have the flexibility to adapt our computational usage to a problem, a wide range of software options, easy licensing and setup, and an easy-to-use platform."

Chris Carella
EVP Business Development

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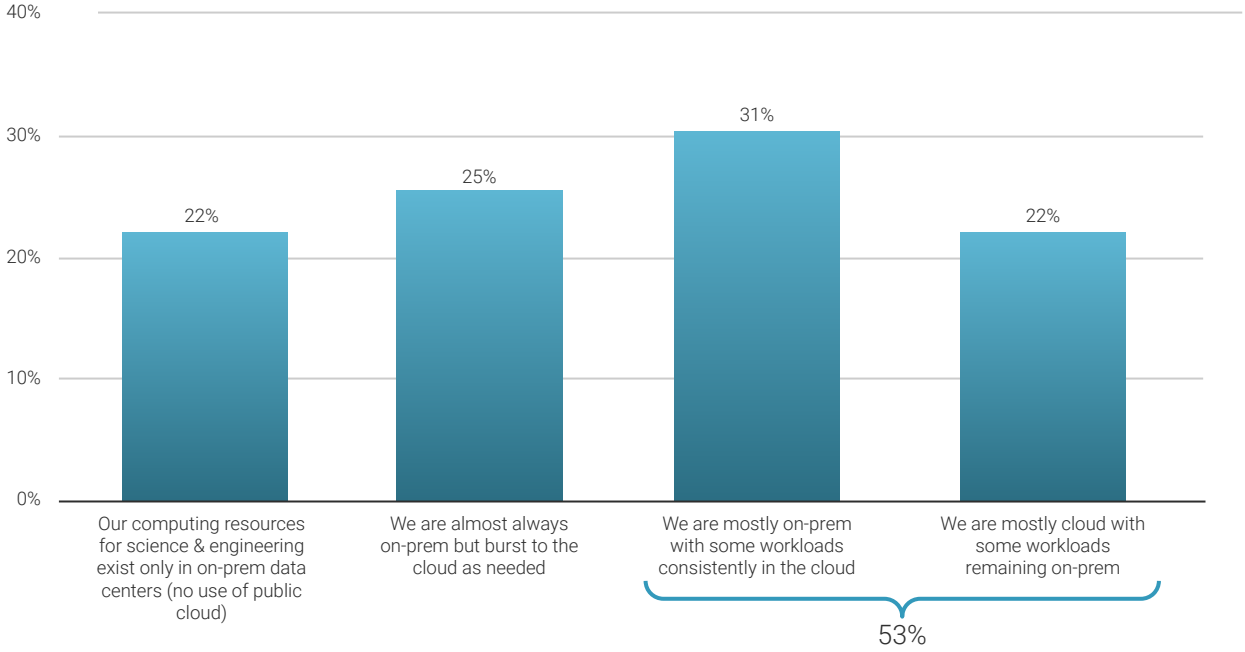
Majority of organizations use cloud consistently for science & engineering workloads

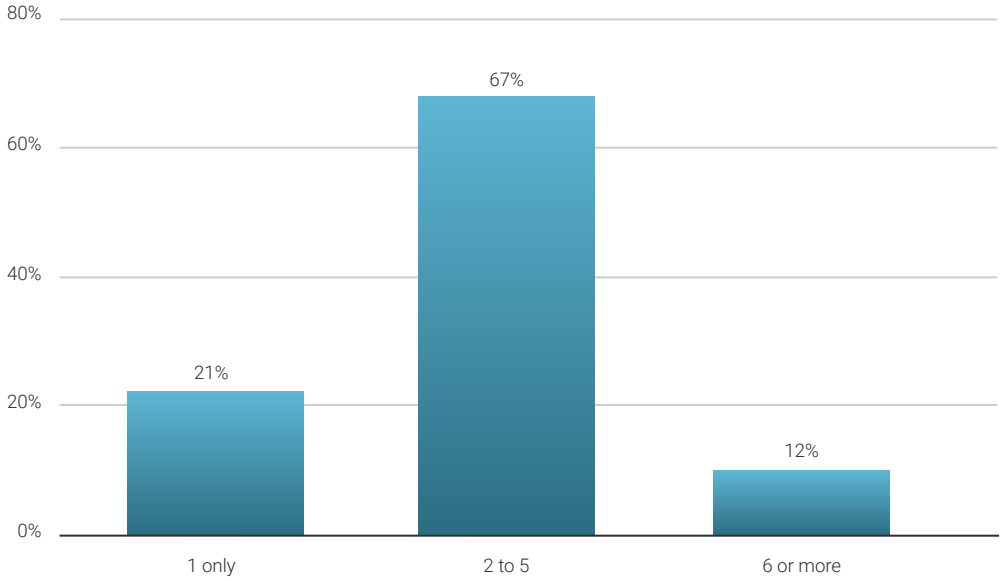
How would you describe your organization's adoption of cloud computing for engineering or scientific simulation?



While most organizations still primarily use on-prem infrastructure, over half (53%) use cloud consistently for science & engineering workloads

Engineering organizations rely on a broad set of software providers for their R&D needs

How many different simulation software products does your organization use? (including open source, commercial, or in-house developed simulation software)



Organizations employing computational science & engineering typically do so with several different software providers

The large number of applications used has implications for how organizations source and automate their engineering technology stack

How Computing Impacts Innovation Velocity

- Easy access to compute accelerates innovation velocity and improves probability of project success
- Easy access to compute correlated with the ability of an organization to tackle broader science & engineering challenges
- Organizations that use cloud automation platforms generally do so as part of a digital R&D strategy

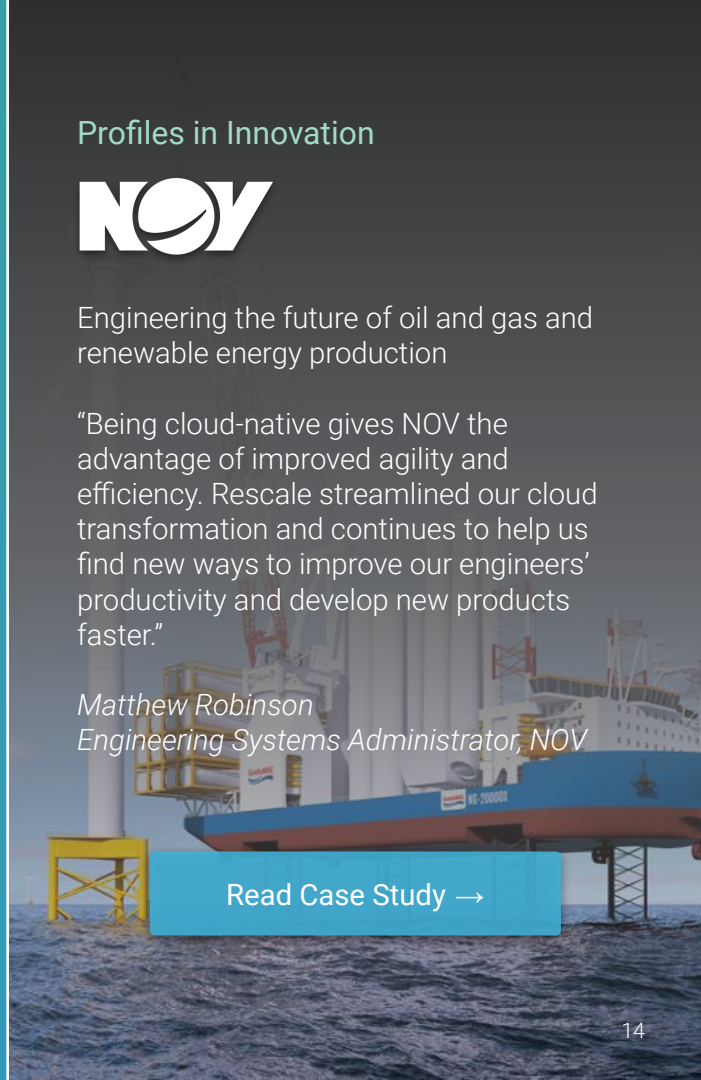
Profiles in Innovation

NOV

Engineering the future of oil and gas and renewable energy production

"Being cloud-native gives NOV the advantage of improved agility and efficiency. Rescale streamlined our cloud transformation and continues to help us find new ways to improve our engineers' productivity and develop new products faster."

Matthew Robinson
Engineering Systems Administrator, NOV



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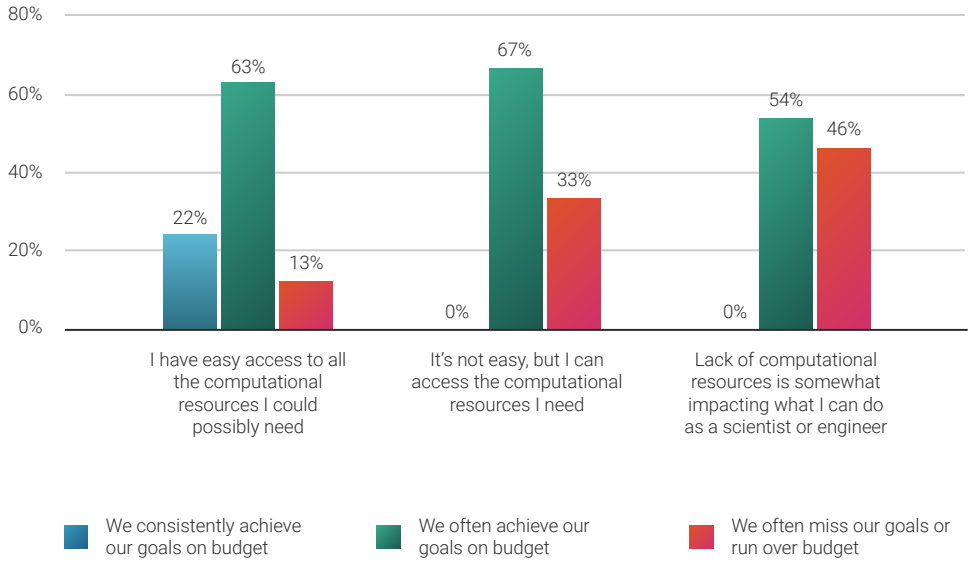
Easy access to computing at scale leads to faster innovation with more on-time and on-budget projects

Impact of computational tools on project success probability



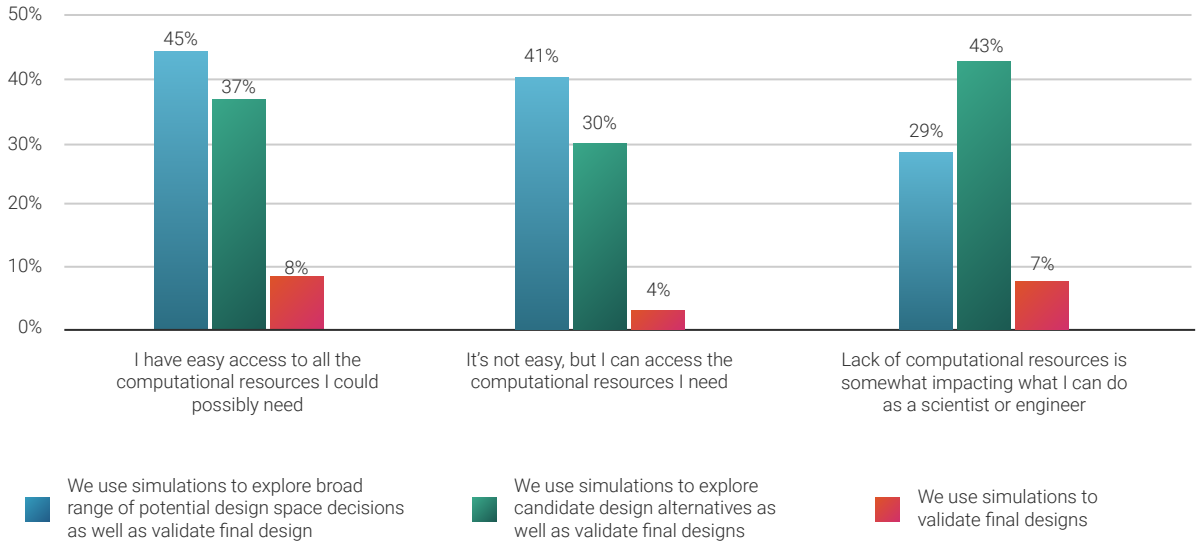
Organizations that provide easy access to compute are much likelier to consistently achieve project goals on budget.

Significantly, not having easy access to compute has nearly a similar effect of not providing compute at all.

Businesses that depend on new product innovation, but do not provide easy access to computing at scale, are likely leaving significant value on the table.

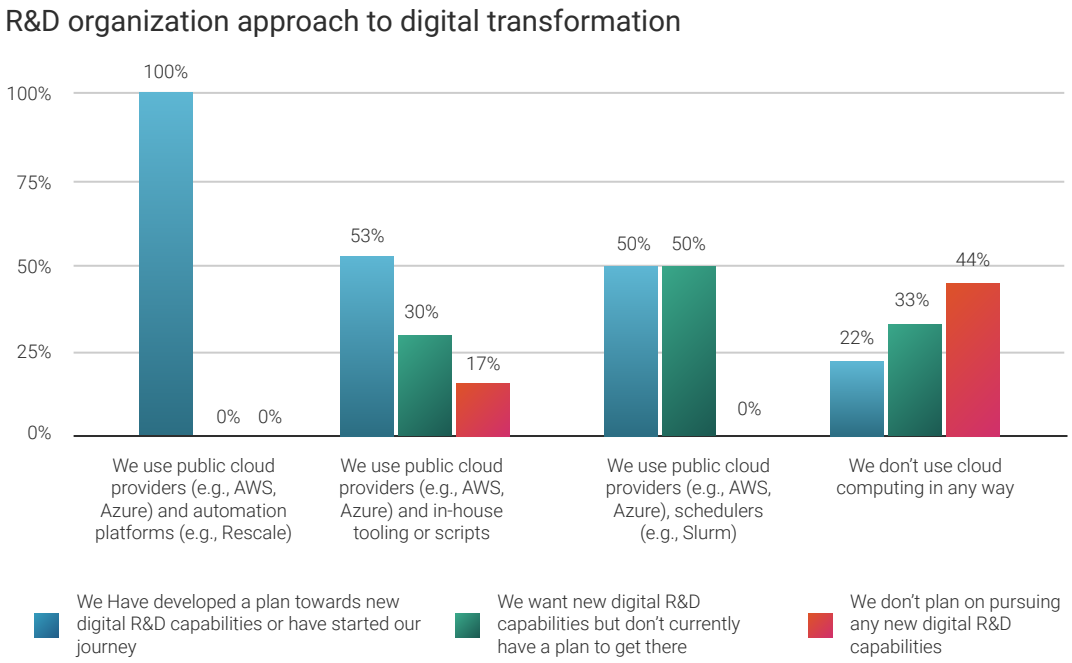
Organizations providing easy access to unlimited computing are tackling bigger science & engineering opportunities

Ease of computing access vs. computing simulation use



Using computing simulation to help determine the direction of new product innovations is more likely to occur at organizations where researchers have easy access to computational resources at scale.

Organizations that use cloud automation platforms generally do so as part of a digital R&D transformation strategy

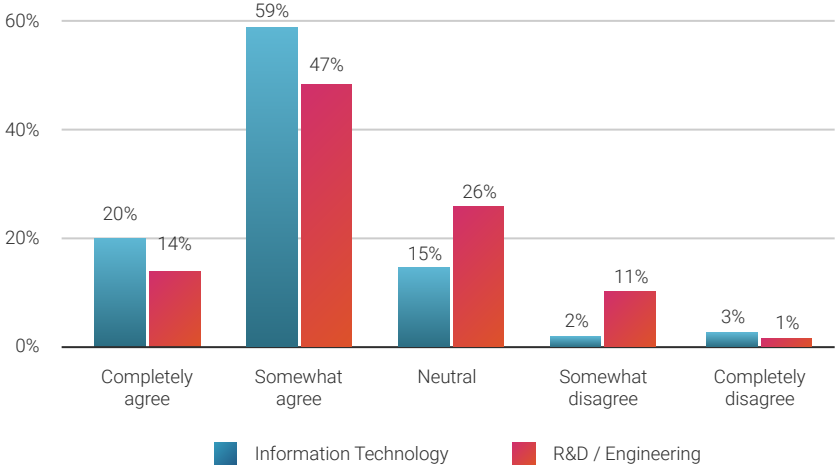


R&D organizations that do not use cloud generally do not see digital transformation as a priority.

Not surprisingly, R&D organizations adopting cloud with the use of an automation platform (e.g., Rescale), generally do so as part of a digital R&D transformation strategy.

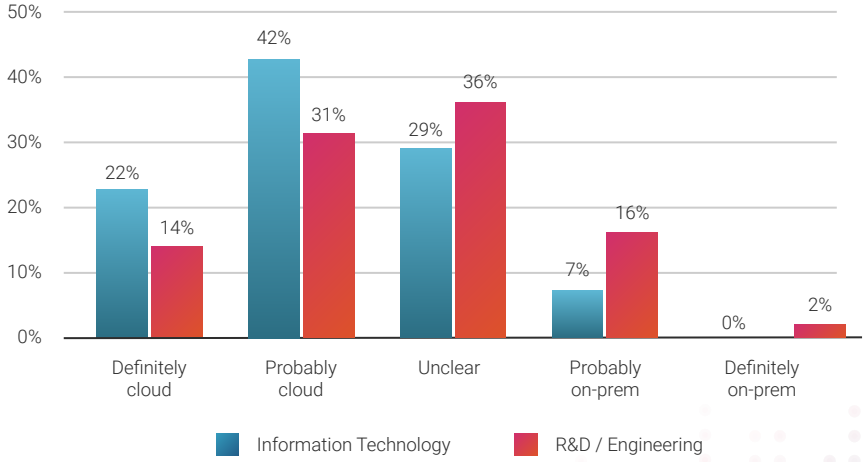
As IT struggles to keep pace with R&D, both believe cloud is better suited to meet R&D demands

IT infrastructure for engineers and researchers struggles to keep pace with product complexity and requirements



Surprisingly, IT/HPC orgs grade themselves more harshly than engineering orgs in assessing their ability to keep pace with engineering needs.

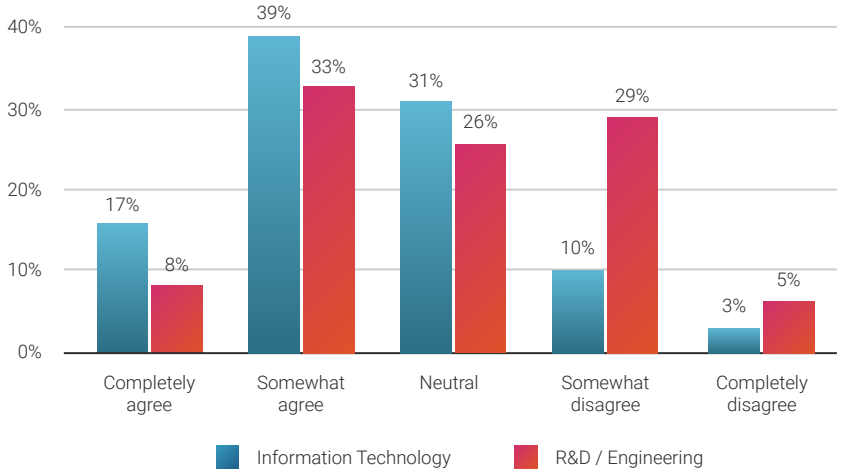
Is cloud or on-prem better suited to technically meet a variety of simulation and modeling demands?



Both IT and R&D generally see cloud as better suited for meeting computational science & engineering demands, with IT having stronger conviction in cloud.

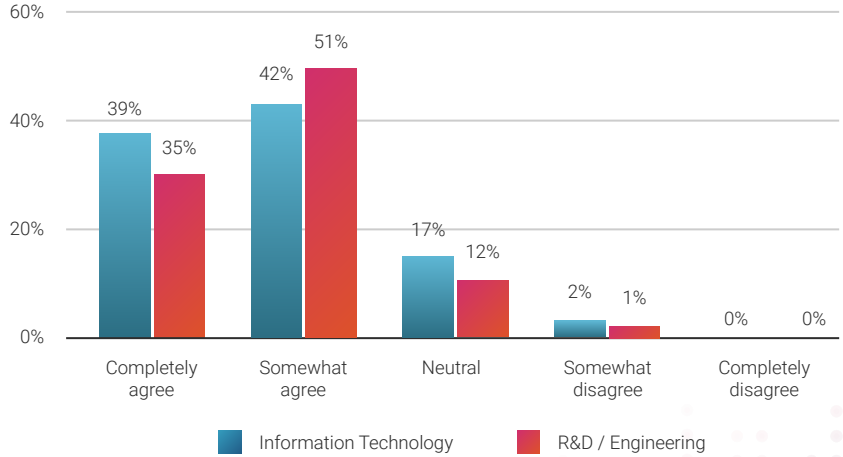
As R&D transitions to an increasingly distributed working model, most believe improved automation would lead to better products

IT infrastructure for engineers and researchers has not adapted for distributed working environments



R&D is generally neutral on whether IT infrastructure has adopted for today's distributed working environments, even as IT feels they have not sufficiently adopted.

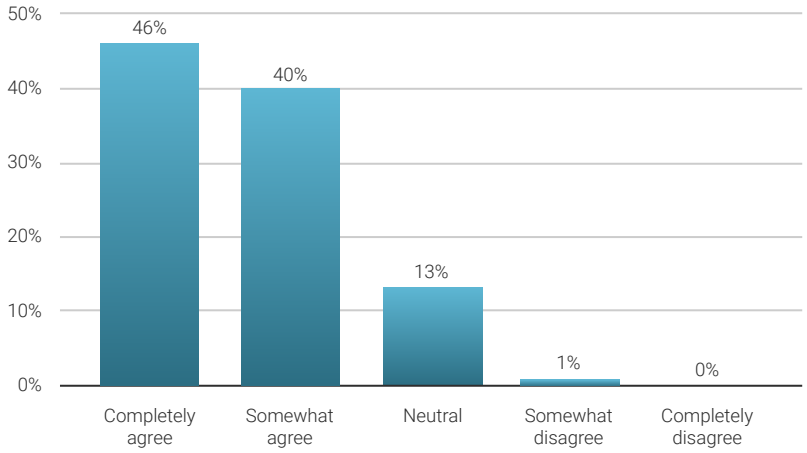
Being able to automate repetitive engineering tasks would significantly improve the quality of products delivered



Not surprisingly, many engineers (86%) believe they would be able to deliver better products with more automation of the tools they use.

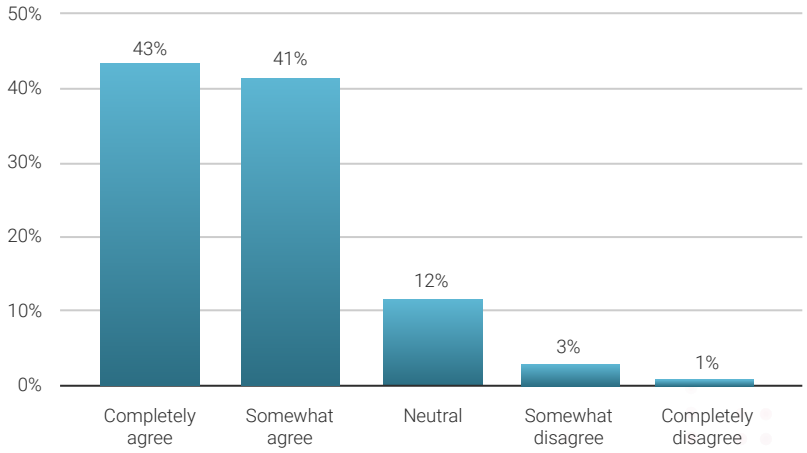
Engineers believe that collaboration tools and faster computing power are essential to enhancing productivity

Collaboration tools are essential to engineering productivity



Engineers agree that collaboration tools are essential to enhancing productivity.

Faster computation speeds increases engineering productivity



Since computational science & engineering rely on high performance computing, it is not surprising that many believe computing speeds impact productivity.

Future of Computational Engineering

- Practitioners predict strong growth in computational engineering and the number of engineering applications used
- As simulation complexity increases, machine learning will play an increasingly important role in product development
- As R&D technology budgets grow, common new tools adopted will include product lifecycle management & collaboration

Profiles in Innovation

AZothBio

Accelerating next-generation pharmaceutical drugs and vaccines using HPC and AI

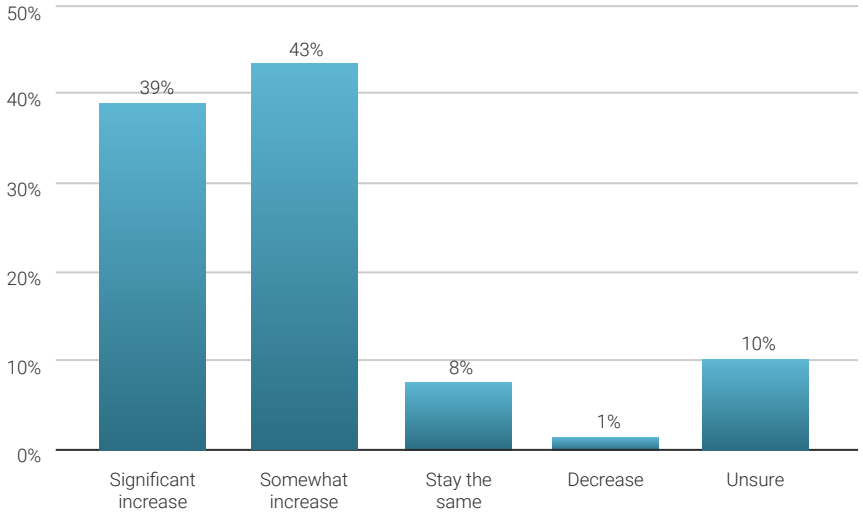
"Through Rescale, we were able to draw results more than 2x faster than our existing workflow, which helped us make better business decisions."

Jerry Maeng
Managing Director, AZothBio

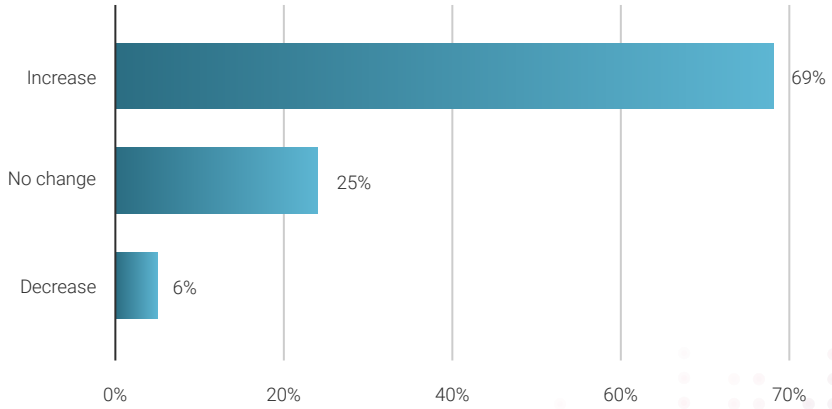
Read Case Study →

Practitioners predict strong growth in computational engineering and the number of engineering applications used

Future use of computational engineering in the next 5 years

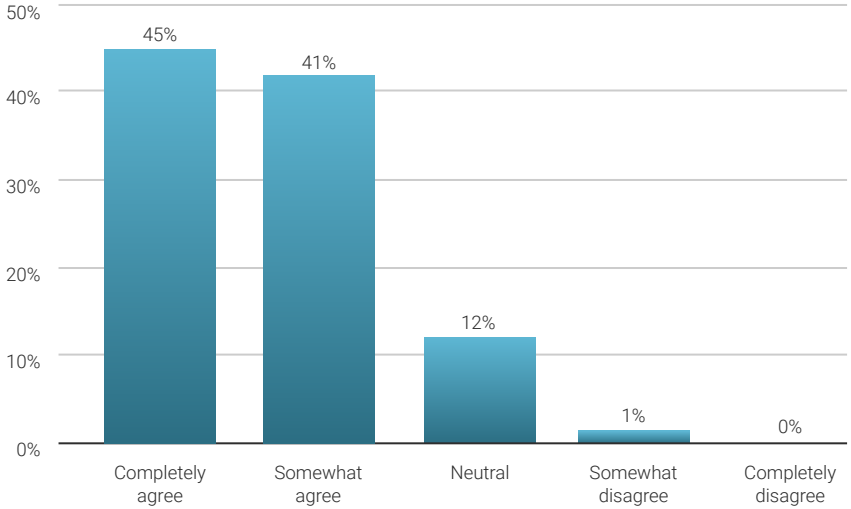


Expected change in number of engineering applications used

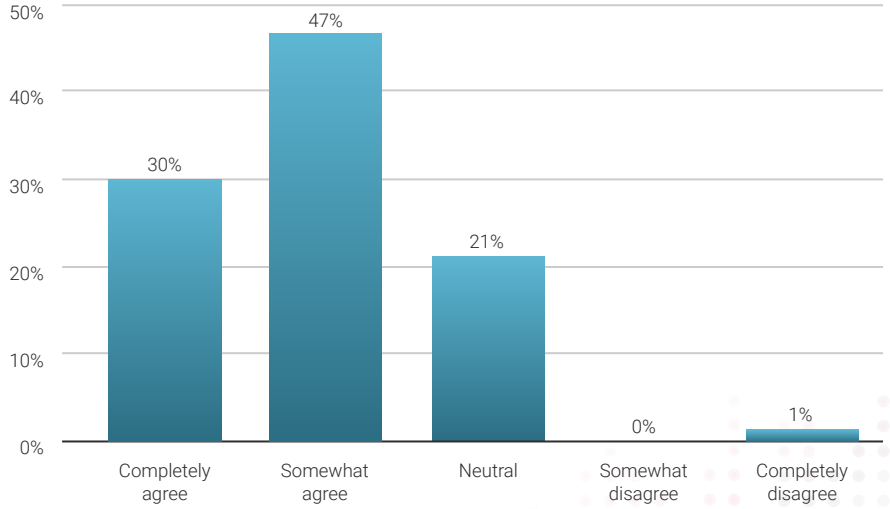


As simulation complexity increases, machine learning will play an increasingly important role in product development

Complexity of simulation and modeling will continue to increase

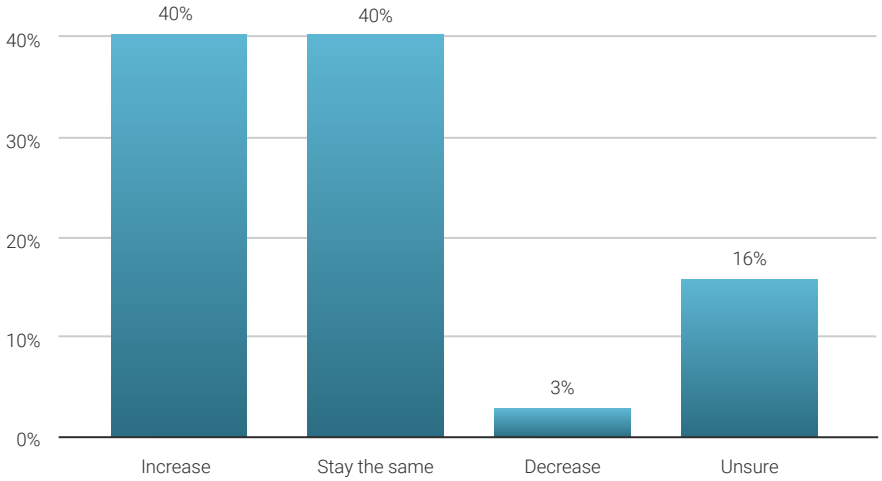


AI/ML will play an increasing role in prototyping and CAE

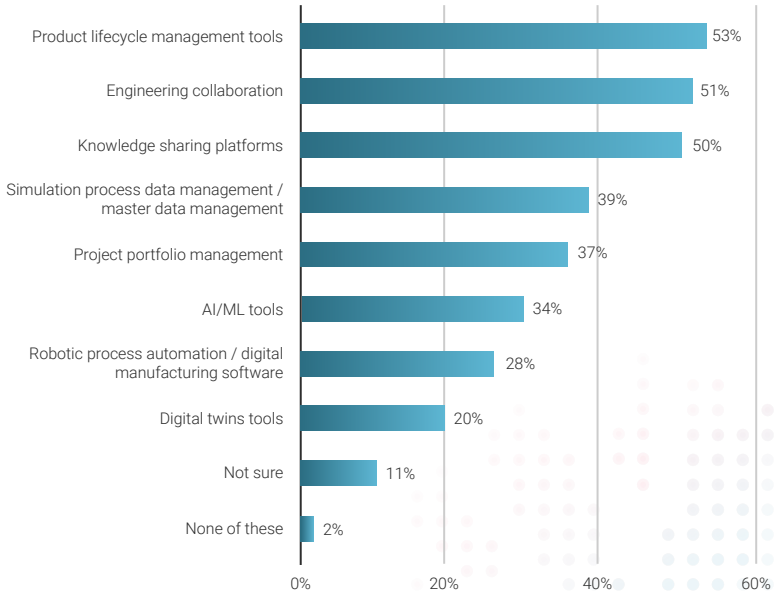


As R&D technology budgets grow, common new tools adopted will include product lifecycle management & collaboration

Expected change in future budgets



Digital tools respondents believe their company is or will be investing in the next 2 years



Conclusion

In this report, we have seen how computational science & engineering is now mainstream with adoption in every major industry. We have also seen a transition to cloud in full swing. For many organizations, navigating this cloud transition will require new skills, and automation tools to manage technology, spend, security, and compliance.

We have also seen that the transition to cloud drives significant business impact. Organizations that are able to give engineers easy access to compute at scale, are having more successful and on-budget projects. As cloud scale and ease of use become increasingly available in more organizations, we will undoubtedly see continued acceleration in science & engineering innovation.

About Rescale

Rescale is high performance computing built for the cloud to empower engineers while giving IT security and control. From supersonic jets to personalized medicine, industry leaders are bringing new product innovations to market with unprecedented speed and efficiency with Rescale, a cloud platform delivering intelligent full-stack automation and performance optimization. IT leaders use Rescale to deliver HPC-as-a-Service with a secure control plane to deliver any application, on any architecture, at any scale on their cloud of choice.

Learn more about high performance computing built for the cloud:


Get in touch with our team of experts


Start your free trial today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High Performance Computing Built for the Cloud

- Digital Engineering
- Workload Optimization
- Intelligent Automation
- Security & Compliance