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Solving Digital Engineering Challenges

Culture, Convergence, and Competencies

OCTOBER 2019

YouGov

ASME
SETTING THE STANDARD

EXECUTIVE SUMMARY

The American Society of Mechanical Engineers (ASME) for more than 100 years has been supporting mechanical engineering professionals and their respective industries through knowledge dissemination and the development of standards, educational products, and live events.

In continuing that support, ASME in early 2019 collaborated with YouGov and Strategic Business Intelligence to investigate the challenges engineers face as digital technologies transform industries aross the globe. Three major themes emerged from this study, in which more than 500 engineers worldwide were surveyed:

Culture: Communicating Throughout the Organization

- **Unclear Cost-Benefit.** C-suite executives do not clearly understand future benefits of digitalization, although they acknowledge the short-term negative impact on productivity, financial returns, and associated incentives.
- **MechE Mindset; Generational Differences.** Traditional, rigid guidelines among mechanical engineers prevent agility in moving toward a digital environment. Many engineers' discomfort with ambiguity prevents progress in this area. Earlier-career engineers, however, view engineering as a creative endeavor, with digitalization as a means to achieve their creative vision.
- **No Roadmap.** Leaders lack case studies, both good and bad, to assess implementation of digital methods. Who else has done this, and what were the results?
- **Perceived Hype.** Executives believe the benefits of analytics and AI have been oversold.
- **Miscommunication Across Internal Units.** IT, cybersecurity, and OT often speak different languages and have competing priorities.
- **Ethics.** Areas of concern include data privacy and cyber attacks.

Convergence: Solving the Interoperability Problem

- **Silos.** Data is difficult to integrate across systems within an organization.
- **Data Lakes.** Managing the rapidly increasing volume of data from varied sources remains a challenge.
- **Old vs. New Equipment.** Respondents noted an inability to integrate legacy systems and equipment with newer systems.
- **Data "Mine."** Endusers are reluctant to share data with OEMs. Data sensitivity, data ownership, IP, and legal issues impede analysis and progress among organizations.
- **Variability.** Lack of standardization in processes, equipment, and analysis prevents integration.

Competencies: Bridging Educational and Skills Gaps

Across industries, respondents agreed on four major areas where their engineering staff require specific competencies:

- Data management/Data analytics and web technology services
- Context of real-world manufacturing: hands-on experience to validate models
- Coding
- Digital engineering management: business efficiency

Education (K-12 & university) must be addressed to prepare the next generation of engineers, as experts anticipate that competencies in digitalization, such as coding, will be as integral to the mechanical engineering profession as heat transfer and fluids engineering.

SOLVING DIGITAL ENGINEERING CHALLENGES DEMANDS ATTENTION TO:

CULTURE

CONVERGENCE

COMPETENCIES

What Is Digital Engineering?

Digital Engineering is the development, use, and integration of digital processes, tools, and outputs across the life cycle of products and systems. Digital processes, tools, and outputs, with the benefits of data analytics and artificial intelligence, can help optimize products and systems by improving performance, security, safety, quality, and efficiency.

Study participants associated “digital engineering” with broader terms like data, 3D modeling, and software, and also included more niche verticals such as augmented and virtual reality, 3D printing, and advanced product simulation.

Introduction

More than 500 engineers surveyed in a recent ASME/YouGov/Strategic Business Intelligence study agree that although a digital transformation is happening, significant challenges exist as organizations implement new technologies with varying success.

The study revealed three major areas that impede effective implementation of digital technologies throughout industries: culture, convergence, and competencies.

Culture: Communicating Throughout the Organization

Overcoming cultural barriers was cited by respondents as major challenge when adopting new technologies. Often, mid-level managers and engineers drive the adoption of new technologies and encountered difficulties when communicating the benefits to those in the C-suite.

"You have about 10 minutes to get the attention of a CEO or senior manager. You've got to be able to provide an example of the impact," said a senior vice president from a US-based firm.

Short-Term Risk, Long-Term Benefit

In addition, the short-term cost and risk associated with adopting a new technology may be clear to a decision maker; the longer-term benefits often are not so apparent. Said one vice president from a sensor manufacturer:

"What I struggled with in conversations with C-Suite management is that this is a 5- to 10- to 20-year evolution, and a lot of public companies think in terms of hitting the quarter and the year. So one of the barriers is a commitment to that transformation, because it's a completely different way of working."

If It's Not Broken....

A senior executive in the oil and gas industry added, "Our PLM system has been in place for four years...operating in a certain way for years, and [we've] delivered products, with profit to customer satisfaction to the level of quality required. Why change? So the immediate challenges are convincing people of that long-term vision."

Mapping the Way Forward

Respondents noted that roadmaps and case studies may help guide conversations across company hierarchy. As one study participant said, "Case studies are important....Because the bottom line is, all of these tools are really great, but you need to be able to tell them what it's going do to their business and the bottom line."

The MechE Mindset

The current method of delivering projects is document-centric. A document is created and distributed, team members pass it around, and they add their own parts. Although most engineers are comfortable with this long-standing method of teamwork, the process has become increasingly inefficient. Future teams will be data-centric. Instead of measuring the progress of a project by the number of reports and drawings produced, teams will instead focus on how much data has been gathered and analyzed.

"A barrier is how we set up our teams and the way we actually do our work. That hasn't really evolved much in the last 20 or 30 years. In engineering, people are still printing out a 2D drawing and handing that to somebody else....[To] adopt these technologies and get to the real benefits, we have to fundamentally rethink how we work, and nobody is finding that easy to grapple with," said one director of digital engineering based in the UK.

The evolution from a document-based approach to data-centered systems encroaches on the next major theme that emerged during the study: interoperability

Convergence: Solving the Interoperability Problem

Old Equipment vs. New Capabilities

Many manufacturers possess assets more than 20 years old. The modernization of those assets, the ability to retrieve the underlying data, and then connect those systems with new ones remains a significant challenge.

"The biggest barrier we found in the factory was what we call a brownfield--equipment that's 10 to 20 years old. Unless you can connect the machines and get the data, all the machine learning and AI don't mean anything. It's useless without interoperability and connectedness" said one senior vice president.

A head of digital engineering for a Germany-based manufacturer added, "Integration is the most important thing right now in the digital factory – the integration of the business functions to the technical functions, like the SAP system with the PLM system."

Data Lakes

And the difficulties in achieving interoperability and data integration are exacerbated by the sheer volume of data from different sources.

"You have a complex product and have to link fluid data with acoustic data, with thermal data, with mechanical data. You have validation and testing. The integration of the data is key. It is also complex and takes time. The rate of change of the data complexity has proven to be much higher than the rate of change of the systems and the processes that support the data integration," noted one Switzerland-based digital engineering consultant.

Data "Mine"

Concerns over IP, data sharing, and data privacy prevent large companies from sharing information with smaller companies and solution providers. But ultimately, data—even if anonymized--needs to be shared to develop solutions to allow systems to operate more efficiently across platforms.

The Standardization Solution

One of the crucial areas engineers could benefit most from is understanding model-based enterprise (MBE) standards. Thirty-two percent of engineers said "effectively using data" is one of their biggest day-to-day issues and 30 percent say the same for "the challenge of having multiple, internal systems 'talk' to each other."

MBE stands to help solve many of these challenges by creating a cohesive system for the use of data. As one mid-career engineer in the transportation industry said: "We have been using a lot of tools, different processes, but I think digital engineering is trying to combine everything, and using other technologies, like analytics and artificial intelligence, to improve the end-to-end lifecycle of an engineering system. I think that's the whole plan for this."

32% *of engineers said*

"using data in an effective way" is a one of their biggest day-to-day issues and 30% say the same for "the challenge of having multiple, internal systems 'talk' to each other"

Competencies: Bridging Educational and Skills Gaps

The Virtual vs. Physical Worlds

Respondents noted a particular need to bridge the divide between academia and industry. In many cases, students are learning about digital technologies like 3D printing without a grounding in practical experience. As one professor from Ohio said, “We have too many students who are learning all about 3D printing without having any background in traditional manufacturing. They are woefully lacking in context and understanding the broader traditional manufacturing capabilities and limitations. We are graduating mechanical engineers who’ve never run a machine. They can design something and understand the theory, but they have no idea how this thing actually gets made and no idea that it can’t get made.”

But proficiency in the virtual world remains a required skill for the current and future workforce. Data analytics and coding—and an understanding of how these skills will impact overall business efficiency—are areas where engineers must be proficient, according to respondents.

Engineers are aware that digitization is expanding the scope of their roles. As one mid-career engineer pointed out, future engineers will need to cross different disciplines to design products.

Multidisciplinary Engineers

“There’s no such thing as the mechanical engineer anymore,” said one mid-career engineer. “I don’t know anyone who’s developed something purely mechanical; it’s going to be integrated with electronic components. And for material selection and environmental, you’re looking at recyclability. So you’ve got chemical engineering that’s coming in. You’ve got materials engineering that’s coming in. And all of that needs to be combined rapidly in the development process.”

The need to understand how multiple engineering disciplines work with each other leads to an educational opportunity. Forty-eight percent of engineers say they would most benefit from training outside of the core areas in which they are experienced.

48% *of engineers*

say they would most benefit from training outside of the core areas in which they are experienced

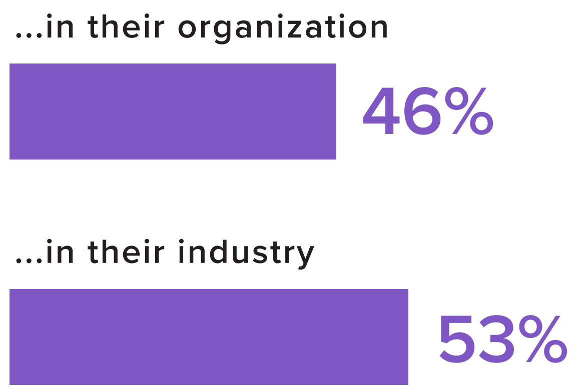
What Does the Future Hold?

The future of digital engineering and multidisciplinary engineering are intertwined. As one late-career engineer in the discrete products production industry said, the purpose of digital engineering "is integrating the different disciplines and providing a platform for that cohesive communication."

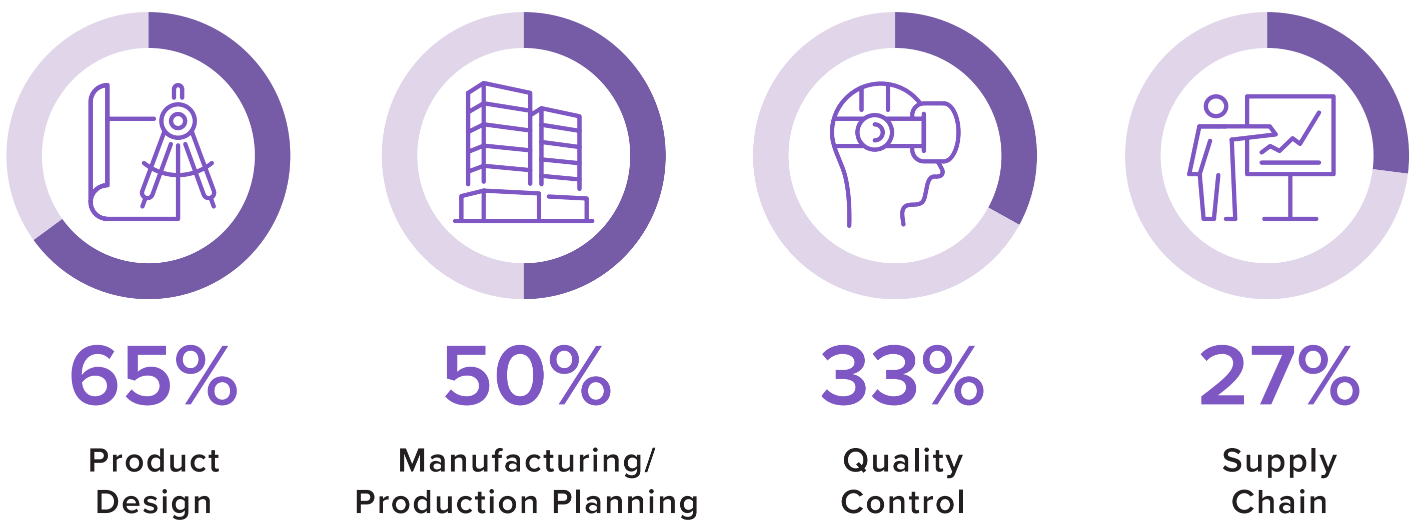
Forty-six percent of engineers say elements of digital engineering are being used to a significant degree in their organization, and 53 percent say the same of their industry. Furthermore, they report that their organization has the most advanced digital engineering capabilities in the areas of product design, at 65 percent, and manufacturing/production planning, at 50 percent.

Ultimately, the future will be determined on how well the different practices and technologies of digital engineering can be mainstreamed into a unified structured paradigm.

PERCENT OF ENGINEERS WHO SAY ELEMENTS OF DIGITAL ENGINEERING ARE USED TO A SIGNIFICANT DEGREE...



ASPECTS OF ORGANIZATION WITH THE MOST ADVANCED DIGITAL ENGINEERING CAPABILITIES



About the Study

To understand current practices and attitudes around digital engineering, the American Society of Mechanical Engineers (ASME) recently commissioned Strategic Business Intelligence, Inc. (SBI) and YouGov, an international market research and data analytics firm to conduct market research. SBI led Phase I of the research, gathering insights in telephone interviews from a wide range of sources from academia, government, industry, think tanks, and standards developing organizations (SDOs). Insights were gathered from 45 individuals, and ASME was identified as the source of the research. For Phase II of the research YouGov conducted three focus groups with 16 engineers. Two quantitative online surveys were also commissioned, one before the focus groups and one after, among 300 and 200 engineers, respectively. All engineers were sourced from YouGov's B2B panel and were required to work in a producing, distribution, or service industry. Participants of Phase II did not know that ASME was the sponsor of the research.

ABOUT ASME

ASME is a not-for-profit membership organization that enables collaboration, knowledge sharing, career enrichment, and skills development across all engineering disciplines, toward a goal of helping the global engineering community develop solutions to benefit lives and livelihoods. Founded in 1880 by a small group of leading industrialists, ASME has grown through the decades to include more than 100,000 members in 140+ countries. Thirty-two thousand of these members are students.

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