The impact of AI on product design and engineering

Signals Report – Manufacturing Spotlight

July 2025

Why read this paper?

Design and engineering–the critical phase in the manufacturing value chain where ideas are translated into product concepts and detailed designs, tested against requirements, and prepared for production–is undergoing radical transformation. Companies are increasingly simulating designs in the cloud and using AI to enhance design quality and efficiency.

This paper explores how manufacturers are adapting to these changes, what they are prioritizing, and why. It also highlights the growing role of shift-left practices and modern software engineering processes in reshaping traditional design and engineering functions.

Key findings

1. **Product design is shifting "left," driven by the use of simulation.**
59% of firms are using simulation in their product design today. 80% of the firms have already identified toolchains across their engineering workflows to scale shift-left practices–a process philosophy focused on bringing downstream activities such as simulation, validation, and compliance earlier in the product development cycle.

2. **Product lifecycle management continues to move to the cloud.**
20% of organizations have already moved and 63% plan to move PLM workloads to the cloud in the coming 3 years. As the data backbone for design and engineering, PLM serves as a single source of truth, offering real-time access, strong security, and version control.

3. **AI integration is coming.**
87% of respondents expect AI to be embedded into core engineering platforms like CAD and PLM. This is because of AI's ability to automate design tasks, recognize CAD features, and streamline engineering documentation and requirements generation in PLM using LLMs.

4. **Digital thread gaining steady momentum.**
Design and engineering tools are steadily advancing toward real-time integration through a connected digital thread, with growing momentum especially in mechanical CAD (MCAD) and simulation tool integration. However, misalignment of BOM across PLM, ERP, and MES is stated as a significant issue by 31% of the respondents.

5. **Software lifecycle management is becoming a crucial aspect of product design and engineering.**
Aligning software development with traditional engineering disciplines is gaining importance across the full product development lifecycle, with 58% reporting alignment between software sprints and hardware milestones. However, software-hardware collaboration is still hindered, not only by technical issues but also by organizational and process-related issues. Notably, 31% cite lack of shared traceability systems for requirements, tasks, and tests as a key barrier.

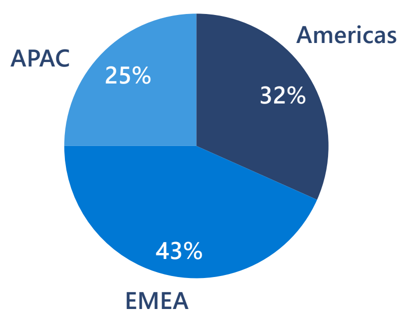
Scope of this report

This report offers insights into the design and engineering processes of discrete manufacturers (including OEMs and component suppliers of mechanical, electrical, plastic, rubber parts) across automotive, machinery & equipment, aerospace, computer, electronic & optical products manufacturing, electrical equipment manufacturing, other transportation equipment manufacturing, and medical devices manufacturing industries.

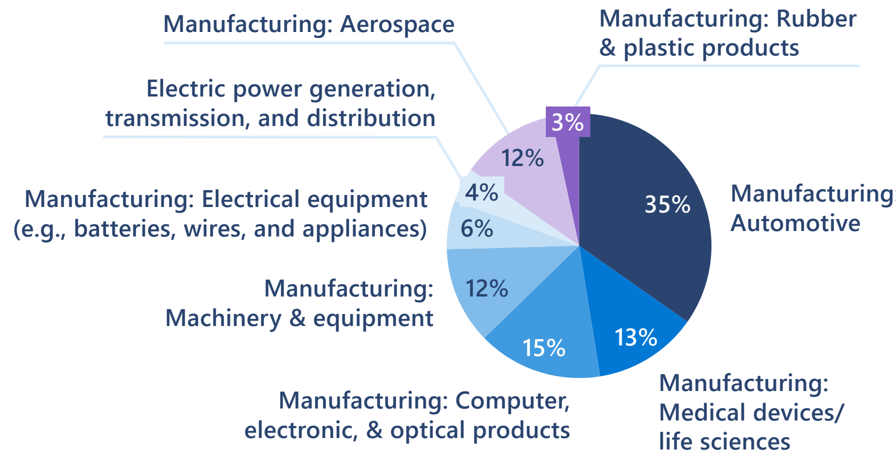
About the data: Survey of 120 executives in design and engineering

Overview of participants (N = 120)

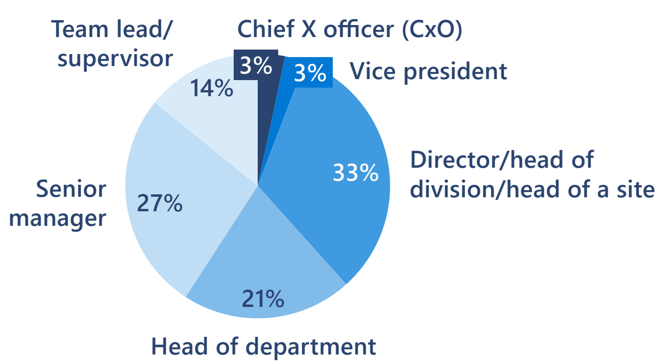
Region breakdown



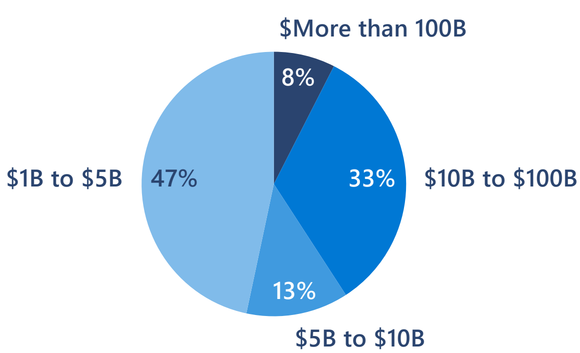
Industry breakdown



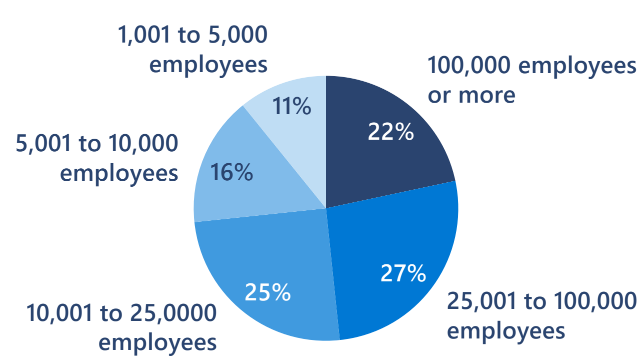
Seniority breakdown



Revenue breakdown



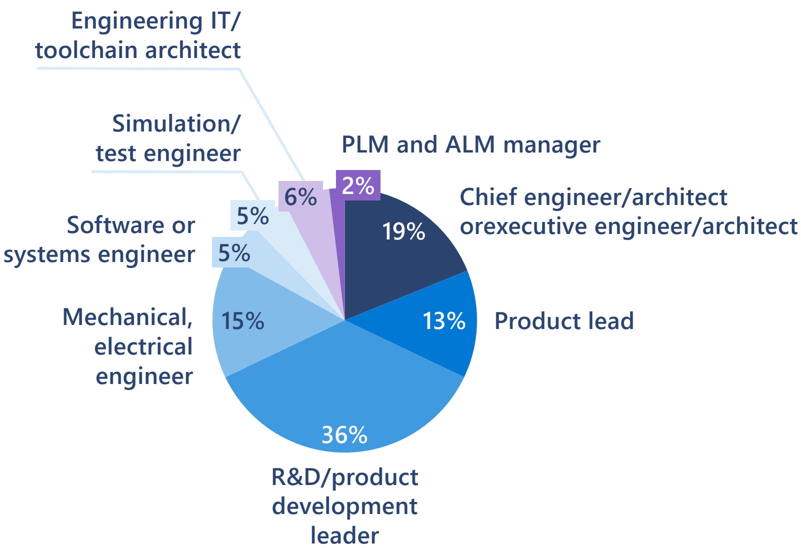
Size breakdown



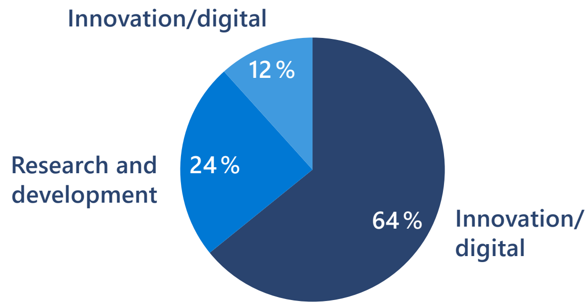
About the data: Survey of 120 executives in design and engineering

Overview of participants (N = 120)

Role in engineering and design breakdown



Department breakdown



Microsoft

Table of contents

Methodology

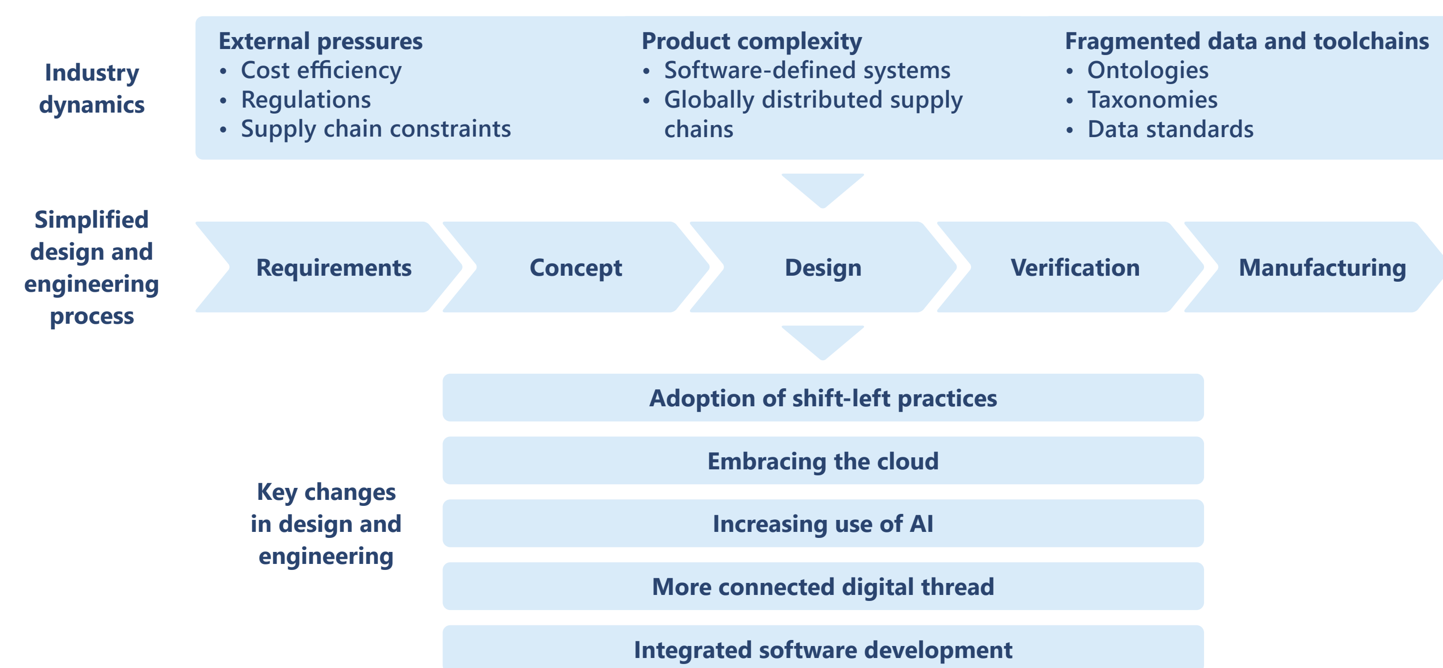
Microsoft developed this document in close collaboration with IoT Analytics, a boutique market research company focusing on IoT, AI, the cloud, edge technology, and Industry 4.0.

The centerpiece of this research is a survey conducted in May and June 2025, with a total of 120 respondents working in the design and engineering field worldwide. The respondents are key stakeholders in R&D, spanning roles in design, engineering, and technology/digital initiatives. The survey respondents represent a diverse cross-section of discrete manufacturers, covering OEMs and component suppliers across diverse manufacturing industries. Geographically, the respondents are primarily from Europe, North America, and Asia-Pacific, and they work for companies ranging from mid-sized enterprises to large multinationals, including those with over 100,000 employees.

Introduction: current state of design and engineering

Design and engineering (D&E) is a critical phase in the manufacturing value chain where ideas are translated into product concepts and detailed designs, tested against requirements, and prepared for production. D&E organizations today face mounting pressure to deliver faster, smarter, and more integrated solutions in an era of rising product complexity, software-defined systems, and globally distributed supply chains. The biggest shift in recent years has been toward harmonizing fragmented toolchains, ontologies, taxonomies, and data standards across autonomous business units without overburdening engineering teams. Key external pressures such as cost efficiency, regulations, and supply chain constraints are adding to this changing landscape. As companies adjust to these new realities with the latest technologies, five changes in the design and engineering landscape are visible:

1. **Companies are adopting shift-left practices.** Key design and engineering activities are introduced earlier in the development process. (See chapter 1)
2. **Companies are embracing the cloud.** Cloud-native architectures are enabling flexible deployment of PLM and other engineering software. (See chapter 2)
3. **AI is increasingly used.** AI is set to become a standard feature in core engineering platforms, driven by the growing adoption of generative AI (GenAI) and agentic AI solutions. (See chapter 3)
4. **Developing a more connected digital thread.** The use of standardized APIs, open data formats, and common data models across R&D disciplines is enabling a more seamless digital thread. (See chapter 4)
5. **Software development integration with traditional engineering.** Software development is no longer a parallel track; it is being integrated alongside mechanical and electrical domains, demanding tighter coordination, DevOps adoption, and enterprise-wide platforms. (See chapter 5)



1 The shift-left

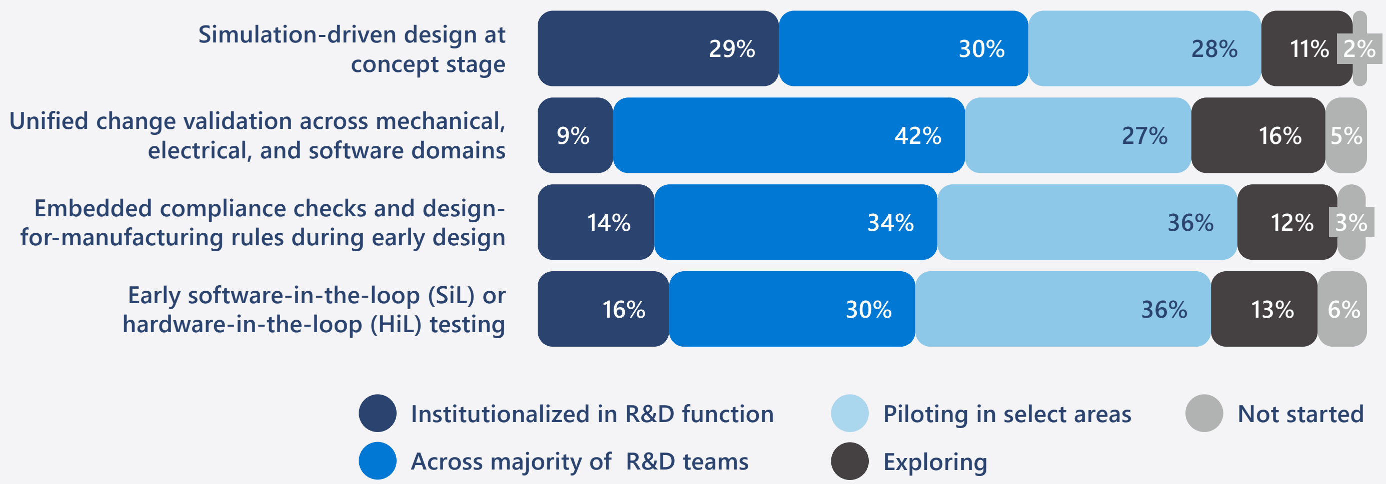
- **Simulation drives shift-left:** Simulation-driven design is the most widely adopted shift-left practice, especially among large enterprises and in the machinery & equipment sector.
- **Core design teams benefit:** Mechanical, electrical, and simulation teams report the greatest impact from shift-left–up to 78% see measurable improvements, with 37% calling it game-changing.
- **Early engineering and design data sharing:** 76% say shift-left helps align engineering constraints and design requirements early, reducing downstream issues and improving cross-functional integration.
- **Integration gaps hindering scaling shift-left:** While 80% have identified toolchains to scale shift-left, lack of shared models and CAD-PLM integration remain key friction points, especially in Asia.

Current maturity of shift-left adoption

Simulation-driven design is the leading shift-left practice.

Simulation-driven design is the most widely adopted shift-left practice, with 29% of organizations having institutionalized it within their R&D functions and another 30% applying it across the majority of their R&D teams. Notably, European companies lead in adoption (69%), outpacing their American (53%) and Asian (50%) counterparts. Among industries, the machinery & equipment sector is at the forefront of this shift. Interestingly, company size appears to be a significant factor–while only 47% of smaller firms report successful implementation, the figure rises to 72% among organizations with over 25,000 employees, indicating that larger enterprises may be better equipped to operationalize simulation-driven approaches early in the product development process.

Exhibit 1: **Shift-left engineering adoption maturity**



Question: How far has your organization progressed in adopting shift-left engineering practices—moving activities like simulation, validation, compliance, and software testing earlier in the product development process?

> "We're trying to catch engineering issues that gets reported downstream much earlier in the process–right at the design stage. And you can only do that with a robust model-based approach, because once it goes to production, fixing these issues is 10x more expensive."
>
> —Senior engineering manager, materials process & physics at a leading aerospace manufacturer

The beneficiaries of shift-left

Mechanical, electrical, and simulation teams see the strongest gains from shift-left.

The biggest beneficiaries of shift-left engineering practices are clearly the mechanical and electrical design teams, with 78% of respondents citing measurable improvements. This is closely followed by simulation and validation teams, where 75% report benefits–notably, 37% describe the impact as game-changing. Once again, European companies lead in realizing the value of shift-left approaches. Across industries, automotive design and simulation teams stand out in their ability to leverage these practices more effectively than their peers in other sectors.

Exhibit 2: Biggest beneficiaries of shift-left practices

Share of respondents in each segment who believe shift-left practices are "Game changing" or have "Significant benefit" in each R&D domain

Segment	Region				Industry					Company	
R&D domain	Overall	EMEA	Americas	APAC	Automotive	Aerospace	Machinery & equipment	Medical equipment	Computer & electronics	More than 25k employees	Less than 25k employees
Mechanical and electrical design	78%	95%	73%	68%	89%	71%	71%	57%	75%	90%	67%
Simulation and validation	75%	95%	59%	74%	84%	86%	57%	57%	50%	77%	73%
Testing and verification	67%	63%	55%	84%	58%	86%	71%	86%	50%	60%	73%
Systems engineering	62%	58%	59%	68%	63%	86%	29%	57%	63%	60%	63%
Embedded software & firmware development	60%	74%	45%	63%	53%	43%	86%	57%	63%	73%	47%
Product lifecycle management and configuration management	53%	42%	55%	63%	42%	43%	57%	86%	38%	53%	53%
Regulatory compliance and certification	45%	42%	41%	53%	32%	57%	43%	71%	50%	47%	43%

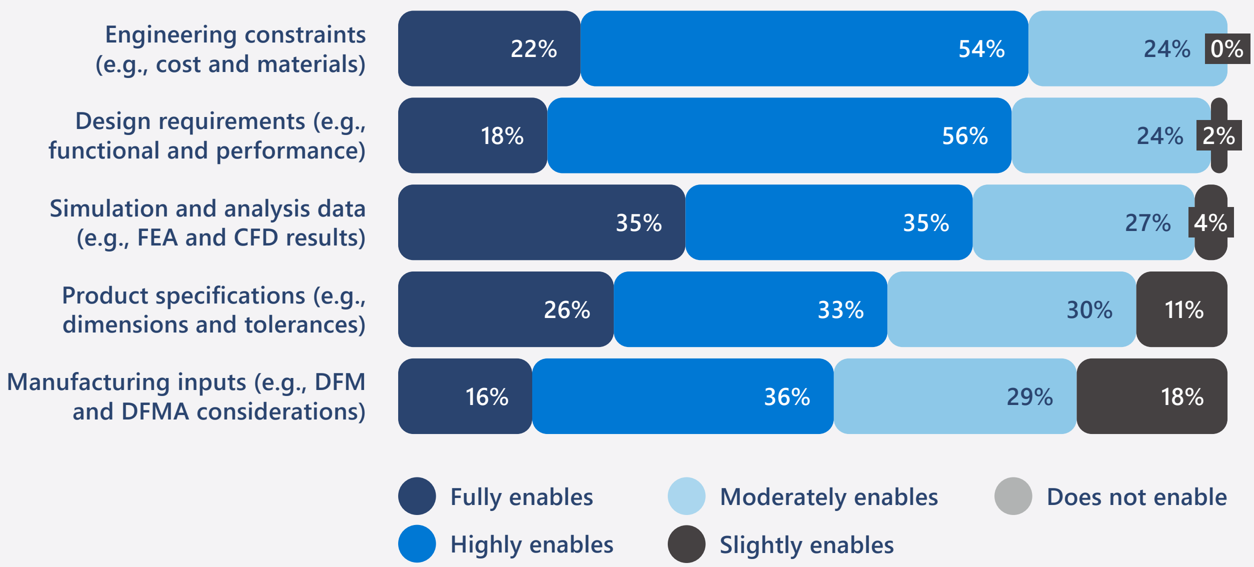
Question: To what extent do you believe shift-left practices (e.g., early simulation, validation, compliance modeling) are benefiting the following R&D domains in your organization?

Where shift-left has an impact

Shift-left accelerates early sharing of engineering constraints and design requirements.

Beyond domain-level gains, shift-left can also drive better cross-functional integration by enabling earlier data sharing and alignment. 76% of respondents report that shift-left practices highly enable early sharing of engineering constraints, such as cost and material specifications, followed by 74% saying shift-left enables early sharing of requirements to design, such as functional and performance requirements, preventing costly downstream issues. By industry, 86% of respondents in the automotive and aerospace sectors state that shift-left enables early sharing of design requirements. In comparison, 100% of medical device manufacturing industry respondents highlight the benefit of incorporating engineering constraints early on.

Exhibit 3: Types of data shared early through shift-left practices



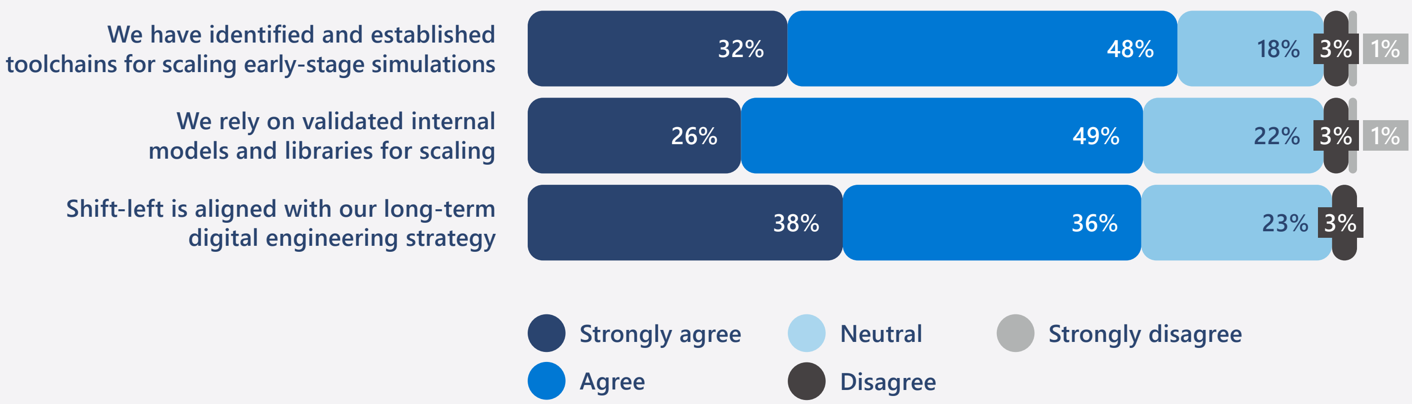
Question: To what extent do you believe shift-left practices (e.g., early simulation, validation, compliance modeling) are benefiting the following R&D domains in your organization?

Organization readiness

R&D teams are ready to scale shift-left using well-defined toolchains, supported by internal databases.

With benefits becoming clearer, the next big question is whether organizations are ready to scale these practices across R&D teams. While 80% of teams have already identified and established toolchains to scale shift-left practices across R&D, 75% of respondents also prefer relying on internal models and libraries for this purpose. Additionally, 74% indicate that shift-left initiatives are well-aligned with their organization's broader digital engineering strategy.

Exhibit 4: Scaling of shift-left practices across R&D activities



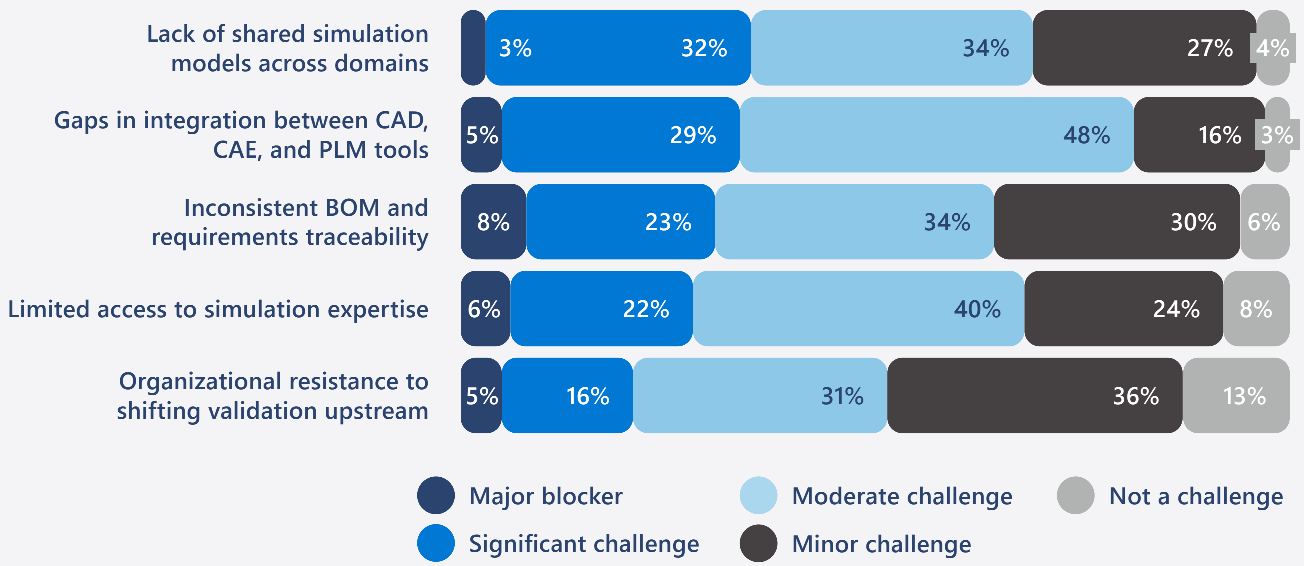
Question: How much do you agree with the following statements regarding your organization's readiness to scale early validation and simulation practices across engineering workflows?

Key challenges to shift-left implementation

Main hurdles are siloed simulation models and poor CAD–CAE–PLM integration.

However, scaling is not without its friction. Lack of shared simulation models across domains (35%) and gaps in integration between CAD, CAE, and PLM tools (34%) are the most significant barriers to adopting shift-left practices. Regionally, these barriers are slightly more prevalent in Asia (43%) compared to the Americas (29%) and Europe (31%).

Exhibit 5: Challenges in implementing shift-left practices



Question: To what extent would the following factors pose a challenge to implementing shift-left practices in your organization?

Understanding these barriers helps engineering leaders prioritize investments in tools and technologies like cloud and AI to scale shift-left successfully.

2 Cloud migration

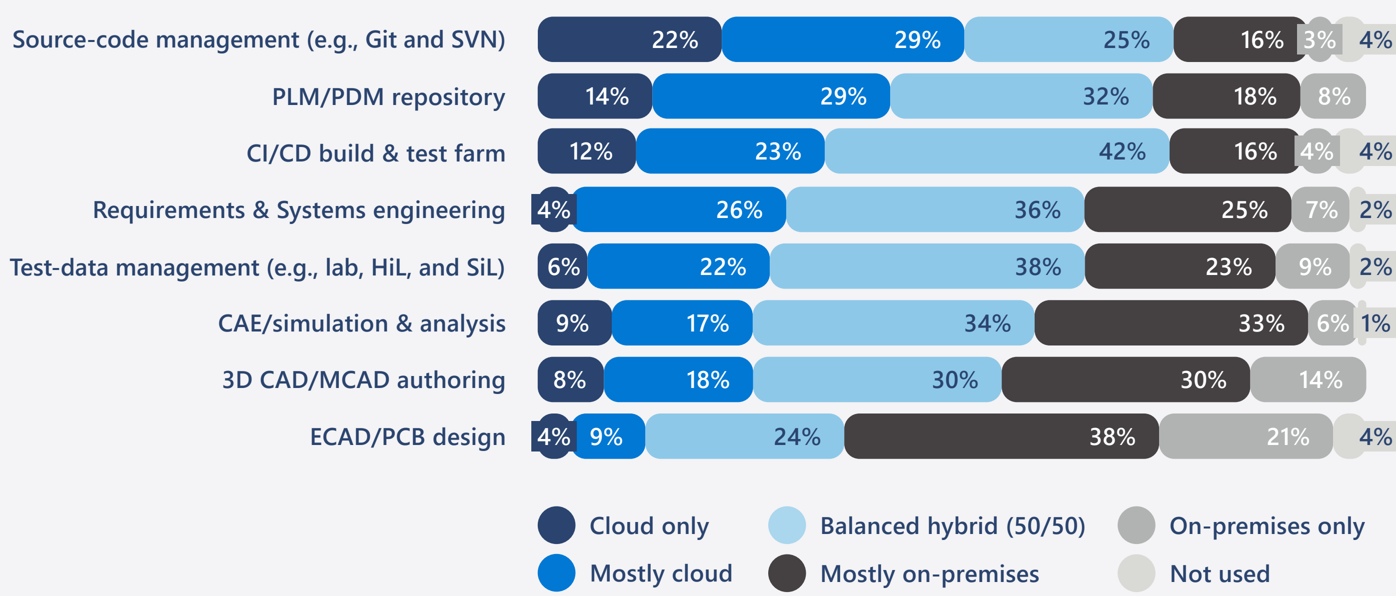
- **Cloud shift begins with PLM:** PLM and source code management tools are leading cloud adoption in engineering, driven by demand for version-controlled, collaborative workflows.
- **Simulation next in line:** Simulation and analysis workloads are the next targets for cloud migration, with growing interest across all regions.
- **Security drives cloud decisions:** Data security and compliance (82%) are top reasons for cloud adoption, outweighing collaboration or integration benefits.
- **IP and compliance concerns:** Key cloud adoption concerns include IP protection (45%), regulatory compliance (44%), and cost predictability (35%).

Current state of engineering toolchains deployment

Source code and PLM/PDM systems lead cloud adoption.

Among engineering toolchains, source code management platforms (51%) like Git, SVN, etc. and PLM/PDM repositories (43%) have emerged as the frontrunners in cloud deployment, signalling a clear preference for moving version-controlled, collaborative workflows online–while more complex systems such as CI/CD pipelines and others continue to rely heavily on hybrid or on-premises environments.

Exhibit 6: Current state of engineering toolchains deployment



Question: Which of the following best describes how each of the listed engineering toolchain components is deployed in your organization?

"Some control system validations need ultra-low latency and deterministic computing environments that current cloud infrastructures can't consistently provide. These are often tied to real hardware interactions and are best kept on local systems."

—Team lead, innovation for design, at a major Indian automotive company

Cloud migration roadmap

PLM leads as the top candidate for cloud migration.

With this deployment landscape in mind, organizations are thinking about the next phase of cloud adoption in engineering. PLM workloads are viewed as the most suitable candidates for cloud migration. 64% of respondents have either already moved PLM workloads to the cloud or expressed high interest in doing so. This is followed by simulation and analysis workloads, with 61% indicating similar cloud adoption trends. Regionally, 72% of respondents in Asia indicated this preference, followed by Europe at 68% and the Americas at 50%. By industry, medical equipment shows the highest preference for cloud deployment of PLM at 86%, while machinery and equipment has the lowest at 36%.

Exhibit 7: Migration of engineering workloads to cloud in the next 1–3 years

Share of respondents in each segment who have "Already adopted" or are "Very interested" in moving each workload to the cloud in the next 1–3 years

Segment	Region				Industry					Company	
R&D domain	Overall	EMEA	Americas	APAC	Automotive	Aerospace	Machinery & equipment	Medical equipment	Computer & electronics	More than 25k employees	Less than 25k employees
PLM	64%	68%	50%	72%	66%	62%	36%	86%	59%	61%	67%
Simulation and analysis	61%	68%	57%	55%	45%	62%	73%	79%	59%	67%	57%
Requirements and ALM tools	55%	54%	50%	62%	61%	77%	36%	57%	41%	61%	50%
Mechanical design (e.g., CAD and MCAD)	50%	54%	60%	34%	58%	38%	55%	29%	53%	59%	43%
Embedded software development	46%	46%	43%	48%	39%	54%	55%	36%	65%	43%	48%
Electrical and electronics design	36%	44%	43%	14%	42%	38%	36%	14%	41%	47%	26%

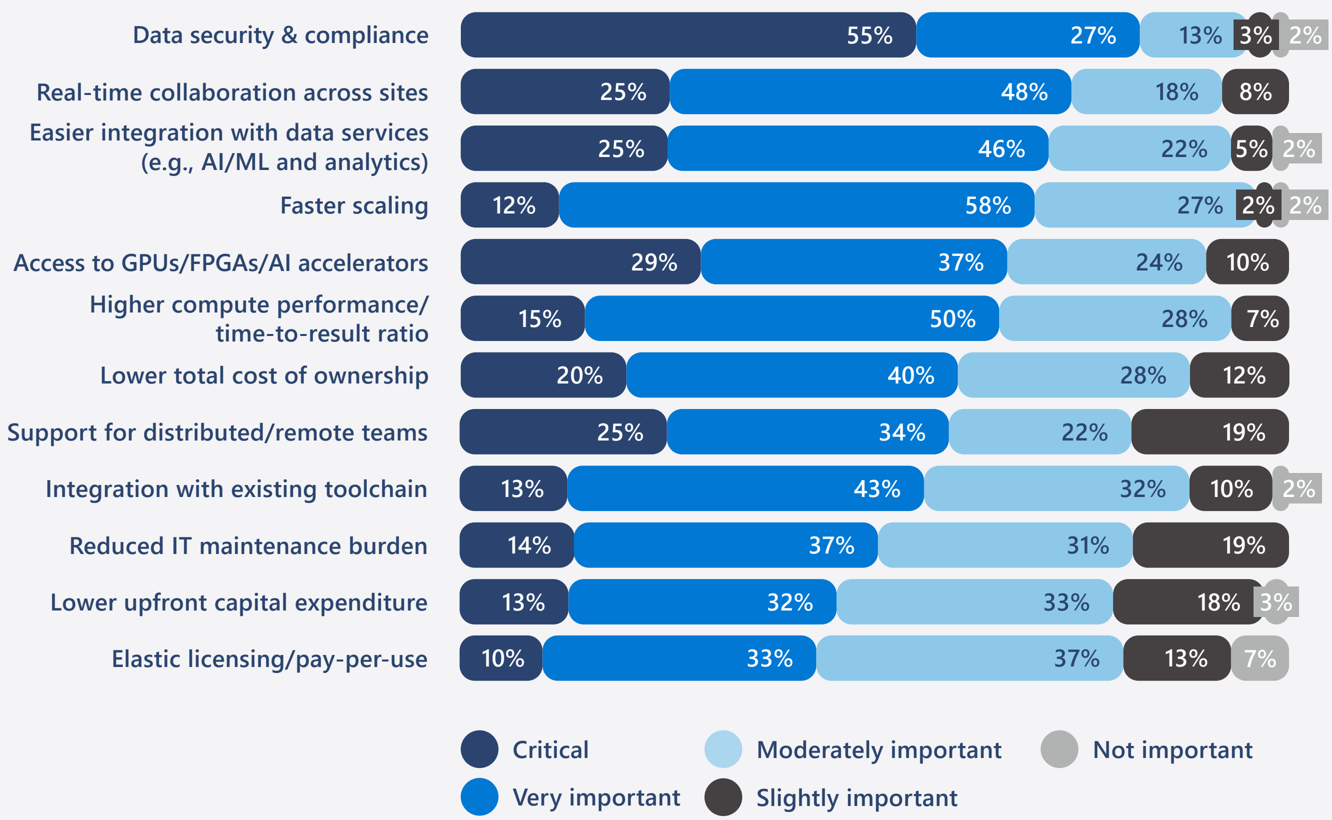
Question: How interested is your organization in moving design and engineering workloads to the cloud in the next 1-3 years?

Benefits of moving engineering workloads to the cloud

Data security and compliance top the list of drivers and deterrents for cloud adoption.

To further understand what is motivating this move and what organizations hope to gain, the research deep dives into potential factors while deciding whether to move engineering workloads to the cloud or not. Data security and compliance (82%) remain the top considerations when deciding whether to move to the cloud, outweighing advantages such as real-time collaboration, easier integration with data services like AI/ML and analytics, and faster scaling.

Exhibit 8: Factors influencing cloud migration



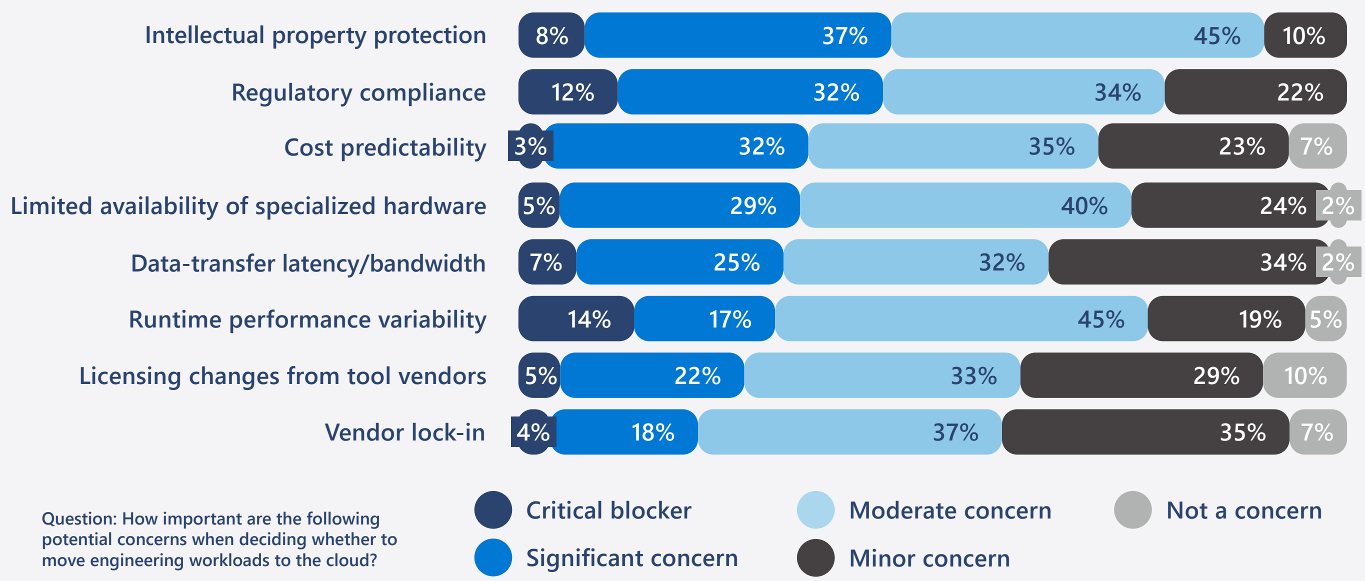
Question: How important are the following potential factors when deciding whether to move engineering workloads to the cloud?

Concerns regarding cloud adoption

Cloud adoption in intellectual property (IP)-sensitive workloads faces hesitation.

Cloud adoption is not without its concerns, especially in technically demanding, IP-sensitive domains. While most respondents did not cite any single issue as a major blocker, IP protection stood out as the top concern, identified by 45% of participants. This was followed closely by regulatory compliance (44%) and cost predictability (35%).

Exhibit 9: **Potential concerns limiting cloud migration**



Question: How important are the following potential concerns when deciding whether to move engineering workloads to the cloud?

> "It comes down to the specific requirements like latency, storage, specialization, and security. For us, we expect that specific manufacturing workflows will remain on-premises to support compliance regulations. There are also a number of applications that require specific hardware that is not yet readily available in the cloud. Also, a number of different countries have data storage requirements that often will require on-premises solutions. As cloud communication becomes faster, there may be some latency-sensitive applications that could move to the cloud, but until then, certain customer-facing servers may remain on-prem as well."
>
> **—Chief engineer, head of connected vehicles and digital products at a major American automotive company**

> "Yes, all engineering workloads can be moved to the cloud as long as the organization can support the required tools and training to successfully make the transition."
>
> **—Senior manager, PLM applications manager at a major American machinery and equipment manufacturing company**

3 The value of AI

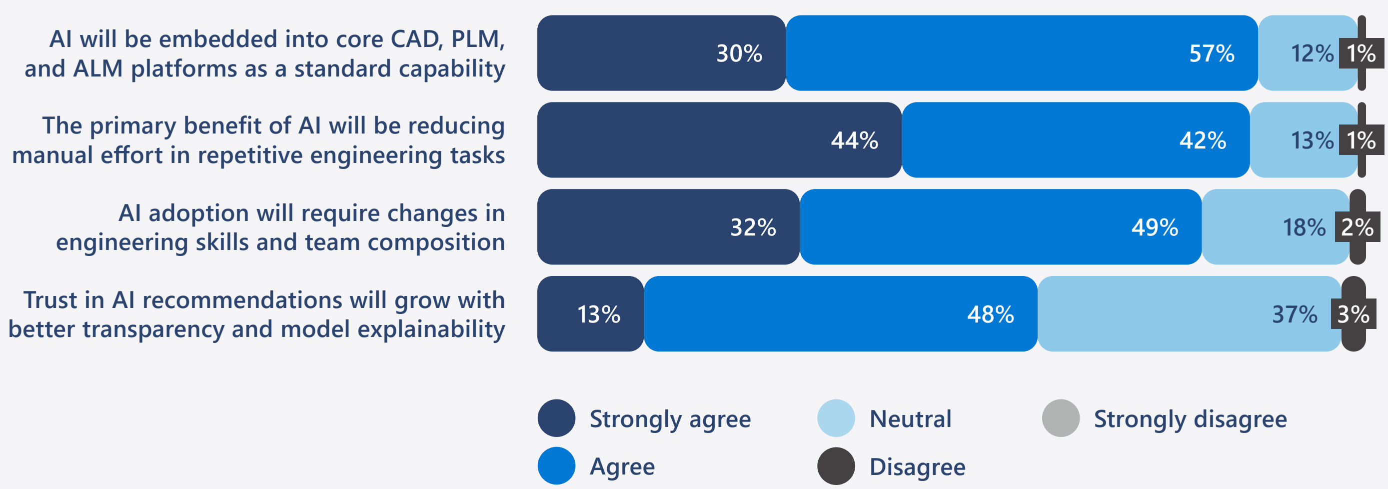
- **AI embeds into core tools:** 87% expect AI to become standard in CAD, PLM, and ALM platforms, especially to reduce repetitive engineering tasks.
- **High-value AI use cases:** AI will drive major gains in simulation prep (78%) and engineering documentation (69%), with the machinery sector leading in code generation (93%).
- **GenAI adoption rising steadily:** Most common GenAI uses are in documentation (54%), software validation (39%), and model-based simulation (32%), with the medical and aerospace sectors leading.
- **Agentic AI still maturing:** 20% are piloting AI agents for tasks like simulation and design exploration, with a measured approach being taken for safety-critical areas such as compliance and embedded code. Traditional D&E vendors are seen as best suited (64%) to orchestrate this ecosystem.

Role of AI in design and engineering workflows

AI will become a standard capability in core engineering platforms.

Organizations are beginning to define where–and how–AI will be embedded within future engineering workflows and to what extent they can leverage AI in their design and development environments. 87% of respondents say AI will be embedded into core CAD, PLM, and ALM platforms as a standard capability, closely followed by primarily reducing manual effort in repetitive engineering tasks (86%), especially in Asia, where 97% of respondents agree with this, compared to 83% in Europe and America.

Exhibit 10: **Role in AI in design and engineering**



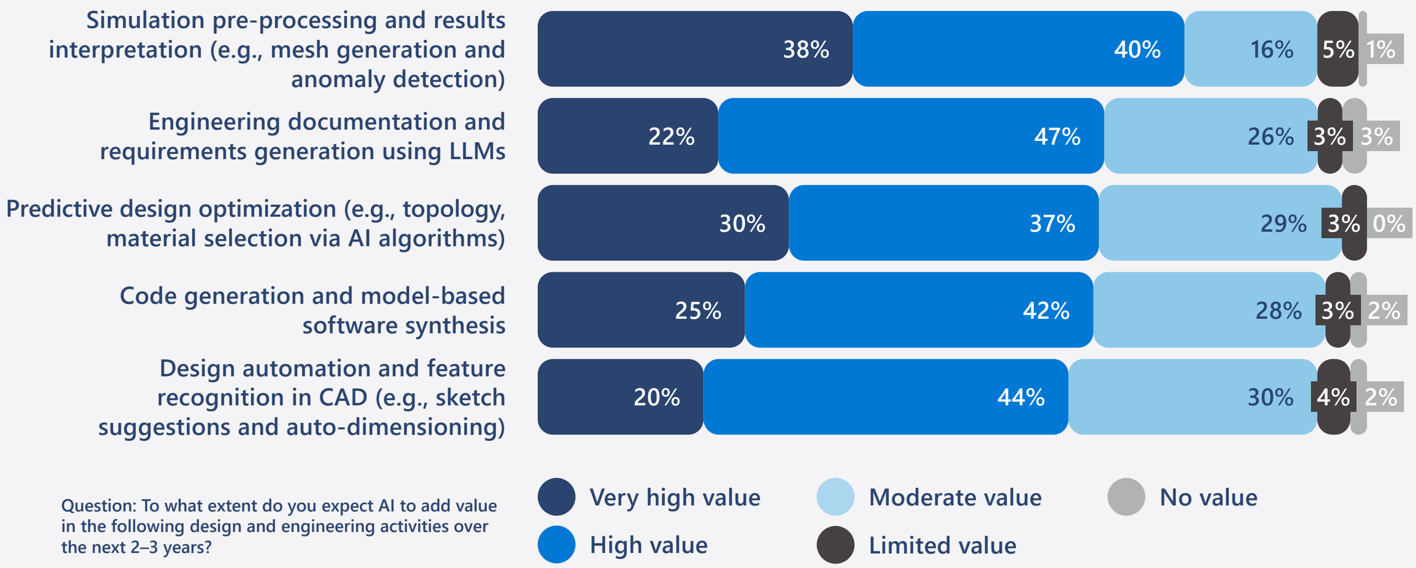
Question: To what extent do you agree with the following statements regarding the role of AI in your future design and engineering workflows?

Value creation from AI

AI is expected to deliver the most value in simulation pre-processing and results interpretation.

Several real-world deployments and applications of AI offer a window into where it may deliver the most value in the near future. In the next 2–3 years, respondents expect AI to provide the most value in simulation pre-processing and results interpretation (e.g., mesh generation, anomaly detection; 78%), followed by engineering documentation and requirements generation using LLMs (69%). Among industries, the machinery and equipment sector has a very high (93%) value creation potential using AI for code generation and model-based software synthesis.

Exhibit 11: **Value creation using AI in design and engineering**



Question: To what extent do you expect AI to add value in the following design and engineering activities over the next 2–3 years?

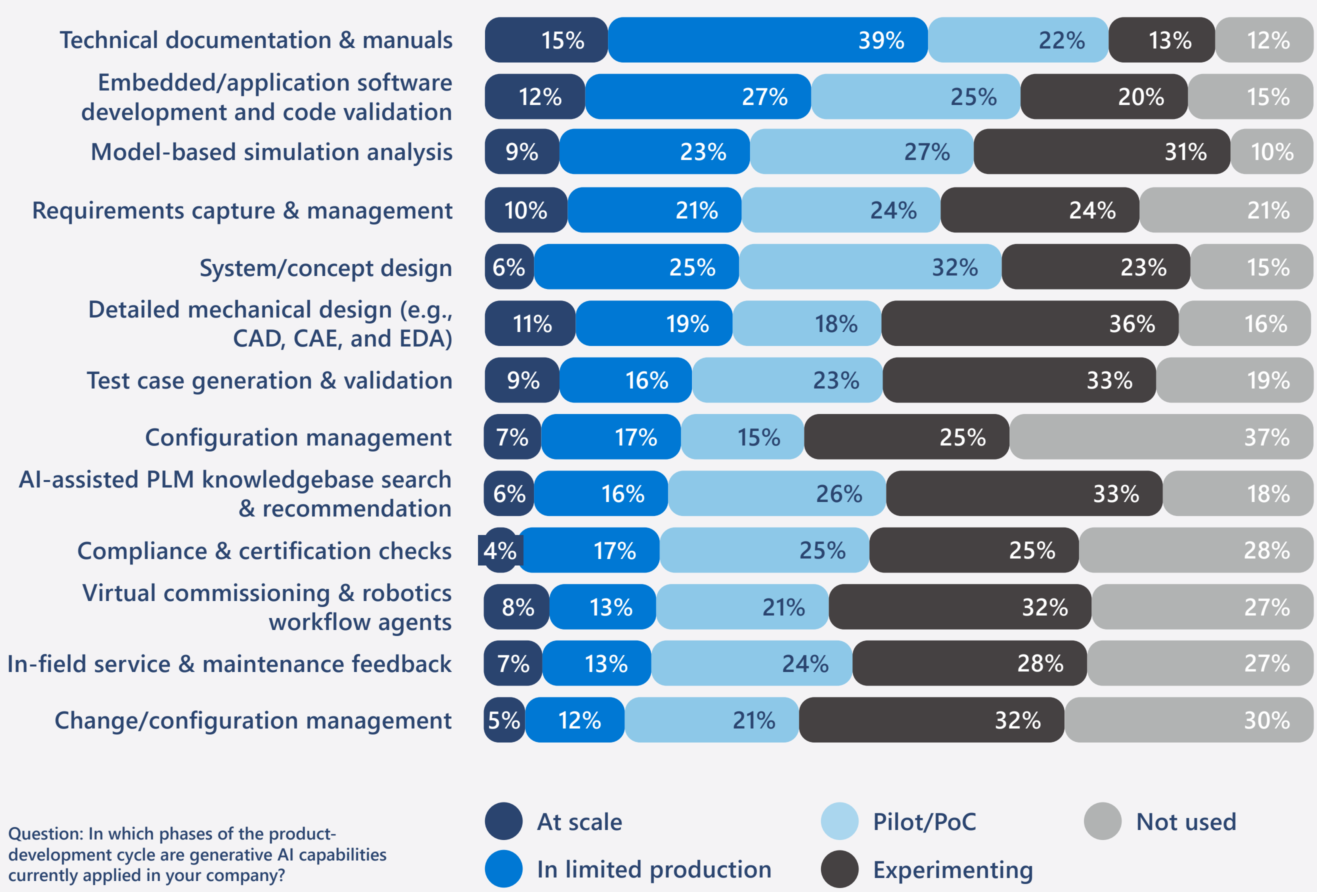
> "To me, the number one value proposition is how do you use AI to synthesize and distil all those specifications and various documents, without losing any design intent or engineering integrity? We're talking about hundreds of pages per spec–what the mechanic really needs is two."
>
> **—Senior engineering manager, materials process & physics at a leading aerospace manufacturer**

Current use of GenAI

GenAI is gaining traction across product development.

With companies still exploring various avenues of value creation using AI, the application of GenAI across the product lifecycle is on the rise. GenAI is being applied in a range of capabilities across various phases of the product development lifecycle. The most widely adopted application of GenAI in engineering today is technical documentation and manual generation, cited by 54% of respondents. This is followed by its use in embedded/application software development and code validation (39%), model-based simulation analysis (32%), and requirements capture and management (32%). The medical equipment and aerospace industries lead in GenAI adoption with 67% and 64%, respectively.

Exhibit 12: Applications of GenAI in design and engineering



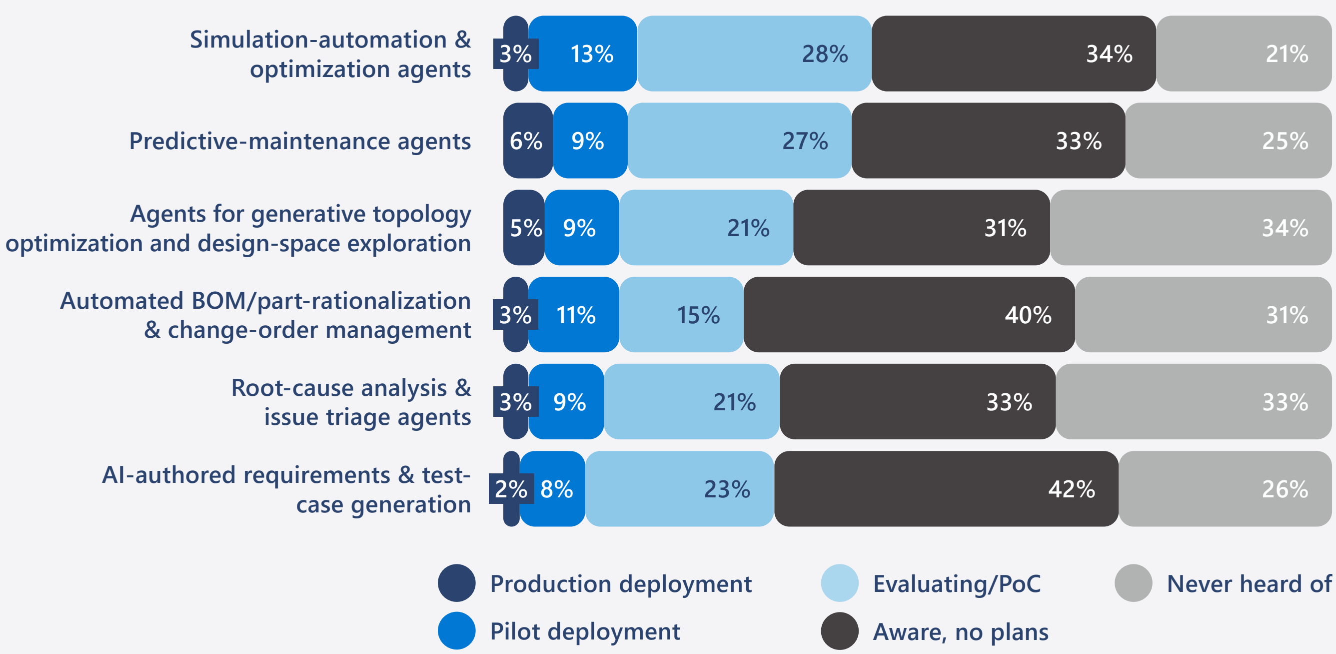
Question: In which phases of the product-development cycle are generative AI capabilities currently applied in your company?

Familiarity with agentic AI

Agentic AI–the next evolution in the use of AI in design and engineering.

As AI evolves, so do its more autonomous forms–such as AI agents. With agentic AI emerging as the next evolution of AI, those performing D&E functions have started exploring its integration into their workflows. While production use remains limited at this stage, 41% of respondents are actively piloting or conducting proof-of-concepts with AI agents for simulation automation and optimization, 36% for predictive maintenance, and 30% for generative topology optimization and design-space exploration. However, 21% to 34% of respondents across these applications have never heard of agentic AI, indicating an awareness gap persisting in the market.

Exhibit 13: Familiarity and exploration of agentic AI



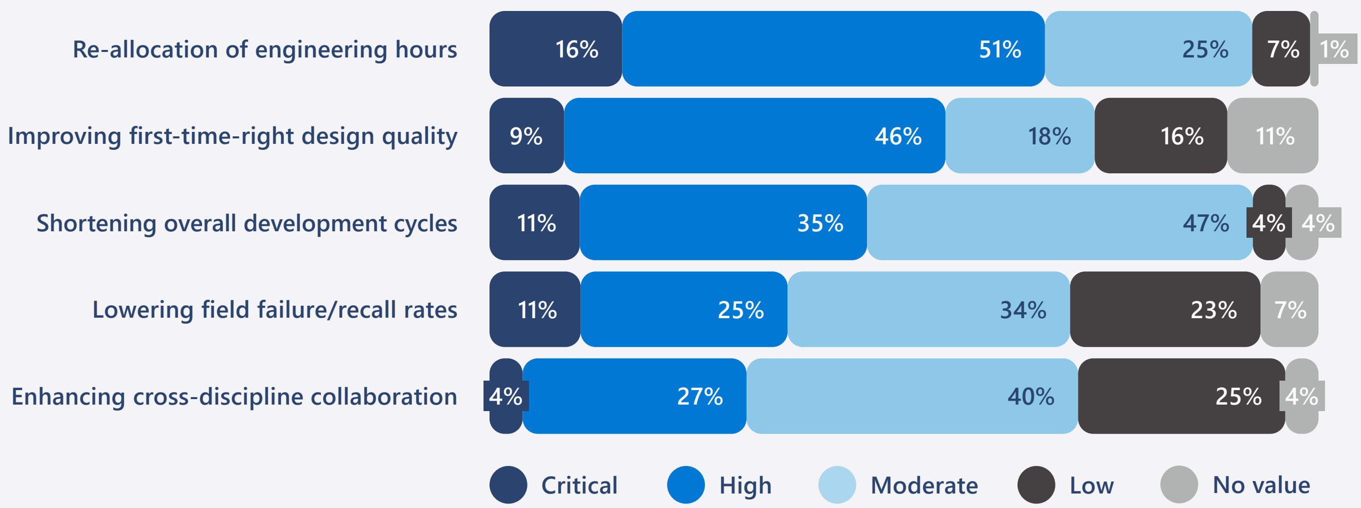
Question: Are you familiar with and exploring agentic AI capabilities in R&D?

Key outcomes from agentic AI solutions

Agentic AI to re-allocate engineering hours to more impactful tasks.

With awareness about agentic AI still evolving, companies are assessing AI agents' role in driving key engineering outcomes. The most valuable outcome from agentic AI is seen as re-allocating engineering hours (67%) to higher-impact tasks, also addressing efficiency and talent shortages. This is especially significant in the machinery and equipment sector, where 77% see it as a major benefit. Other outcomes include improving first-time-right design quality (55%) and shortening overall development cycles (46%).

Exhibit 14: **Key outcomes from agentic AI**



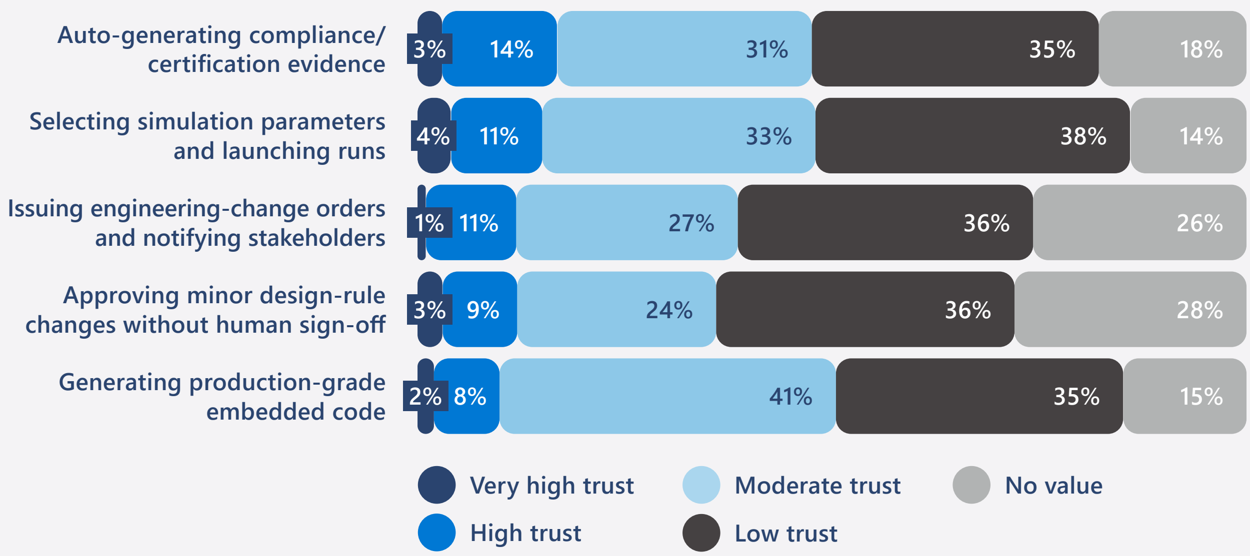
Question: How valuable would AI Agents be for the following outcomes?

Trust in agentic AI

Confidence level in AI agents indicates cautious optimism at this stage.

For critical activities such as auto-generating compliance documentation, selecting simulation parameters, launching runs, and generating production-grade embedded code, organizations are taking a measured approach, reflecting the current focus on validating reliability and building confidence in agentic AI systems. Industry-wise, small segments of the automotive (24%) and aerospace (21%) sectors highly trust agentic AI tools for the above activities.

Exhibit 15: Trust in AI agents for specific tasks



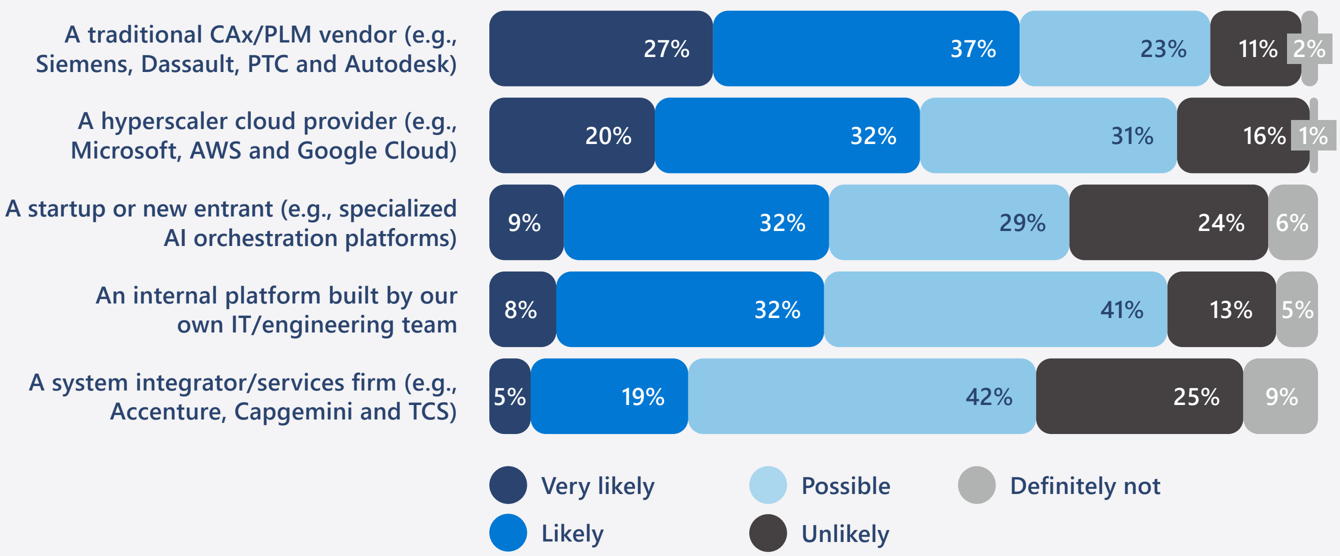
Question: How much trust does your company have in AI agents for decision making in certain specific engineering decisions?

The future of design and engineering software?

Traditional design and engineering software vendors are best positioned as orchestrators in the future, closely followed by hyperscalers.

As confidence in AI agents continues to grow, respondents say traditional D&E software vendors (e.g., Siemens, Dassault Systemes, PTC, and Autodesk; 64%) are best positioned to orchestrate AI-powered D&E environments in the future, especially aerospace companies (86%) preferring them over other types of vendors (ranging between 57% and 63%). Hyperscaler cloud providers (52%) and startups or new entrant types (41%) follow.

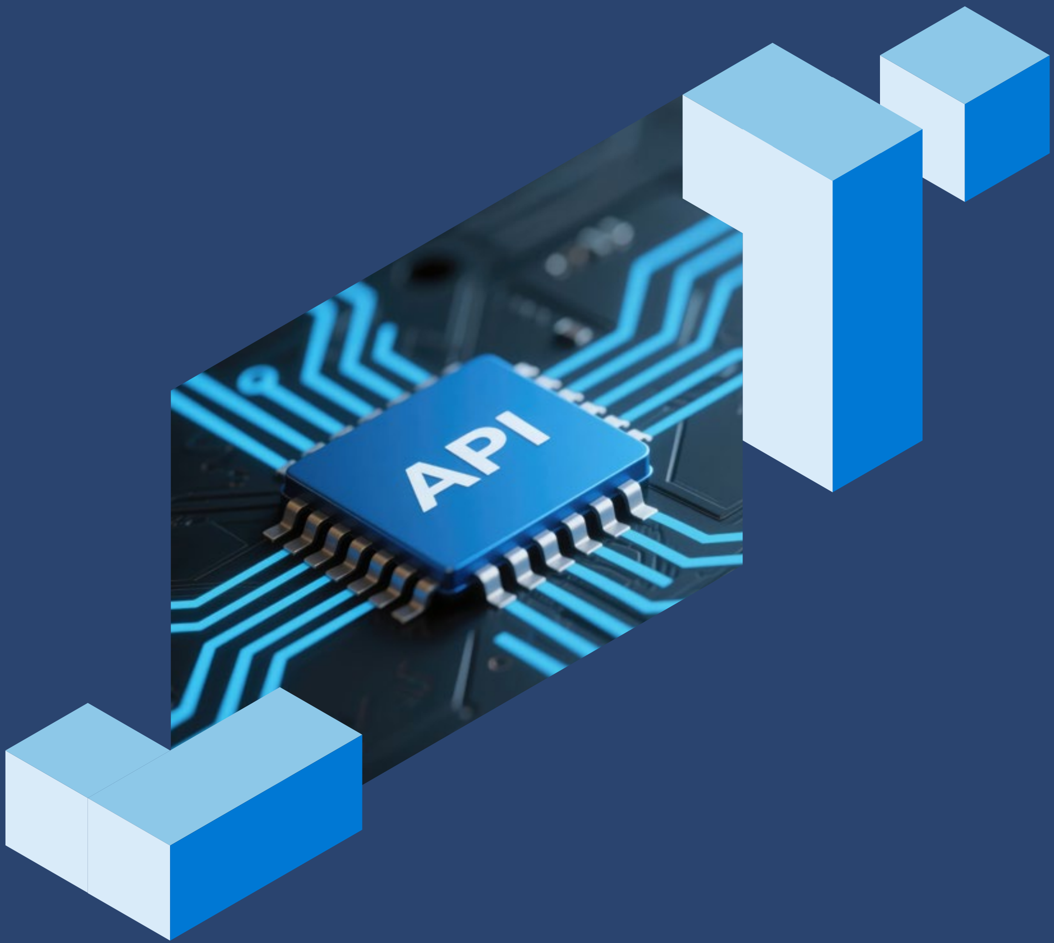
Exhibit 16: **Likely AI-enabled engineering orchestrators**



Question: Who do you think is the most capable to play the central role in orchestrating your AI-powered design and engineering environment?

4 The digital thread

- **Integration still patchy overall:** Different D&E software is often not tightly integrated today. The strongest links can be found between MCAD and simulation (3.6/5), and the weakest integration is electro-mechanical packages (ECAD↔MCAD; 3.1/5).
- **Top friction: BOM misalignment:** Key challenges include inconsistent BOMs across PLM, ERP, and MES (33%), and poor traceability to manufacturing; the automotive industry faces the highest schema-level friction (43%).
- **Adoption of integration tools:** Organizations are adopting SysML, AAS, middleware (OSLC, APIs), and knowledge graphs to bridge silos–led by aerospace, while machinery & equipment lags behind.
- **APIs help but are limited:** Most API integrations are use-case specific (49%) or limited to departmental scope; the medical equipment industry still heavily relies on basic file-based connectors (80%).

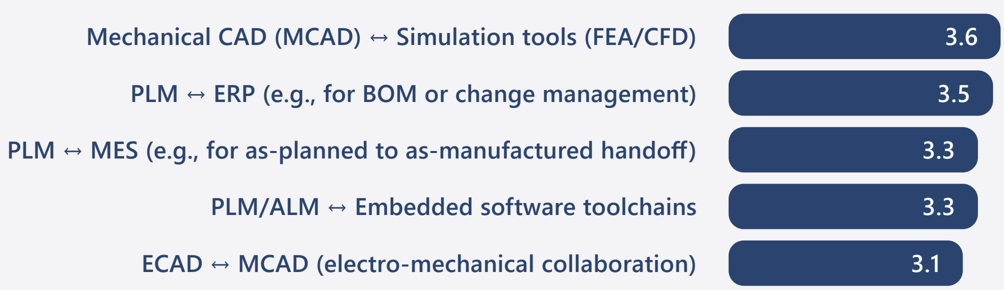


Current state of digital threads

Digital threads still show gaps.

Based on an integration score assessing the current state of real-time data flow across a set of engineering tool chains where 1 indicates "Not integrated" and 5 indicates "Fully integrated with real-time data flow," the highest level of integration was observed between MCAD and simulation tools having an integration score of 3.6/5, followed by PLM and ERP systems with a score 3.5/5. The lowest was for ECAD ↔ MCAD (electro-mechanical collaboration) integration at 3.1/5. The average integration score across software was 3.3/5, highlighting significant room for improvement. Industry-wise, for MCAD and simulation tools integration, machinery & equipment shows the highest integration at 3.9/5, and medical equipment shows the lowest at 3/5.

Exhibit 17: Data connections across engineering toolchains



Question: To what extent are the following systems integrated to support a continuous digital thread in your organization?

1 = Not integrated
to 5 = Fully integrated with real-time data flow

Why some respondents indicate low integration between systems

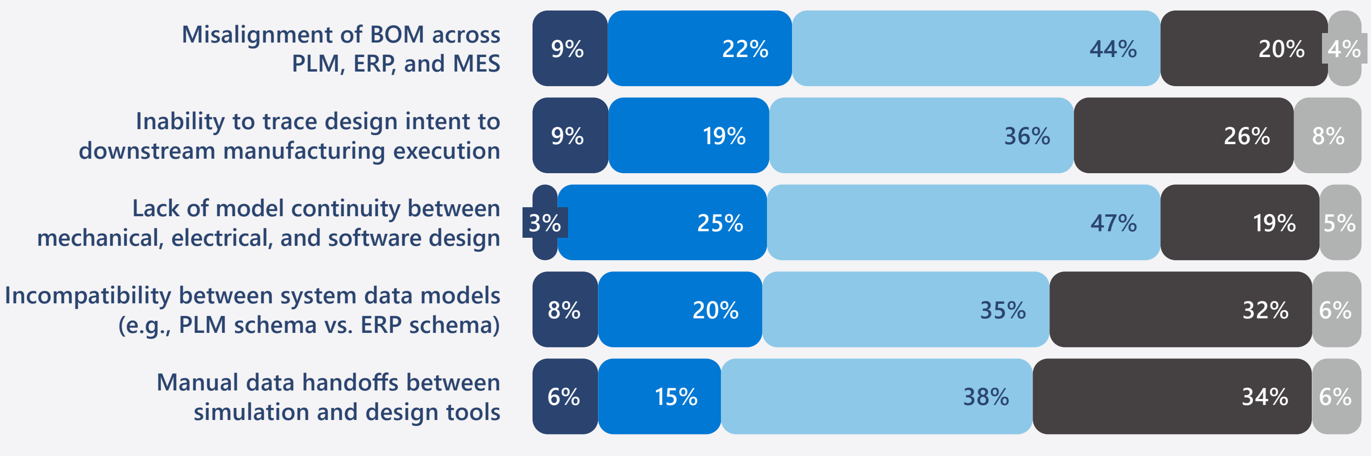
- Typically related to the number of users of these applications and their specific needs. The other factor is collaboration and communication between stove-piped groups with the organization
- Lack of integration and compatibility
- Significant complexity of tools, regions, and legacy solution

Friction points in maintaining digital thread continuity

Misaligned BOMs and incompatible data models are major friction points.

Despite growing integration, many organizations still face key roadblocks in sustaining seamless connectivity across these systems. Top friction points include misalignment of BOMs across PLM, ERP, and MES systems (33%), followed by inability to trace design intent to downstream manufacturing execution (28%). Industry-wise, for misalignment of BOM across PLM, ERP, and MES and for incompatibility between system data models (e.g., PLM schema vs. ERP schema), the automotive industry indicated the greatest friction (43%).

Exhibit 18: Friction points in maintaining a digital thread continuity



Question: How significant are the following friction points when attempting to maintain continuity across design and engineering systems?

> "What really keeps me up at night is not the big software platforms–the PLMs, the MES–but the hundreds, if not thousands, of little homegrown tools across the company. You can't just get rid of them unless you have a solution to replace them. That's the real challenge for digital thread."
>
> **—Senior engineering manager, materials process & physics at a leading aerospace manufacturer**

> "Integration complexity is having a major role for not adopting a digital thread solution. Also, different cost centers and silos are not much focused on the centralized budget for the integration tool."
>
> **—Lead electrical design engineer at a major machinery and equipment manufacturing company in India**

What workarounds respondents are using in maintaining lifecycle continuity

- We rely on engineers manually explaining design intent to manufacturing through meetings or annotations, but there’s no formal linkage in our systems, which leads to disconnects
- We are maintaining a cloud drive based excel or similar tools for the lifecycle continuity majorly for the post order and pre order movement of the product. Also a lot of communications are mail based majorly from factory end.
- Strong initiatives to integrate different R&D stakeholders and by adopting systems (digital) to track product development from cradle to grave
- We have a dedicated in-house IT team, along with support from the software providers to fix the issues

Why are some respondents only able to adopt integration tools in a limited capacity

- Adoption is limited due to integration complexity and tool incompatibility across domains. There's also low awareness and limited support for common data models like SysML and AAS
- Limited or low adoption of certain tool practices are related to it being progressively done and not completed or due to the integration complexity of these practices in the automotive industry
- We haven't fully adopted common data models due to limited cross-domain expertise with standardized modeling frameworks
- Highly complex set of applications managing business data for different disciplines from a single source

Adoption of tools and practices for digital thread connectivity

Organizations are adopting tools like common data models to overcome integration hurdles.

However, to address these challenges, organizations are turning to a range of tools and practices aimed at improving integration fidelity. Use of common data models across disciplines (e.g., SysML and AAS), automated change propagation between upstream/downstream systems, data federation platforms or middleware (e.g., OSLC, APIs, and ETL tools), Cross-domain model management in PLM (MCAD + ECAD + embedded) and use of knowledge graphs or ontologies to unify engineering data are few of the prevalent tools/practices. While the aerospace industry is leading in adoption, the machinery and equipment industry lags.

Exhibit 19: Tools and practices to improve digital thread continuity

Average adoption rating (1 = Not used to 5 = Widely adopted and standardized) for each tool/practice between companies in each segment

Question: To what extent has your organization adopted the following tools or practices to improve digital thread connectivity?

Segment	Region				Industry					Company	
R&D domain	Overall	EMEA	Americas	APAC	Automotive	Aerospace	Machinery & equipment	Medical equipment	Computer & electronics	More than 25k employees	Less than 25k employees
Use of common data models across disciplines (e.g., SysML and AAS)	3.3	3.3	3.0	3.6	3.4	3.6	3.3	3.4	2.9	3.2	3.4
Automated change propagation between upstream/downstream systems	3.2	3.3	3.0	3.3	3.2	3.6	3.1	3.3	3.3	3.1	3.4
Data federation platforms or middleware (e.g., OSLC, APIs, and ETL tools)	3.2	3.2	3.2	3.3	3.4	3.2	3.0	3.1	3.5	3.4	3.1
Cross-domain model management in PLM (MCAD + ECAD + embedded)	3.2	3.2	3.2	3.2	3.4	3.6	2.9	3.0	3.1	3.2	3.2
Use of knowledge graphs or ontologies to unify engineering data	3.1	3.0	3.2	3.1	3.3	3.4	2.5	2.9	2.9	3.1	3.0

"Lifecycle continuity should be assured so that the tools could be used during all life cycles of the product and so that the tools can help have a continuous support. Fixes should be done directly in the tools to make sure that they could be used during all life cycles."

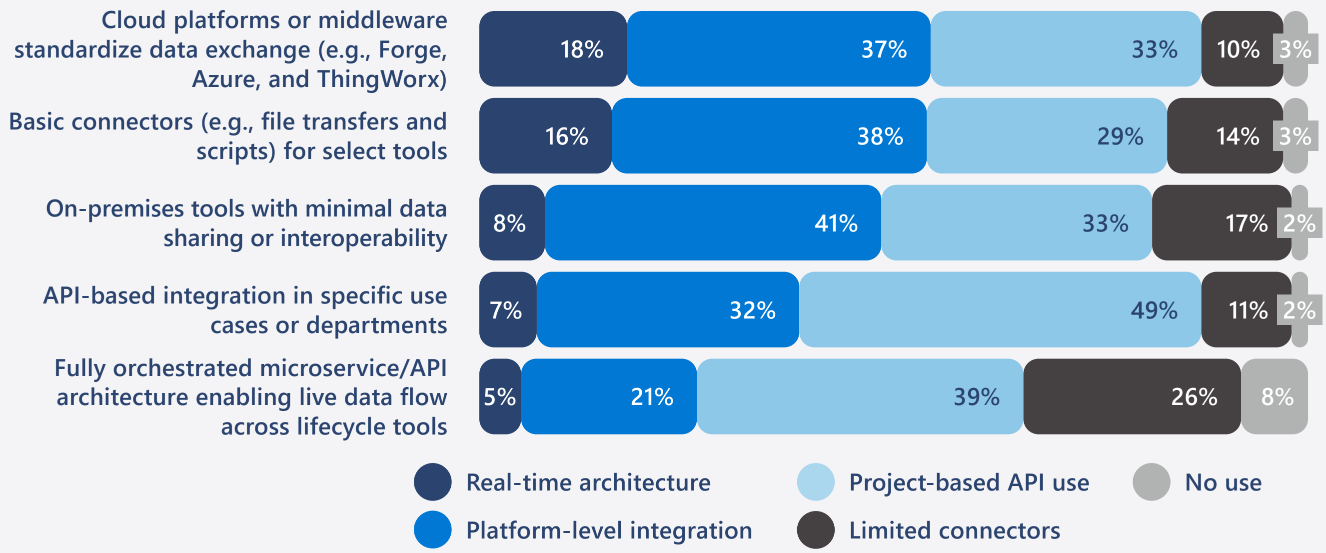
—Chief architect, leading software modelling for ECUs at a major French automotive company

Use of cloud platforms and APIs for toolchain integration

Cloud platforms and APIs are key to enabling scalable integration.

Technology enablers such as cloud platforms and APIs also play a critical role in achieving scalable, real-time integration. Currently, API-based integrations are commonly implemented at the departmental level or for specific use cases (49%), followed by on-premises toolchains with platform-level integration (41%). However, real-time, architecture-driven integrations remain rare. Basic connectors (e.g., file transfers, scripts) for select tools are widely implemented in the medical equipment manufacturing industry (80%).

Exhibit 20: Cloud platform and APIs for digital thread connectivity



Question: How would you rate your organization's use of cloud platforms and APIs for integrating CAD, PLM, ERP, MES, and simulation tools?

5 The role of software development

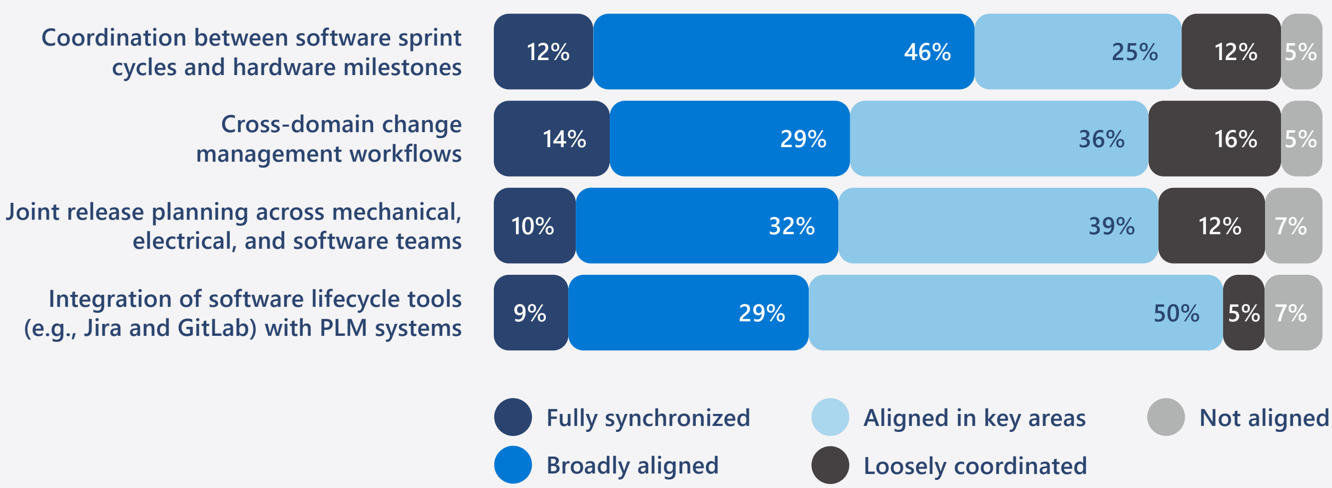
- **Partial software-hardware alignment:** 58% say software sprints and hardware milestones are aligned; 50% report toolchain integration (e.g., Jira with PLM) in some areas, but full synchronization is still rare.
- **Persistent cross-domain challenges:** Major issues include lack of shared systems (31%), misaligned release cycles (26%), and limited software understanding by hardware teams–especially acute in aerospace (60%).
- **Modern tools gaining ground:** GitHub and GitLab are standard in 30%+ of organizations–especially prevalent (65–71%) in computer & electronics industries–while proprietary repos are used in select product lines.
- **Rise of vertical frameworks:** 62% of industrial automation companies adopt domain-specific tools like IEC 61131-3 IDEs; 23% say these are mandatory for compliance in critical processes.

Alignment of software development processes with engineering

Software and traditional engineering workflows are becoming more coordinated.

Another relevant area organisations are exploring is the degree of alignment between software development processes and traditional engineering disciplines such as mechanical, electrical, and systems engineering. 58% of respondents say coordination between software sprint cycles and hardware milestones is broadly aligned if not fully synchronized. This is followed by cross-domain change management workflows (43%) and joint release planning across mechanical, electrical, and software teams (42%). However, half of the respondents say alignment of software lifecycle tools (e.g., Jira and GitLab) with PLM systems is in place in key areas.

Exhibit 21: Alignment of software development with traditional engineering



Question: To what extent are your software development processes aligned with traditional engineering disciplines (mechanical, electrical, systems)?

Collaboration challenges across software and hardware teams

Bridging software and hardware remains challenging, with gaps in several areas.

While alignment is underway in many organizations, bridging disciplines still presents major challenges in practice. Lack of shared systems for requirements, tasks, and test traceability (31%), misaligned release cadences (e.g., software agility vs. hardware lead times; 26%), and limited understanding of software logic and dependencies by hardware teams (26%) are some of the significant challenges. This is highly experienced in the aerospace sector (60%) compared to other industries.

Exhibit 22: Challenges in software and hardware team collaboration

Share of respondents in each segment who point to each challenge as a "Major blocker" or "Significant challenge" when software teams collaborate with mechanical and electrical engineering teams

Segment	Region				Industry					Company	
R&D domain	Overall	EMEA	Americas	APAC	Automotive	Aerospace	Machinery & equipment	Medical equipment	Computer & electronics	More than 25k employees	Less than 25k employees
Lack of shared systems for requirements, tasks, and test traceability	31%	32%	26%	33%	32%	60%	17%	14%	25%	27%	34%
Misaligned release cadences (e.g., software agility vs. hardware lead times)	25%	24%	26%	27%	28%	60%	0%	14%	25%	27%	24%
Limited understanding of software logic and dependencies by hardware teams	25%	16%	21%	47%	24%	40%	17%	14%	38%	20%	31%
Difficulty mapping SBOM to physical product configuration	19%	16%	21%	20%	16%	40%	0%	29%	13%	13%	24%

Question: How significant are the following challenges when software teams collaborate with mechanical and electrical engineering teams?

> "Each team uses different systems without integration, which prevents end-to-end traceability. Additionally, hardware teams lack exposure to software logic and its impact, leading to misaligned decisions and integration challenges."
>
> **—Director, R&D lead for a major plastic packaging manufacturing company in Vietnam**

Microsoft

What are the main collaboration issues between software, mechanical, and electrical teams, as seen by a few respondents

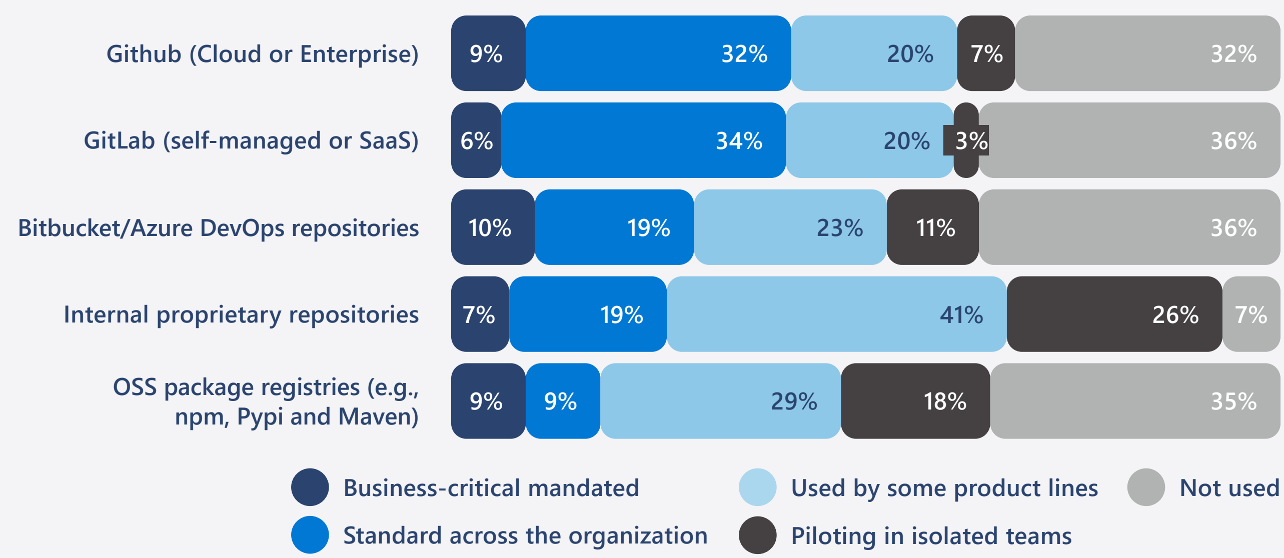
- Diagnostic trouble codes signal hardware issues but are controlled by software. The main root cause is primarily the complexity of such systems. Also, lead times and standard lifecycles are different
- The SBOM often lacks clear references to hardware components or configurations, making it hard to map software to specific product variants and ensure consistency
- Data formats lack unified versioning, different development methodologies, incompatible tools

Adoption of open-source development tools

To bridge software-hardware gaps, organizations are adopting modern tooling ecosystems.

In response to these challenges, organizations are increasingly turning to modern tooling ecosystems to close the gap. Github (Cloud or Enterprise) and GitLab (self-managed or SaaS) are a standard across the organization for over 30% of respondents, especially in the computer & electronics devices manufacturing industry (65%–71%). Meanwhile, over 40% of respondents use internal proprietary repositories in specific product lines.

Exhibit 23: Open-source tools for software development of design and engineering software



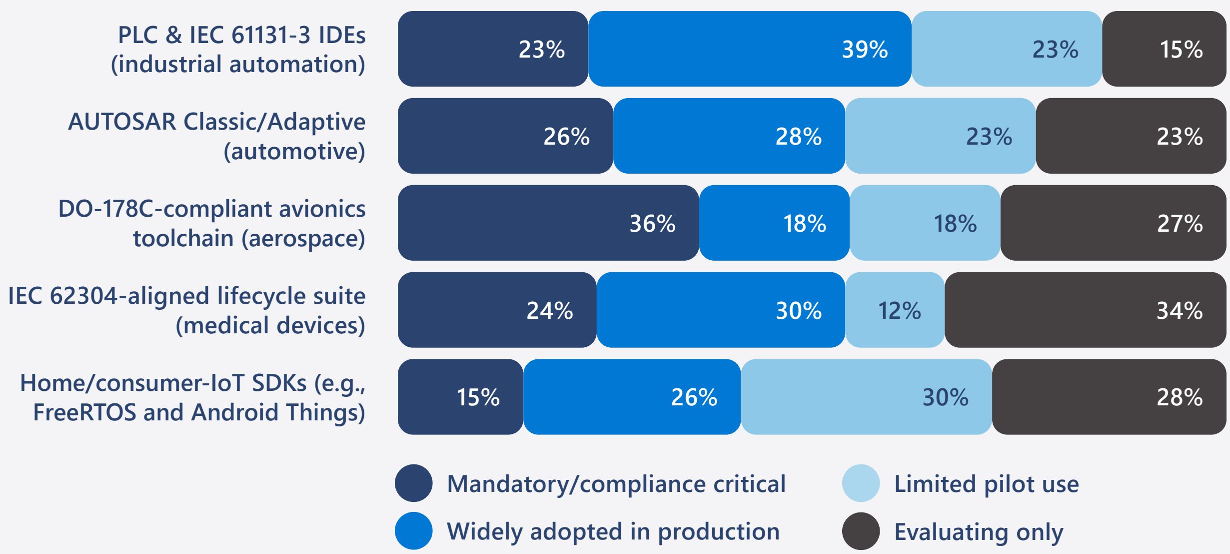
Question: What is the level of adoption of open-source tools for software development across your organization?

Vertical-specific software frameworks and regulatory toolchains

Aerospace is the leader in embracing vertical-specific frameworks.

Alongside open-source, some sectors are doubling down on vertical-specific frameworks to meet regulatory or performance demands. 36% of aerospace firms adopt DO-178C toolchains as a compliance requirement. This is followed by the industrial automation sector, which has shown strong adoption with 62% leveraging standards such as PLC programming environments and IEC 61131-3 IDEs. Notably, 23% of these industrial automation organizations consider its use mandatory for compliance-critical processes.

Exhibit 24: OVertical-specific software frameworks or regulatory toolchains



Question: To what extent has your organization adopted vertical-specific software frameworks or regulatory toolchains?

Case study: Leading aerospace manufacturer

Building a digital thread across the full value stream

1 Overview

- A major aerospace OEM aimed to establish a digital thread across a 12-gate operational value stream–from concept (Gate 0) to production (Gate 12).
- Key focus: enabling data traceability, access, and compliance across engineering and non-engineering teams.
- The long-term vision was to build toward a fully integrated digital twin, using AI for data distillation and continuous learning.

2 Challenges

- Highly fragmented data landscape with hundreds of commercial and homegrown tools, PDFs, and siloed systems.
- Difficulty identifying who produces and consumes which engineering artifacts at each gate.
- Concern over data security and compliance in leveraging GenAI and public cloud platforms

3 Solutions

- Mapped the operational value stream to define artifact flow and ownership across producer-consumer relationships.
- Built a data ontology and taxonomy, laying the foundation for structured digital thread implementation.
- Leveraged AI (e.g., LLMs) for spec rewrite and document distillation, with cautious adoption due to IP risks

4 Results/benefits

- Established a clear understanding of “what is produced, when, and by whom”–a foundational step toward full digital thread.
- Reduced manual effort in navigating engineering specs via AI-assisted distillation, making data consumable for humans and machines.
- Set the groundwork for machine-readable data, secure archival, and eventual digital twin integration.

> “We mapped the operational value stream–12 gates from concept to production–to understand what engineering artifacts are produced; who consumes them, and when; where its stored and recovered; who’s allowed to see, why they're allowed to publish, and who’s allowed to change what along the operational value stream. Just understanding those relationships was foundational to our digital thread.”
>
> **—Engineering lead at a major American aerospace manufacturer**

Microsoft

Getting started with AI

A four-step approach is helping design and engineering teams adopt and scale AI.

AI adoption in D&E is gaining momentum, but success requires more than just deploying new algorithms. It demands a thoughtful approach that aligns AI efforts with design challenges, leverages data across disciplines, and empowers teams to work in new ways.

Survey data and industry insights reveal a four-step approach many D&E teams are already using or planning to adopt to move from scattered experiments to scalable AI integration: 1) identify early-stage engineering challenges, 2) focus on cloud-ready AI use cases, 3) strengthen structural data links and build cross-domain AI teams, and 4) upskill with AI-powered software development tools. This framework is helping teams drive efficiency, improve product quality, and accelerate time to market.

Framework for AI adoption in design and engineering.

Clear use cases, strong data foundations, cross-disciplinary teams, and targeted upskilling form the backbone of AI adoption in D&E.

As design and engineering teams explore AI use cases–such as generative design, simulation acceleration, or intelligent part classification–success depends on how organizations frame, structure, and support these efforts. A structured approach ensures that AI is relevant, feasible, and repeatable across projects.

4 steps to getting started with AI in design and engineering

1

Identify early-stage engineering challenges
Pinpoint where AI can create impact early in the lifecycle, such as requirements validation, concept feasibility, or early simulation. Look for repetitive or manual processes that delay downstream decisions.

2

Focus on cloud-ready AI use cases
Focus on AI workloads that benefit most from cloud scalability, such as large-scale simulation, generative design, or multi-domain optimization. A practical starting point within multi-domain optimization is migrating PLM to the cloud. As the backbone of product data management, PLM requires real-time access to unified product data and design context across mechanical, electrical, and software domains, making it a critical enabler for advanced, AI-driven engineering workflows.

3

Strengthen structural data links and build cross-domain AI teams
Ensure that data models, part IDs, and metadata are standardized across domains so AI can meaningfully connect design, BOMs, simulations, and service data. Unite experts from PLM, MES, service systems, and data engineering to implement AI use cases like anomaly detection, lifecycle analytics, or predictive quality.

4

Upskill with AI-powered software development tools
Familiarize teams with GenAI copilots, AI-assisted debugging, and ML-integrated CI/CD pipelines–empowering faster, more intelligent software development cycles in building D&E software.

How Microsoft can support your next actions

Microsoft

Adopting AI presents a significant opportunity, and the impacts are transformational across the product design and engineering value chain, helping to drive improvements in efficiency, quality control, cost reductions, and time to market. Given the highly competitive and dynamic environment, now is the time for action. There are also many challenges due to the rapidly evolving nature of technology, and it is critical to determine the optimal areas for implementation to maximize the benefits and impact of AI.

The Microsoft Cloud for Manufacturing can help your product design and engineering processes with a market-leading industrial AI technology platform and real solutions to engineering processes. Solution examples:

- Digital Twins Simulations–quickly simulate scenarios for product design optimization, process improvement, and factory setup decisions with reduced data sampling.
- Product Lifecycle and Design–boost agility, efficiency, and scalability by running PLM and CAE workloads on the cloud.

Learn more about unlocking the future of manufacturing with AI-powered digital threads

Learn more about top AI use cases in manufacturing

IOT ANALYTICS

This report is based on research by IoT Analytics.

IoT Analytics, founded and operating out of Germany, is a leading global provider of market insights and strategic business intelligence for the IoT, AI, the cloud, edge technology, and Industry 4.0.

Visit our website
Contact us

Microsoft