

TECH TIDE REPORT

The Forrester Tech Tide™: Smart Manufacturing, Q2 2025

Twenty Technologies Underpin Smart Manufacturing

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Summary

Smart manufacturing is increasingly critical to manufacturers' ability to win, serve, and retain their customers. To accelerate their performance in smart manufacturing, organizations are evaluating and adopting a range of contributing technologies. This Forrester Tech Tide™ report presents an analysis of the maturity and business value of 20 technology categories that support smart manufacturing. Business and technology leaders should read this report to shape their company's investment approach to these technologies.

Leverage Smart Manufacturing To Drive Agility And Effectiveness

Industrial giants rose to dominance making high-quality physical objects. Lower-cost competition and increasingly complex multistakeholder ecosystems mean this old route to success is no longer enough. To survive, industrial firms must adapt, deliver new value to new stakeholders, and respond to the shifting expectations of both their customers and their customers' customers.

Smart manufacturing technologies drive greater efficiency in manufacturing operations, reducing cost, waste, and inefficiency. But more importantly, these technologies give manufacturers the ability to engage with suppliers, partners, and customers more closely than ever before, powering new business models that combine excellence in the manufacture of physical objects with excellence in interpreting and acting upon data-driven insights about those objects and their use.

Curate A Set Of Technologies That Enable Smart Manufacturing

Forrester surveyed technology decision-makers, suppliers, and other subject matter experts in our search for the most important smart manufacturing technologies. The technology categories analyzed in this Forrester Tech Tide meet these three criteria:

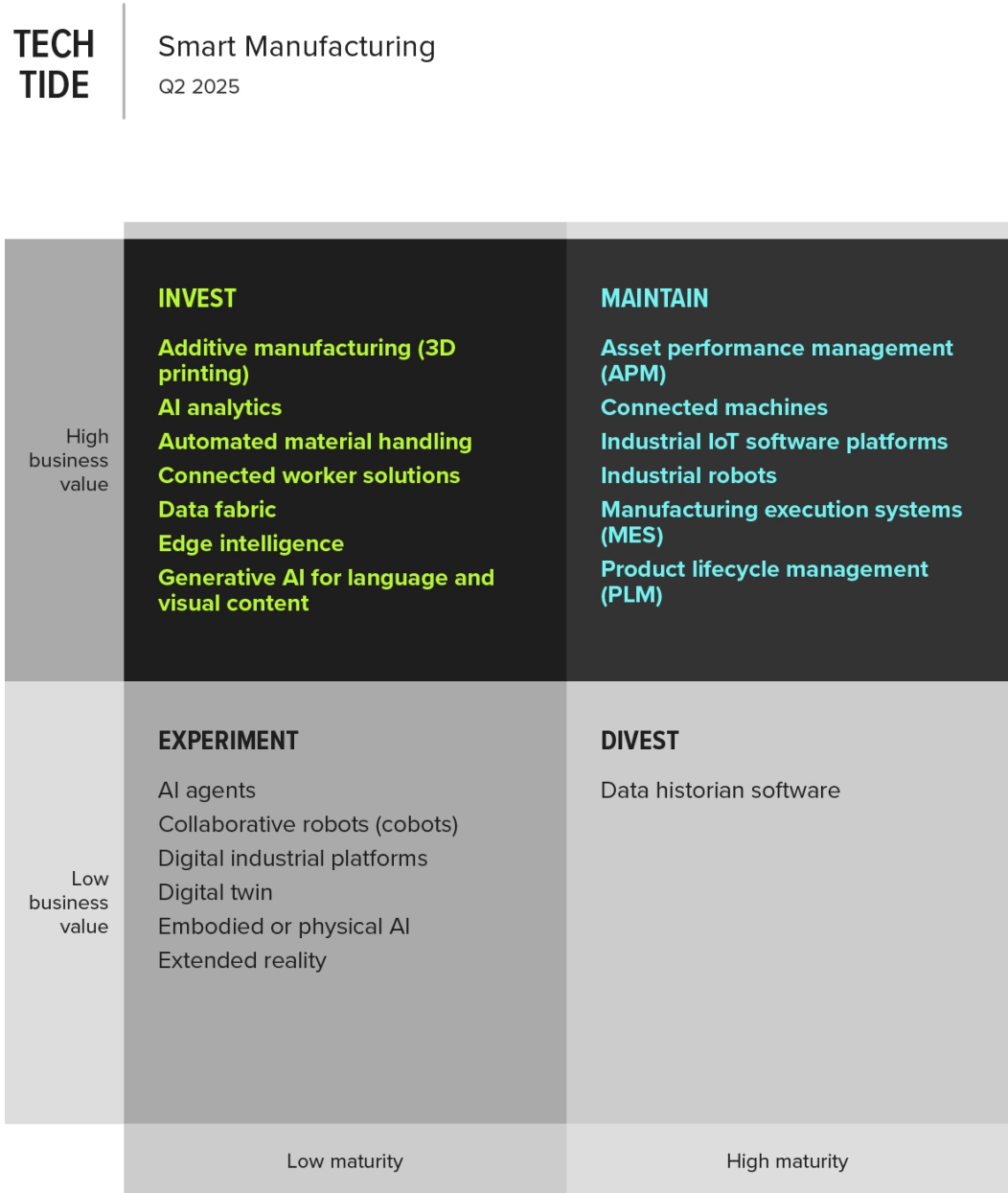
- **They are important contributors to manufacturing smartly.** The technologies in this report enable manufacturers to control factories; track parts; and design, build, and operate industrial products and services.
- **They are commercially available at enterprise scale.** These technologies are all available today. The vendors that offer them vary in size, regional focus, and market approach and include established businesses and recent market entrants.
- **They have (or will have) market traction.** The technologies in this report are regularly the subject of user client inquiries and conversations. We've included the technologies that clients use today and those that they should plan on using in the near future.

Select Smart Manufacturing Technologies That Offer High Business Value

The central 2x2 graphic offers a summary of the state of the technology categories that support smart manufacturing initiatives (see Figure 1).

Figure 1

Tech Tide™: Smart Manufacturing, Q2 2025



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Evaluate Business Value And Maturity For Each Smart Manufacturing Technology

We plot the categories on two dimensions:

- **Business value.** Many smart manufacturing technologies are operational or tactical in nature. Cost savings via expedited administrative tasks or reduced product spoilage drive measurable business value. Added business value occurs in strategic areas that improve how work is done or add advanced analytics to drive insight, support better decisions, or accelerate an enterprise's digitization roadmap.
- **Maturity.** The current state of smart manufacturing technology is characterized by variables such as the rate of product innovation, the nature of the dominant vendors, adoption by customers, the number of production deployments, and other relevant indicators of market maturity.

Determine Strategies For Smart Manufacturing Based On Business Value And Maturity

The business value and maturity dimensions, in turn, position each category in one of four quadrants:

- **Experiment.** Low maturity and low business value characterize technologies in the Experiment zone. Most enterprises should limit their exposure to these technologies to bounded experiments, waiting for the expected business value of these newer categories to improve before investing.
- **Invest.** Low maturity and high business value characterize technologies in the Invest zone. These new technologies have ripened to the point where enterprises can confidently invest.
- **Maintain.** High maturity and high business value characterize technologies in the Maintain zone. These are the bread-and-butter technologies that most enterprises rely on to run their business. They're generally stable, well-understood technologies that continue to have high returns to the business. Most enterprises should maintain their installation and usage of these technologies.
- **Divest.** High maturity and low business value characterize technologies in the Divest zone. These older technology categories have reached a point where their business value has dropped. Most enterprises should be looking for newer, higher-value replacements and divesting from these categories.

Invest In And Maintain Technologies With High Business Value

In mapping the enabling technologies for the smart manufacturing ecosystem, we found that:

- **Strong dependencies exist among these technologies.** None of these 20 technologies makes much sense in isolation. For example, extended reality tools make most sense in smart manufacturing use cases where they offer a window on the digital twin, which is itself informed by AI analytics that extract insight from industrial IoT software platform data at the edge. And these dependencies aren't limited to the 20 technologies we highlight in this report: Those AI analytics informing the digital twin may run at the edge, but they probably use models developed, trained, and refined in the cloud.
- **None of these technologies are obsolete yet.** We recommend that clients begin to explore divesting themselves of one of our 20 technologies. But we're not necessarily saying that this technology is no longer of value — in specific scenarios, it may still be critical. We're highlighting that other solutions are beginning to supersede more established products. Focus on the task you're trying to accomplish rather than the technology you've always used to accomplish it.


Experiment With AI Agents, Collaborative Robots, Digital Twin, And Others

Six of the smart manufacturing technologies fall into the Experiment quadrant of the Tech Tide, with low maturity and low current business value. AI agents are the latest addition to a technology segment where innovation has dramatically accelerated in the past couple of years, but the added complexity of agent-based solutions force manufacturers to proceed with care. Digital twins, too, have become more complex in recent years, encouraging manufacturers that might once have comfortably invested in a digital twin of one machine to move more slowly in experimenting with more complex twins.

AI Agents

AI agents are intended to operate invisibly and even autonomously, executing specific discrete tasks within a larger orchestrated workflow. [These agents](#) are part of a new phase of AI innovation, and they combine analytical and decision-making capabilities with some ability to take action. AI agents are a significant field of experimentation within smart manufacturing, as manufacturers and their technology partners rush to identify the use cases for which they are best suited — and the critical dependencies that must be addressed to ensure success outside the testbed (see Figure 2).

Figure 2
Experiment: AI Agents

 <p>Strategy: EXPERIMENT</p> <p>MATURITY ↓ Low</p> <p>BUSINESS VALUE ↓ Low</p> <p>EXAMPLE USE CASES</p> <ul style="list-style-type: none">• Field service• Quality inspection• Automated negotiation <p>SAMPLE VENDORS Cognite; Figure; Google; Microsoft; OpenAI</p>	<h2>AI agents</h2> <p>Definition General AI systems trained to act on behalf of an enterprise or individual by performing tasks, making decisions, and autonomously interacting with data or other systems.</p> <p>Maturity rationale There is huge interest in AI agents, but the reality of deploying them cost-effectively, safely, and usefully at scale is not yet fully understood, especially in complex asset-intensive industries like manufacturing where the risks are significant.</p> <p>Business value rationale AI agents promise to transform the execution of specific tasks and may deliver real business value by doing so. But tasks are part of broader workflows, and the practical implications of orchestrating the software, machines, and people that undertake those workflows at scale have not yet been satisfactorily addressed.</p>
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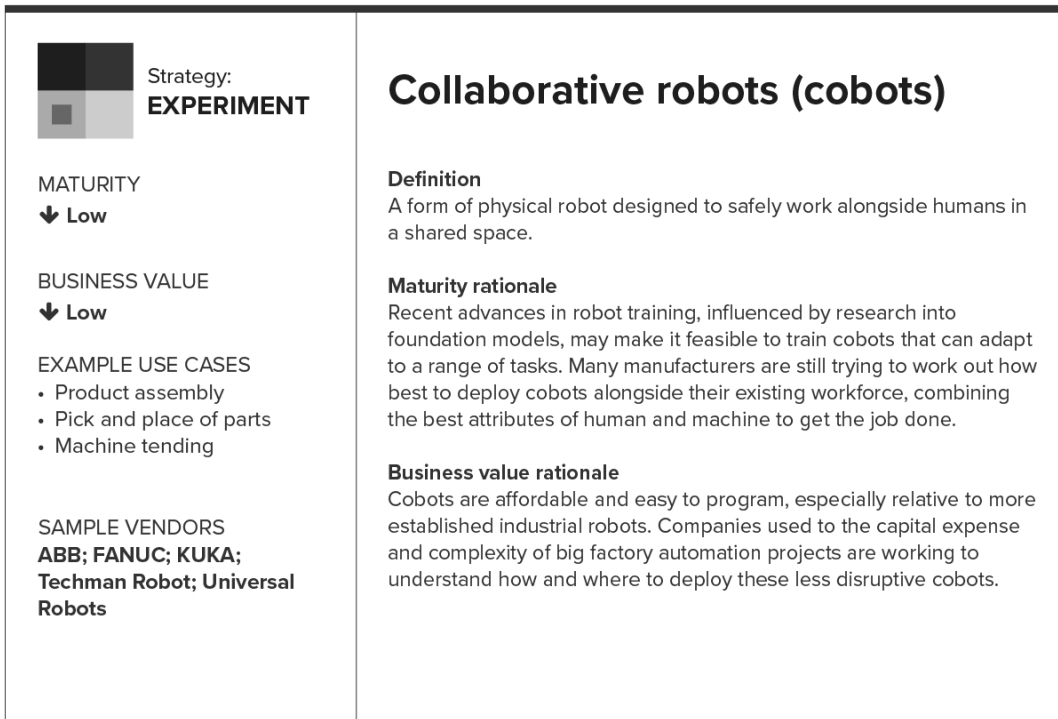
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Collaborative Robots (Cobots)

The robots used in manufacturing have traditionally been big, expensive, and optimized for a single task. They've also been kept apart from the human workforce. Collaborative robots are different, as they're explicitly designed to work safely alongside people (see Figure 3).

Figure 3

Experiment: Collaborative Robots (Cobots)



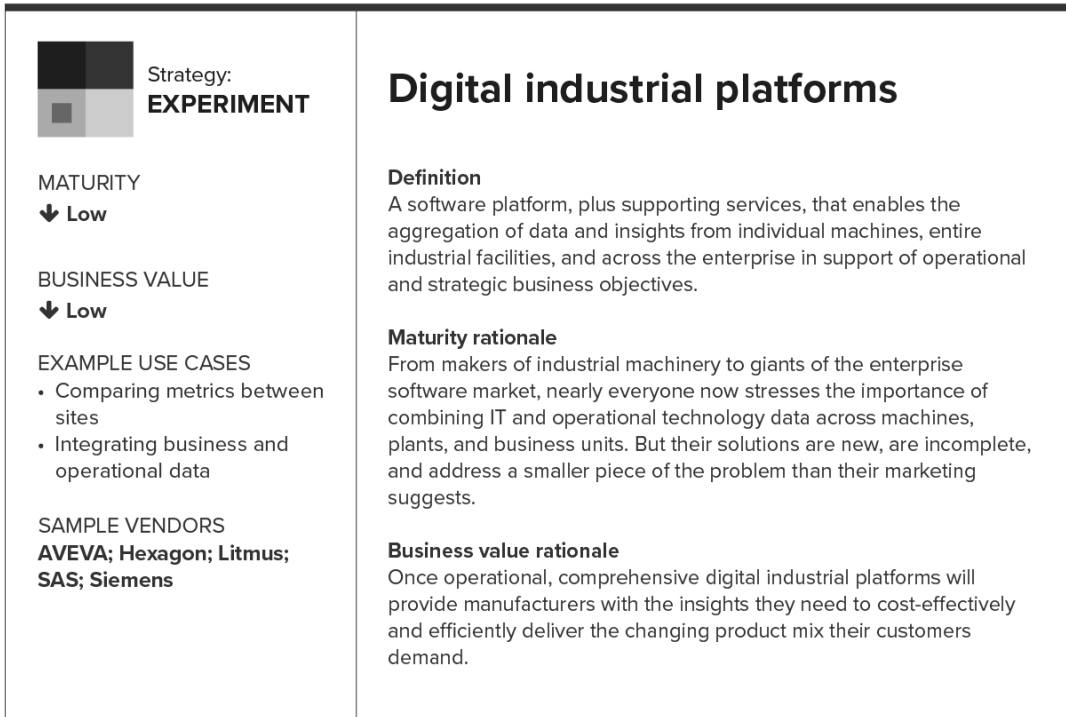
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Digital Industrial Platforms

Digital industrial platforms address a clear need in the manufacturing sector, combining operational data from multiple factory sites with business data from head office to support more effective decision-making. The need is clear, and a wide range of software vendors are playing to their existing strengths as they move to address parts of it. The challenge for manufacturers is to understand how they might make these different offerings work together to meet real business objectives (see Figure 4).

Figure 4

Experiment: Digital Industrial Platforms

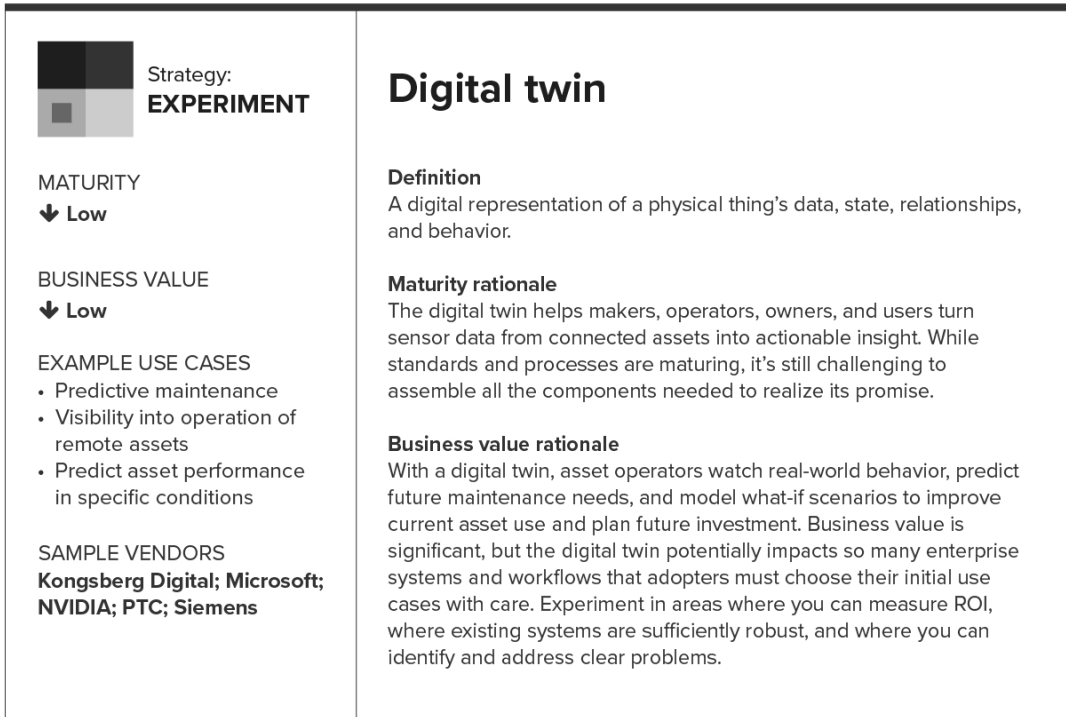


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Digital Twin

It's easy to be drawn in by the visual aspect of many digital twins — the animation of a real-world object on a computer screen — but that misses the point. The real value lies in the models used to track, simulate, and predict real-world behavior inside a virtual environment, informed and updated by sensor readings from the physical asset. After a period during which most digital twins were simple and vendor- and asset-specific (a pump maker might provide a digital twin of their pump), interest is growing in richer digital twins of more complex assets and processes, which require integration with a broader set of enterprise systems (see Figure 5).

Figure 5
Experiment: Digital Twin




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Embodied Or Physical AI

Interesting things happen when AI is built into machines that must observe and interact with the real world. The development and training of [robots](#) and [autonomous vehicles](#) is accelerating, thanks to innovations in AI like the foundation model. Instead of laboriously teaching a robot the step-by-step response to each situation it might encounter, researchers increasingly use AI techniques to help the robot work out how to adapt and respond to the unexpected (see Figure 6).

Figure 6

Experiment: Embodied Or Physical AI

 <p>Strategy: EXPERIMENT</p> <p>MATURITY ↓ Low</p> <p>BUSINESS VALUE ↓ Low</p> <p>EXAMPLE USE CASES</p> <ul style="list-style-type: none">• Autonomous vehicles• Advanced robotics• Humanoid robots <p>SAMPLE VENDORS AgiBot; Covariant; Figure; NVIDIA; Wayve</p>	<h2>Embodied or physical AI</h2> <p>Definition A subfield of AI, often linked to robotics and autonomous mobility solutions, that focuses on developing systems that can perceive, interpret, and respond to the physical world.</p> <p>Maturity rationale Startups and research labs around the world demonstrate impressive developments in enabling technologies like foundation models. Less progress has been made in simplifying the integration of these emerging technologies into complex business workflows or developing robust safeguards against AI-powered accidents in the real world.</p> <p>Business value rationale Robots tend to be good at the dull, the dirty, and the dangerous, and plenty of tasks currently done by humans fit the bill. If AI can train robots faster and enable them to operate in less predictable environments, businesses facing a shortage of skilled labor are sure to pay attention.</p>
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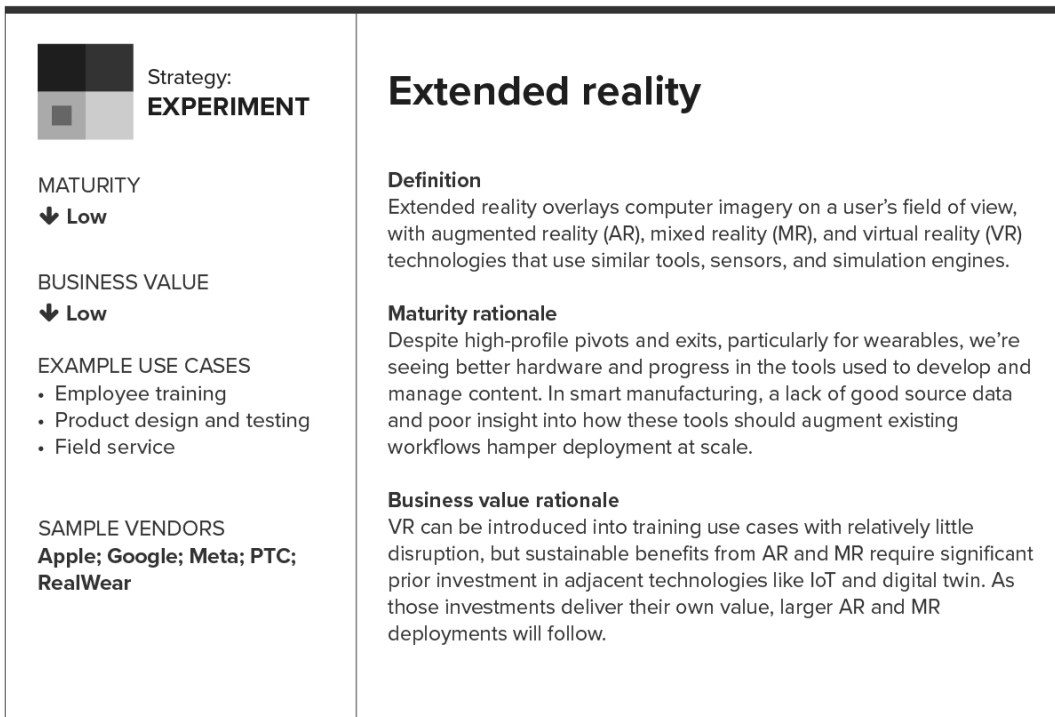
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Extended Reality

Over a decade of hype for Google Glass, Microsoft HoloLens, and Apple's Vision Pro built unrealistic expectations for augmented, mixed, or virtual reality — collectively, extended reality (XR). While XR is often associated with these devices, which mostly haven't met expectations, similar technologies work on regular smartphones and tablets. As part of a broader strategy to gain value from what is [sometimes called the industrial metaverse](#), experiments with XR show promise in everything from product design and prototyping to inspection, training, and remote assistance. [In the right context](#), even wearable headsets make sense (see Figure 7).

Figure 7

Experiment: Extended Reality



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Invest In Additive Manufacturing, AI Analytics, Data Fabric, And Others

Seven of the smart manufacturing technologies fall into the Invest quadrant of the Tech Tide, with low maturity and high current business value. We may not have all the answers yet, but technologies like additive manufacturing (3D printing), connected worker solutions, and edge intelligence are of proven and growing value. It's time to invest in each of these technologies, both by obtaining the technology itself and by pushing through the organizational changes required to make these investments pay off.

Additive Manufacturing (3D Printing)

Long a tool for hobbyists and designers of rough-and-ready plastic prototypes, additive manufacturing is now [part of mainstream manufacturing workflows](#). Combined with generative design software, industrial-grade printers solve old engineering problems by producing surprising new shapes from metal or composite materials. Quality, speed, reliability, and cost considerations mean these printers aren't likely to replace every tool in a typical factory, but the niches for which their attributes make them a good fit continue to grow larger. Invest in the hardware, software, and mindset to make your business additive-ready (see Figure 8).

Figure 8

Invest: Additive Manufacturing (3D Printing)

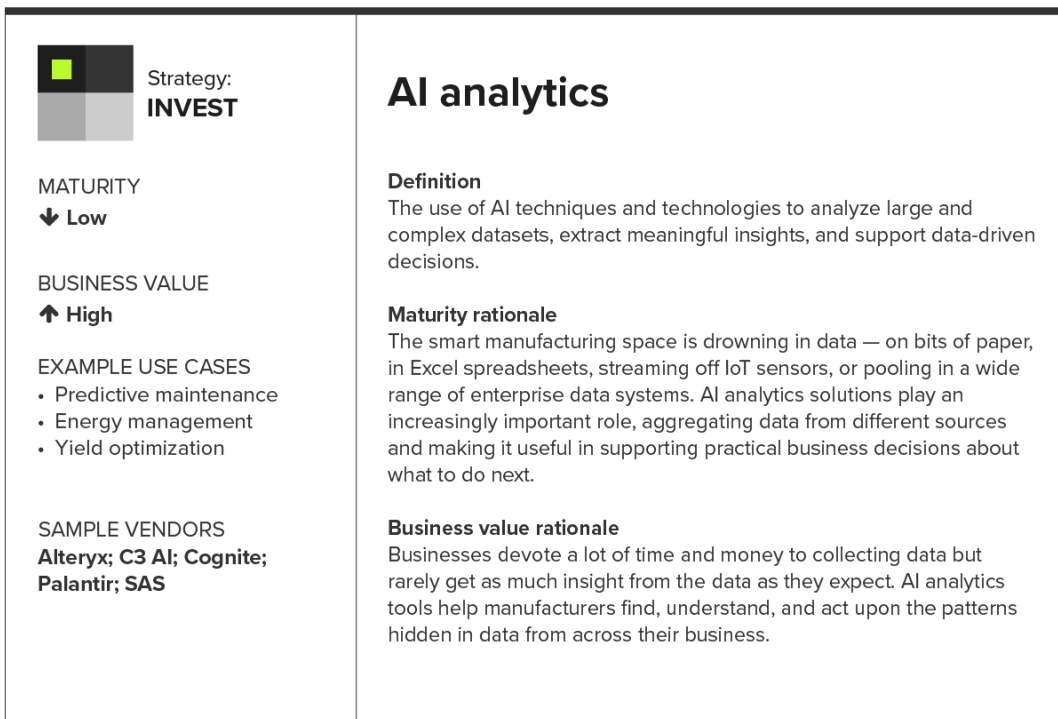


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AI Analytics

AI analytics tools help manufacturers find patterns in data. More importantly, these tools help identify the reasons for those patterns and may be able to recommend specific remedial actions (see Figure 9).

Figure 9
Invest: AI Analytics



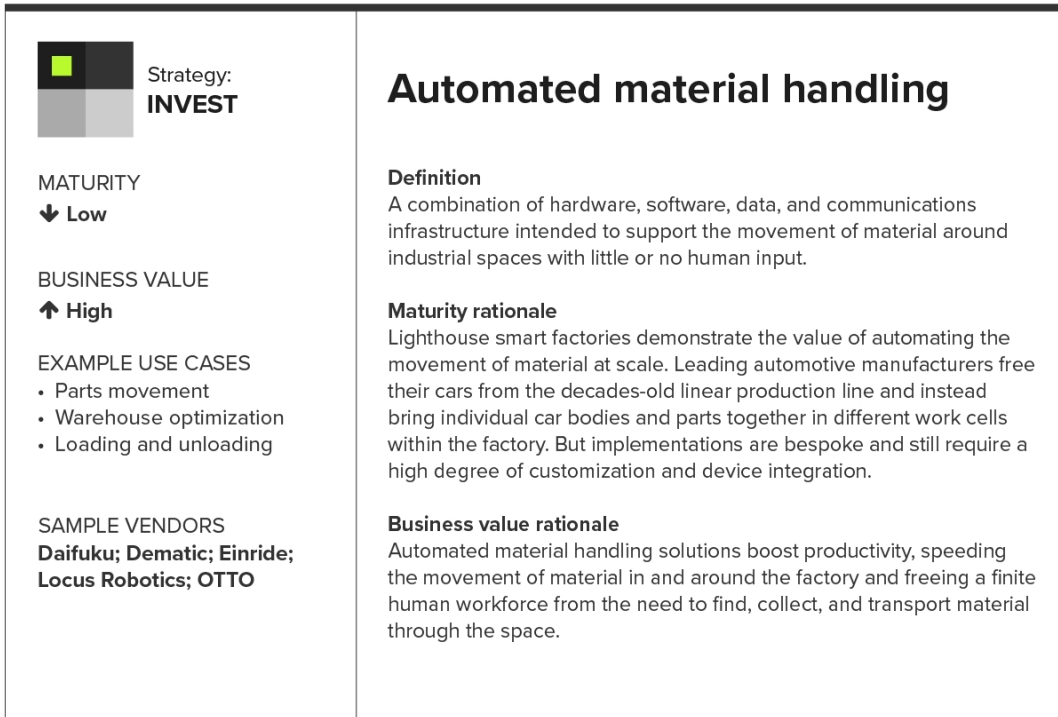
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Automated Material Handling

Autonomous mobile robots (AMRs), conveyors, autonomous forklifts and trucks, and other forms of physical automation tend to be better at **delivering material** from one point to another inside a controlled environment than a person pushing a cart (see Figure 10).

Figure 10

Invest: Automated Material Handling



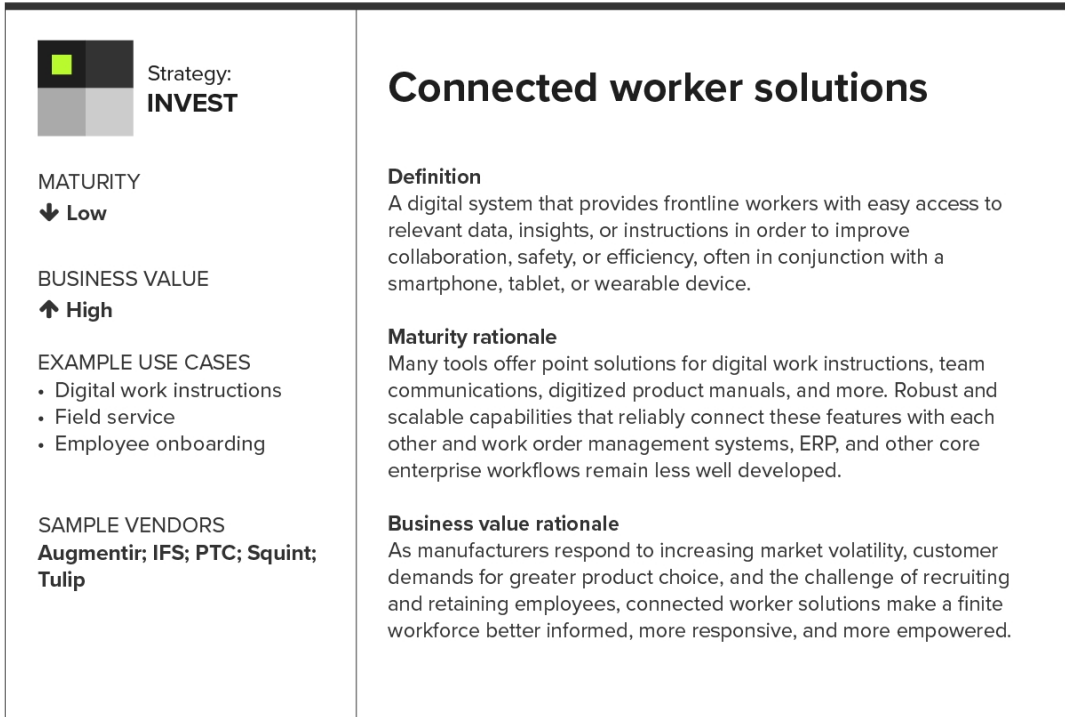
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Connected Worker Solutions

Connected worker solutions provide front-line workers with easy access to relevant data, insights, or instructions, improving collaboration, safety, and efficiency. Despite all the attention currently focused on artificial intelligence and robots, the human workforce **remains a critical piece** of most manufacturing workflows. Connected worker solutions give that human workforce the knowledge — and the agency — it needs to respond to a complex and rapidly changing working environment (see Figure 11).

Figure 11

Invest: Connected Worker Solutions



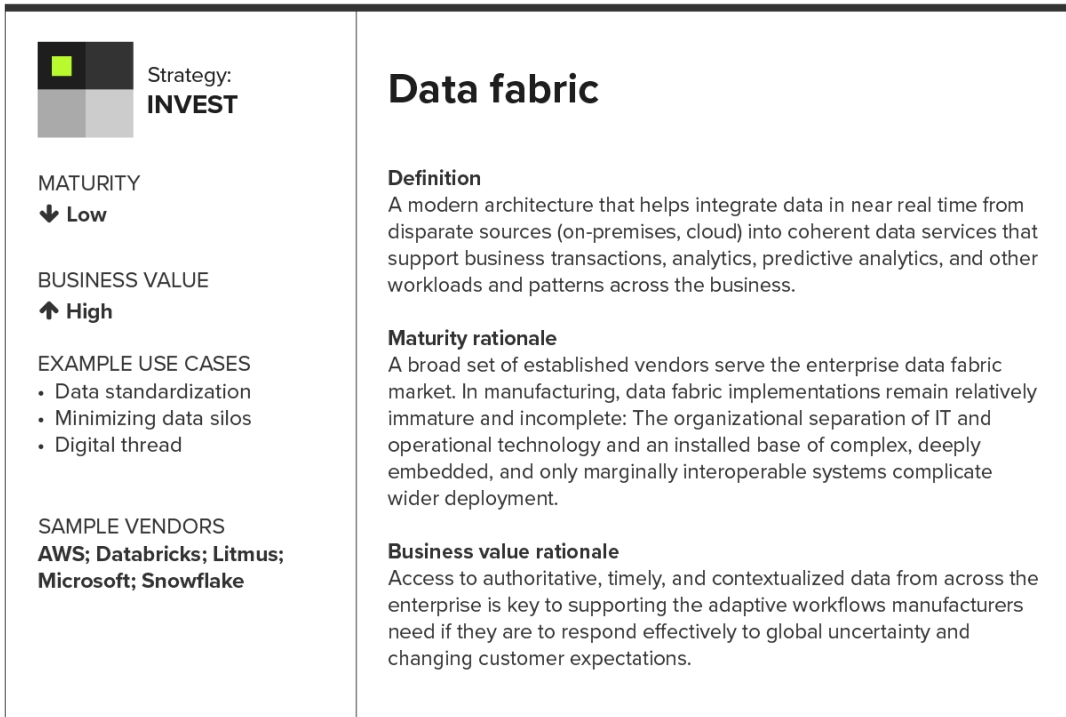
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Data Fabric

A [data fabric](#) addresses the gap between traditional data architecture and emerging business needs that cut across institutional and technological silos. Implemented correctly, a data fabric minimizes complexity and hides heterogeneity by embodying a cohesive model of data that reflects business requirements rather than the technical details of underlying systems and sources (see Figure 12).

Figure 12

Invest: Data Fabric



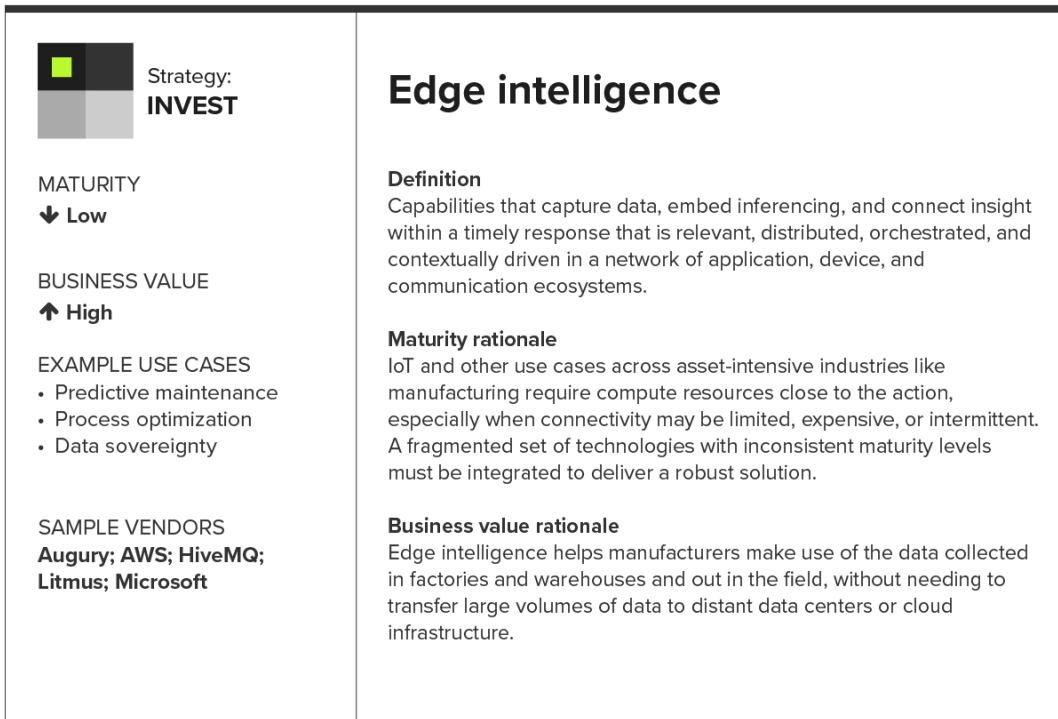
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Edge Intelligence

Edge intelligence is an evolution of IoT advanced analytics in which much of the data analysis and machine learning is done on compute resources that exist much closer to where the data is generated. This is particularly important in machine learning when dealing with large and unstructured datasets (see Figure 13).

Figure 13

Invest: Edge Intelligence



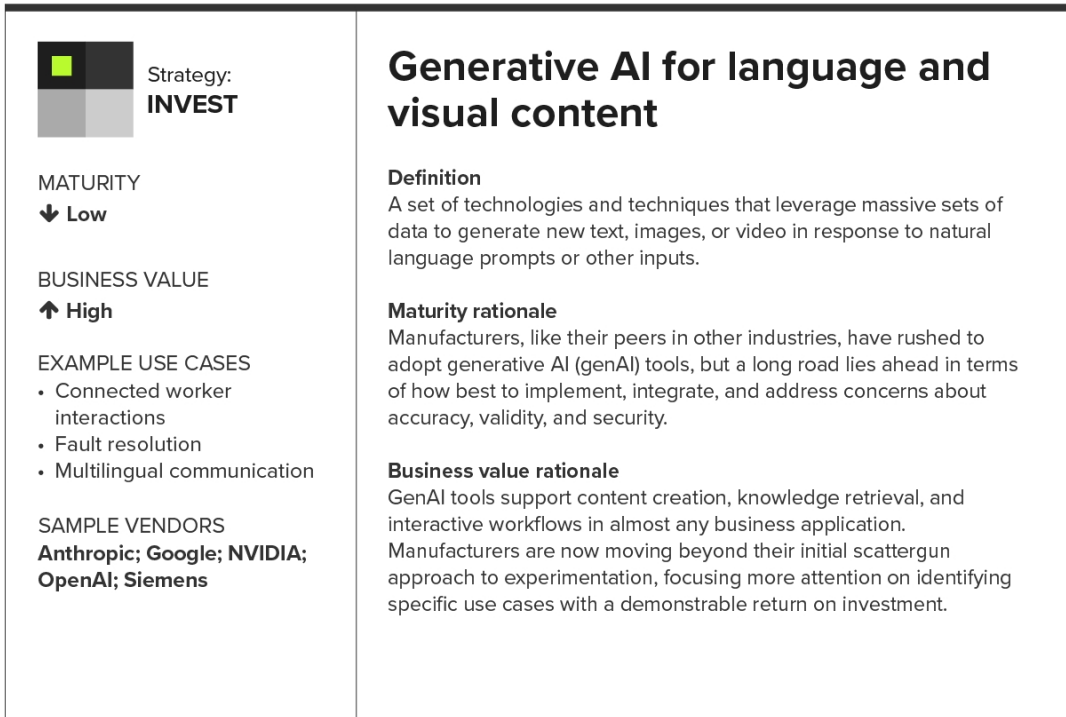
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Generative AI For Language And Visual Content

At least experimentally, generative AI enables many [use cases in the manufacturing sector](#), from letting a service engineer chat with the machine they're maintaining to supporting complex product design workflows. Specific technology and implementation decisions vary, but [generative AI for language](#) tools and use cases tend to be more mature and better understood than their equivalents for [visual content](#) (see Figure 14).

Figure 14

Invest: Generative AI For Language And Visual Content



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Maintain Connected Machines, Industrial IoT Software Platforms, And Others

Six of the smart manufacturing technologies fall into the Maintain quadrant of the Tech Tide, with high maturity and high current business value. Key technologies like connected machines, industrial robots, and manufacturing execution systems have been making their way into smart manufacturing workflows for years. They still deliver

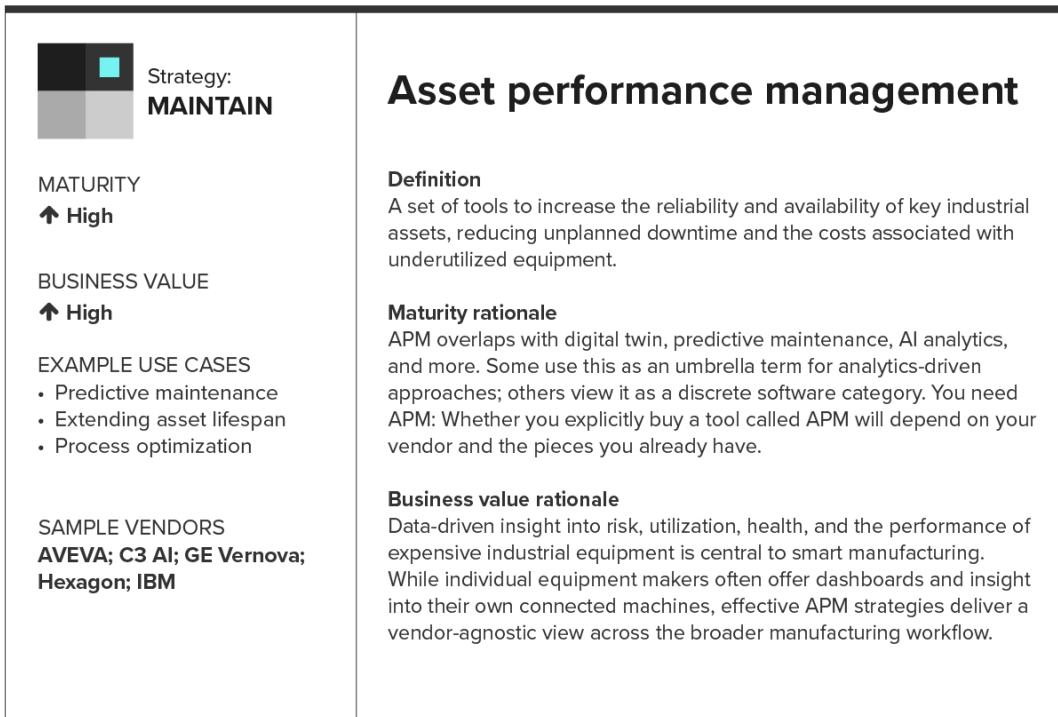
business value and continue to become richer, more capable, and more integrated. Double down on existing investments, maintaining your focus on these critical building blocks for your smart manufacturing strategy.

Asset Performance Management (APM)

Asset performance management combines several important concepts from the smart manufacturing domain, touching analytics and AI, connected machines, digital twin, and IoT to make the use and maintenance of expensive machines more efficient and predictable. Richly instrumented and well-understood machines can be valued differently, creating opportunities to sell outcomes rather than equipment. Some vendors explicitly sell an APM solution; others offer similar capabilities by extending other tools in their portfolio. Whatever your vendor calls it, you want some (see Figure 15).

Figure 15

Maintain: Asset Performance Management (APM)



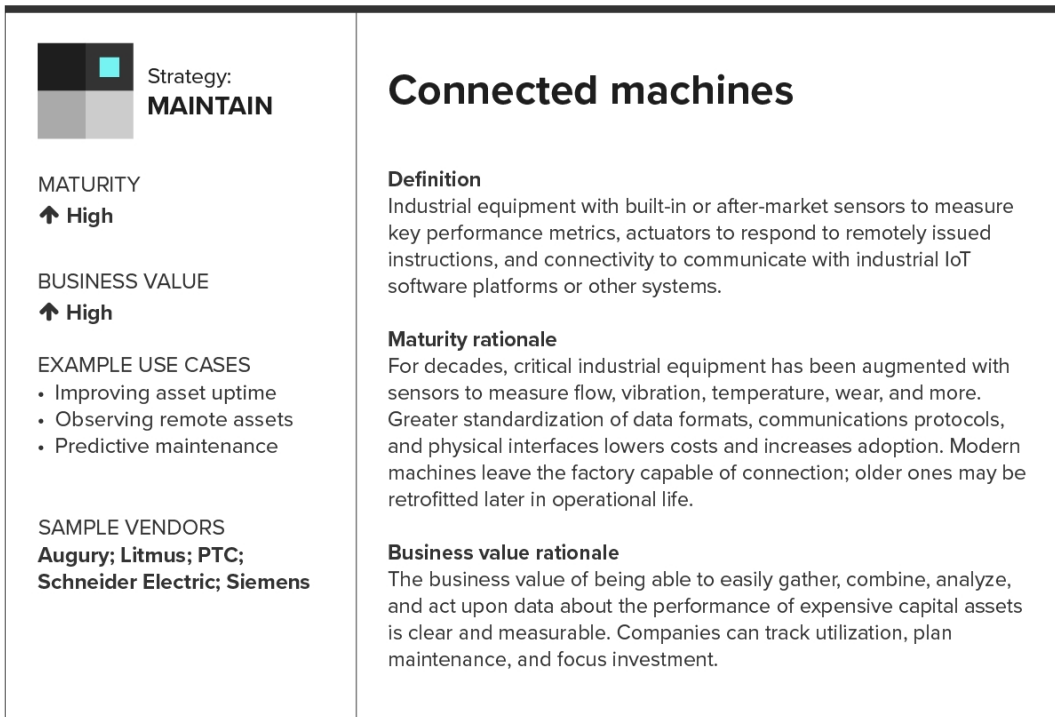
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Connected Machines

Smart manufacturing use cases like predictive maintenance, APM, and [anything as a service](#) (XaaS) require data about the state and use of machines. Makers of industrial equipment now tend to ship connectable versions of their products, but there's also an ecosystem of after-market sensors for installation in or alongside older machines. Data from connected machines is [a hot commodity](#), and machine makers, owners, operators, and maintainers are squabbling over it. Formal agreements to govern the use of this data lag some way behind the simpler work of generating and collecting that data in the first place (see Figure 16).

Figure 16

Maintain: Connected Machines



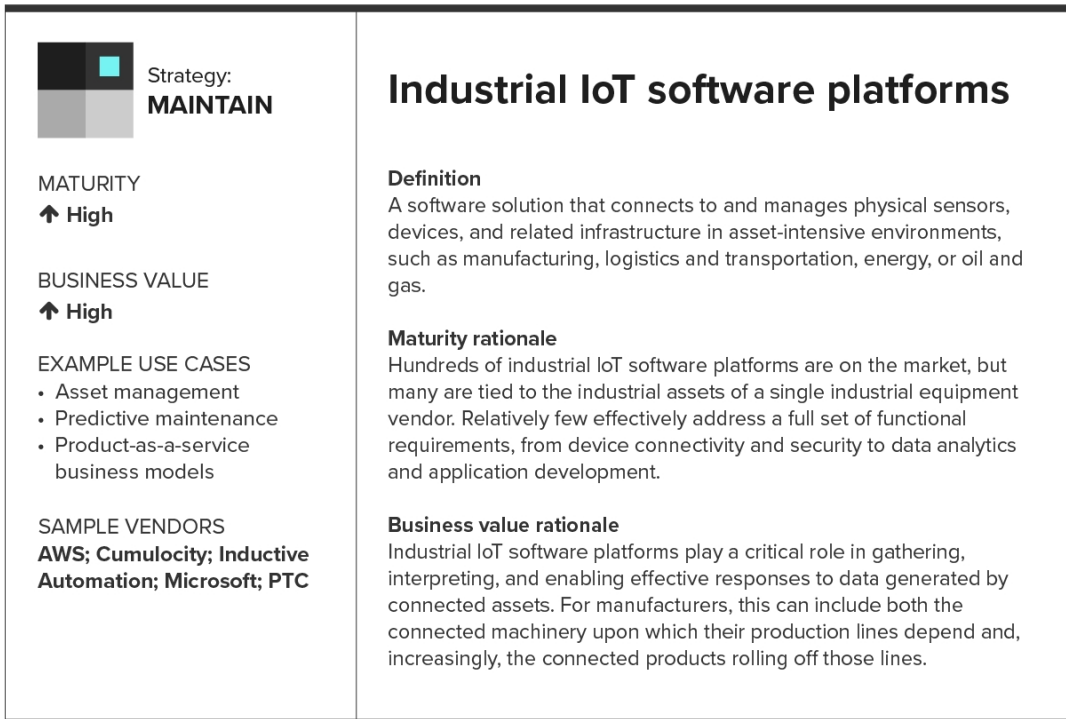
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Industrial IoT Software Platforms

Many firms use a platform to manage their IoT deployments. This segment is extremely fragmented, with hundreds of industrial specialists, hyperscale clouds, enterprise software vendors, and other technology vendors seeking to capture a share of the market. Forrester expects consolidation as participating vendors and systems integrators make acquisitions to extend their ability to support the fragmented array of IoT-specific software protocols, network interfaces, and devices (see Figure 17).

Figure 17

Maintain: Industrial IoT Software Platform



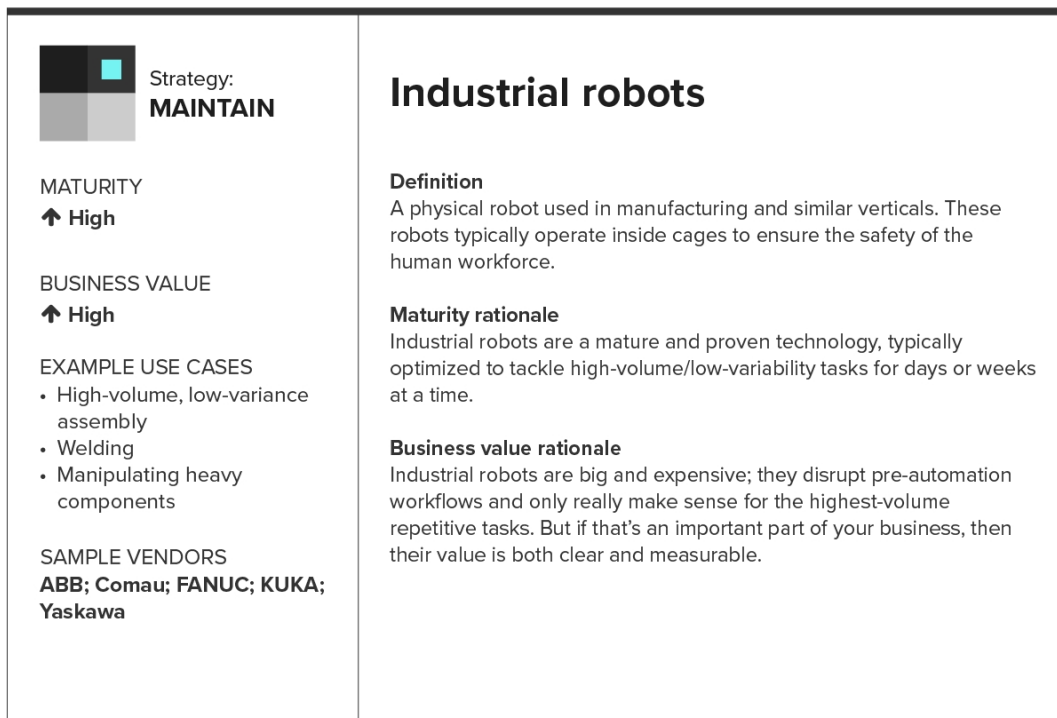
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Industrial Robots

Industrial robots — powered devices with one or more arms that can be programmed to move in three or more axes in support of industrial automation applications, including lifting, welding, etc. — have been around since the 1960s. They're typically fixed in place, often kept apart from the human workforce, and optimized to tackle high-volume/low-variability tasks like assembling identical car models or placing one specific bottle type in one specific box for days or weeks at a time. Employers, policy makers, and workers are still figuring out how best to [integrate robots alongside the human workforce](#) (see Figure 18).

Figure 18

Maintain: Industrial Robots



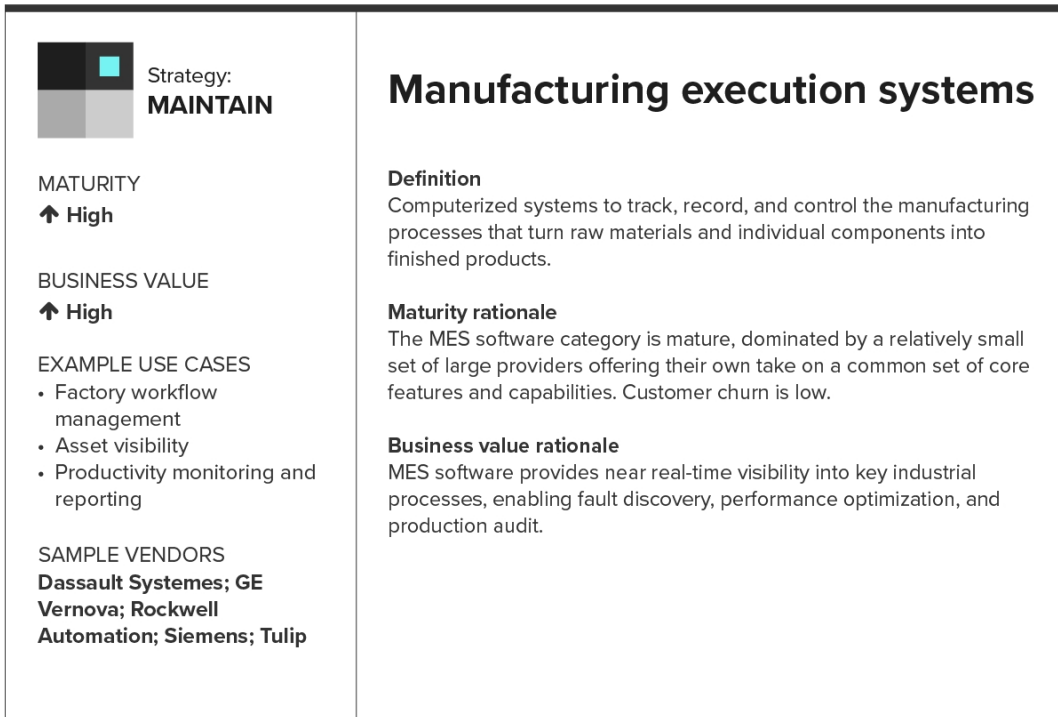
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Manufacturing Execution Systems (MES)

A manufacturing execution system controls the processes and materials that combine to deliver a finished physical product. This supports everything from resource scheduling on the factory floor to delivering a digital record of the product “as built,” which can be important in regulated industries or to precisely target product recalls. As manufacturers work to make their processes more resilient and flexible, the MES is increasingly being called upon to play a role within [manufacturing operations management](#) workflows (see Figure 19).

Figure 19

Maintain: Manufacturing Execution Systems (MES)



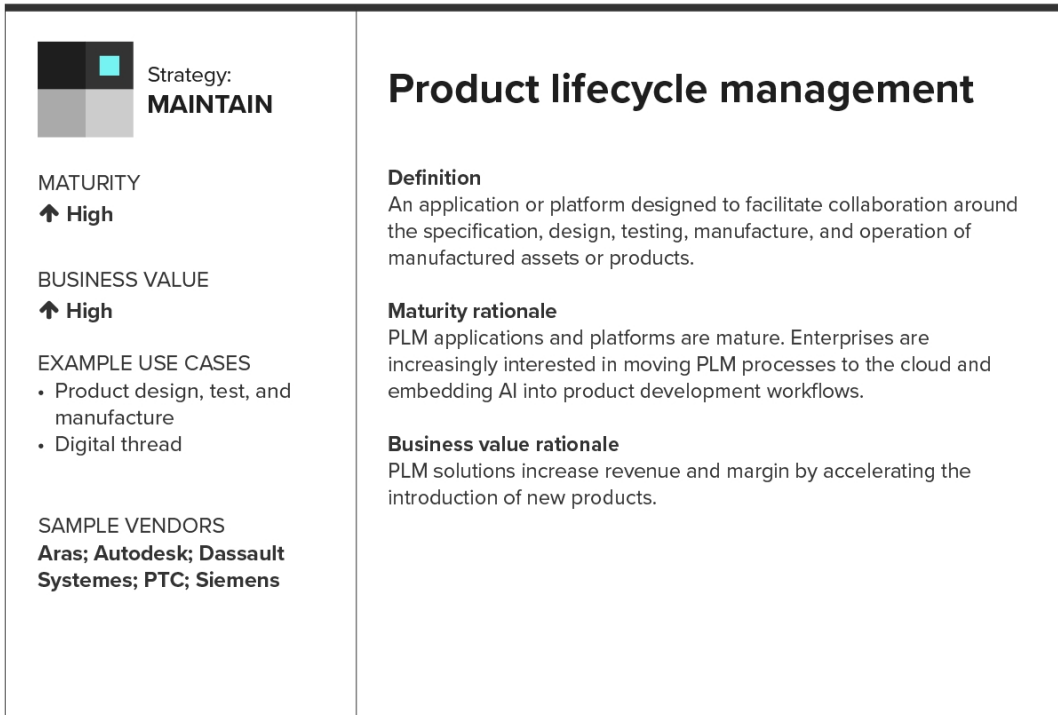
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Product Lifecycle Management (PLM)

Product lifecycle management solutions enable an enterprise to accelerate the development and delivery of new products and product variants. They provide a secure collaboration platform for gathering and validating requirements and for developing and testing designs, simulating their performance in manufacturing and in deployment with customers. PLM controls all elements of bills of material (BOMs), including mechanical, electrical, electronic components or subassemblies, and the versioning and testing of embedded software (see Figure 20).

Figure 20

Maintain: Product Lifecycle Management (PLM)



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Divest From Data Historian Software

One of the smart manufacturing technologies falls into the Divest quadrant of the Tech Tide, with high maturity and low current business value. But it would be wrong to assume this technology is no longer of value; it remains critical in specific use cases.

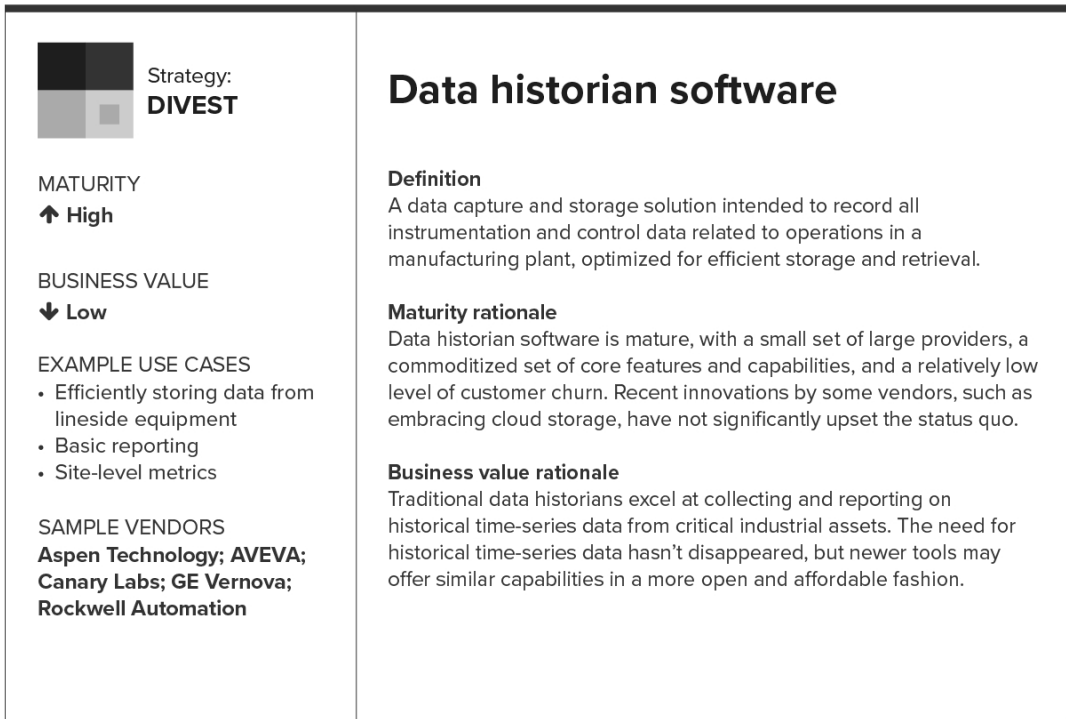
Rather, we're highlighting that other solutions are beginning to supersede the historian. Focus on the task you're trying to accomplish rather than the specific technology you've always used to accomplish it in the past: You may find that a newer alternative can do the job just as well.

Data Historian Software

A data historian collects large volumes of simple diagnostic data from a connected asset and stores it for subsequent reporting. Data from a historian is one input to a range of smart manufacturing use cases. As the type and volume of manufacturing data change, traditional data historians play a smaller role. These tools must either evolve to do more, slip quietly into a supporting role behind more-visible technologies, or risk being superseded entirely by other approaches to data collection and management (see Figure 21).

Figure 21

Divest: Data Historian Software



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Supplemental Material

Methodology

The purpose of the lists of sample vendors we include in the figures about each category is to further clarify the nature of the category — not to serve as a vendor selection shortlist for readers seeking to choose a vendor in that category. The fact that a vendor isn't included in a list doesn't indicate that Forrester believes it isn't worth considering. For guidance about vendor selection, Forrester publishes separate research (Landscape and Forrester Wave™ reports) in which Forrester analysts offer customized advice to our clients.



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