EBOOK

Industry 4.0 and AI:

What You Can Learn from the Leaders

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Where are manufacturers in 2025?

How effectively can we learn from each other and accelerate our progress toward Industry 4.0 and the use of AI? At our flagship MES & Industry 4.0 Summit in June 2025, we created a workshop designed to gauge progress and help participants learn from each other. We accomplished that, and in this paper, we are sharing it with others. What we learned also helped set the stage for the entire event.

This snapshot is based on a survey of respondents who participated in that workshop. Critical Manufacturing's Strategic Advisor, Jeff Winter, led the workshop and utilized AI to assist in designing the workshop and breakout sessions. AI also helped to aggregate, summarize, and contextualize the survey data to provide an in-depth view of respondents' progress on their Industry 4.0 journey. This paper includes a summary of the survey responses.

Although the dataset is small, we believe this report accurately reflects the progress leading manufacturers are making and where challenges remain. We hope these companies' experiences help you identify where you are on the journey and get new ideas on what to prioritize or discuss with your team.

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Industry 4.0 approach

Industry 4.0 is a journey, as we have been saying for years. It encompasses so much that projects must build on each other. As a result, companies may take very different approaches to get to their specific visions. In many cases, companies lack a clear definition of Industry 4.0. Many refer to it by other names, such as digital transformation or company-specific visions.

The question was: "What is your company's definition of Industry 4.0, and how formally is it documented and communicated?" In our group of respondents, about half have a documented Industry 4.0 Strategy, but many of those strategies are incomplete. The other half have no strategy, despite many having awareness or digitalization efforts underway. Our view is that Industry 4.0 strategy is best as part of the overall business strategy. See the Tech-Clarity strategy eBook.[1]

Responses span the spectrum:

"It is a very well-documented strategy, managed through a multi-year program."
"Industry 4.0 itself is not actually defined; we have a definition and documentation about manufacturing digitalization, which goes in that direction. We have it documented in a centralized tool where we have the governance regulations, directives, and guidelines."

"Loosely documented but not formal. We have a digital transformation process going."

"The strategy is not formally documented and has been primarily communicated verbally by C-level executives to project management."

Most manufacturers are investing in Industry 4.0, and they are investing the same amount or more than they previously did. According to one research study, over three-quarters plan to invest at least 20% of their budget in Smart Manufacturing. Note that these initiatives may take the form of modernization, optimization, or transformation.

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Leaders and benchmarking

Whether Industry 4.0 is a formally defined and documented strategy or not, companies do have people championing related initiatives. Approximately one-third of the participants have a cross-functional team leading the effort. A C-level executive is leading the Industry 4.0 program at nearly one-quarter of these companies. In approximately 13% of companies, IT leadership is leading this effort, and at another 10% of companies, operational technology (OT) or automation leaders are the primary champions. Only 10% have a dedicated Industry 4.0 leader.

A similar question, without the option to choose a team, in a Deloitte research study showed a strong inclination for the leader to be an Operations executive, followed by IT roles[2]. The cross-functional team approach can be highly effective if roles and responsibilities are clearly defined. We agree that having operations play a key role in steering the initiative is crucial.

We also asked "What do you currently do for Industry 4.0 benchmarking?" Industry 4.0 benchmarking is a common practice, with approximately three-quarters of these companies engaging in some form of it. They are taking a range of approaches, including formal (SIRI, SEMI) and external peer or event benchmarking. Others conduct internal benchmarking, or vendor/customer/academic benchmarking. Some report that their benchmarking is not very formal, but the fact that so many companies are doing it is encouraging.

Research from McKinsey and the World Economic Forum indicates very significant benefits from Industry 4.0 initiatives.[3,4] Given that potential, it makes sense to benchmark to ensure the company is keeping pace with the market.

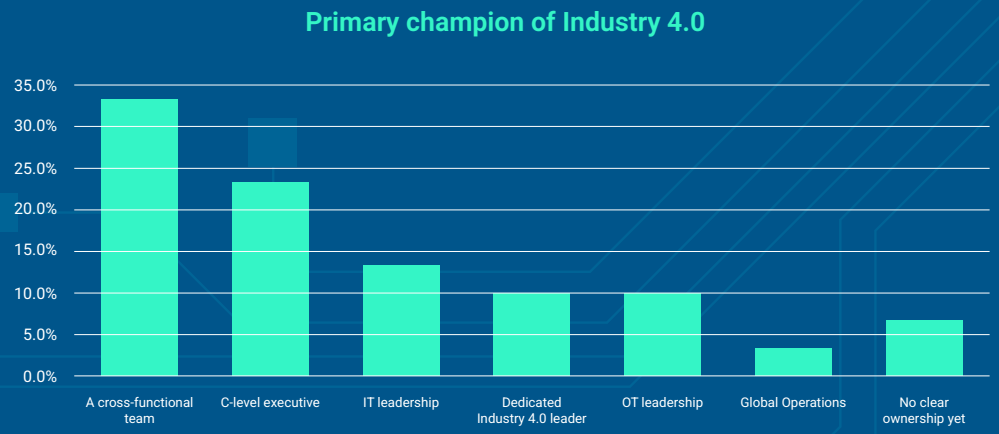

Figure 1: Primary champion of Industry 4.0

Here is a selection of responses gathered from the participants:

"We try to work with the SIRI maturity assessment. We want to benchmark the knowledge, technology readiness, and management awareness."

"We do benchmarking on our core production processes at fairs, and do reference visits in our region. We do this benchmarking in-house."

"No tools or frameworks. We are down-to-earth people with knowledge of their processes (and gaps)."

Industry 4.0 use cases in Pilot and in Production

● In Pilot ● In Production

Supply Chain Management		Design & Engineering		Manufacturing & Production		Maintenance		Safety		Quality		Information Systems & Cybersecurity		Warehouse & Inventory		Aftermarket / Customer Service	
44	66	52	65	123	129	45	53	57	60	83	132	105	114	42	60	32	40
15 16	End-to-end supply chain visibility	3 5	Generative design using AI	10 12	Collaborative robots	12 10	Anomaly detection	4 5	Wearable safety devices with real-time alerts	19 18	Automated in-line quality inspection	6 8	AI-powered threat detection and response	18 18	Real-time inventory monitoring	3 4	Aftermarket predictive maintenance
4 6	Digital twin of supply chain	11 13	3D modeling & simulation using Digital Twins	22 23	Real-time production monitoring	9 14	Asset health monitoring	1 1	AI-based hazard detection via cameras	15 17	SPC (Statistical Process Control) in real-time	8 10	Zero-trust security frameworks	2 2	AI-powered inventory optimization	3 4	AI-powered call center knowledge support
- 1	Blockchain for traceability & provenance	9 12	Additive Manufacturing	- 3	AI-powered process optimization	3 5	AI-powered predictive maintenance	16 14	Digital safety checklists & incident reporting	4 6	AI-powered defect pattern analysis	13 13	Cyber-resilience and backup systems	7 11	Autonomous vehicle delivery	4 8	AI-powered chatbots for support
4 5	Alternate component optimization	3 3	AR/VR/XR for design reviews	2 3	AI-powered production planning optimization	2 2	AI-powered root cause analysis	7 13	Environmental monitoring	4 14	Closed-loop quality control feedback	5 6	Security information & event management (SIEM)	- -	AI-powered dynamic load matching	2 4	AR/VR/XR for remote service assistance
1 3	AI-powered routing optimization	- 4	AI-powered failure mode prediction	- 1	AI-powered energy optimization	2 1	AI-powered maintenance planning	5 4	Proximity detection & collision avoidance systems	3 1	AI-powered process parameter optimization	17 11	Secure remote access solutions	2 7	Digital twin of warehouse operations	- -	AI-powered warranty claims optimization
- -	AI-powered inbound delay forecasting	7 5	Automated bill of material generation	- 1	AI-powered production line balancing	- -	AI-powered spare parts inventory optimization	6 4	Safety training via AR/VR/XR	2 2	Supplier quality collaboration platforms	8 6	Patch & vulnerability management automation	- -	Smart slotting & layout optimization	10 9	Connected product feedback loops
3 5	Intelligent supplier selection	3 9	Digital thread across product lifecycle	1 1	AI-powered dynamic scheduling	2 8	Contextual predictive maintenance	4 3	Behavior-based safety analytics	4 9	Automated non-conformance management	6 6	DataOps & pipeline orchestration	- -	Order processing chatbot	7 6	Remote asset monitoring & diagnostics
2 2	AI-powered raw material cost estimation	7 4	AI-powered coding	9 9	Autonomous mobile robots (AMRs)	14 13	Automated work order generation	9 11	Safety trend analytics	2 1	Voice of customer analytics integration	7 10	OT asset inventory and risk management	3 6	Predictive stock replenishment	3 5	IoT-enabled usage analytics for service planning
1 2	AI-powered raw material optimization	8 9	Digital twin of product	19 20	Digital work instructions & SOPs			1 1	Connected PPE with compliance monitoring	4 5	Predictive quality	4 5	Unified Namespace (UNS)	8 15	Warehouse automation		
4 4	Supplier risk monitoring via predictive analytics			7 10	Closed-loop production feedback systems			3 4	Real-time risk scoring	9 15	Machine vision for anomaly detection	9 10	Industrial data lake / data fabric	2 1	Predictive inventory depletion forecasting		
6 5	Connected supplier portals			22 21	Digital performance dashboards					13 21	In-line quality analytics	1 2	Semantic data modeling				
3 3	Carbon footprint tracking			9 6	Digital twin of factory, line, or equipment							1 5	Edge architecture for pre-processing & local autonomy				
												6 2	Low-code/no-code integration layers				
												4 2	Federated data governance frameworks				

Figure 2: Industry 4.0 use cases in Pilot and in Production

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Industry 4.0 in use

Regardless of a company's position in the Industry 4.0 journey, most have already implemented and use some technologies. Across various disciplines core to Industry 4.0, we asked them to select all 'In production use cases.' We also asked which ones are in pilot. The chart on the previous page is a tally of these responses.

Manufacturing and production

Real-time production monitoring and digital performance dashboards are in use by over two-thirds of these companies; over half also use digital work instructions and SOPs. MES often includes all of that; Critical Manufacturing MES also incorporates a visual digital twin of the factory, a technology that a third report their company is using. The next most commonly used Industry 4.0 technologies in production are robots, specifically collaborative robots and autonomous mobile robots (AMRs). Note that as many or more companies have these technologies in pilot as those that use them today.

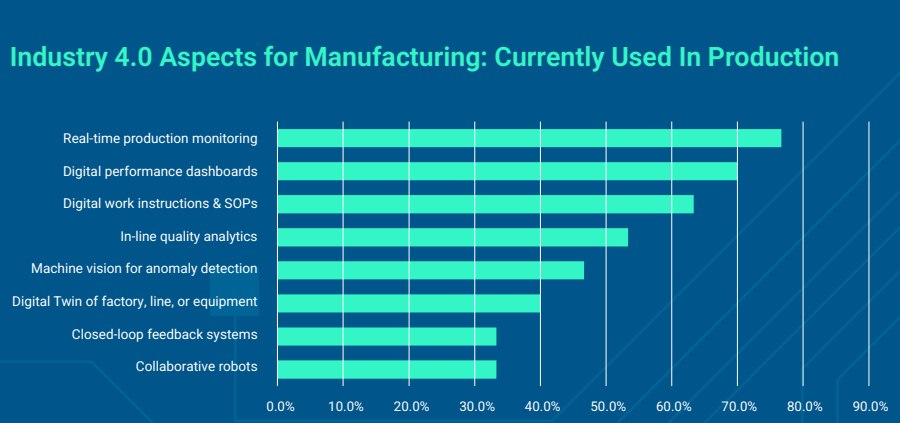

Figure 3: Industry 4.0 Aspects for Manufacturing: Currently Used In Production

MES may also encompass quality, maintenance, and inventory management.

- **Quality:** Nearly two-thirds report using automated in-line inspections. Half have statistical process control (SPC); nearly half have in-line quality analytics. Again, many are piloting a wide array of quality systems, including all of those listed here.
- **Maintenance:** Nearly half of the companies have automated work order generation, followed by anomaly detection. Nearly a third have asset health monitoring. A few also use contextual predictive maintenance. These are also most commonly in a pilot.
- **Inventory:** 60% have real-time inventory monitoring. Over a quarter use warehouse automation, and nearly that many also use autonomous vehicle delivery. Many of these manufacturers have pilots in these areas.
- **Supply chain:** Half of the workshop participants report having end-to-end supply chain visibility, which is impressive, considering it is not an easy feat to achieve. Nearly one-quarter have connected supplier portals. One in six companies has a digital twin of the supply chain, and one in six reports using alternate component optimization.
- **Design and engineering:** 40% use some type of product digital twin, nearly a third use additive manufacturing or 3D digital printing; almost a quarter claim automated BOM generation, and the same number have a digital thread through the entire product lifecycle.
- **Aftermarket/customer service:** Over a third of these companies utilize connected product feedback loops, and a quarter also employ remote asset monitoring and diagnostics. A handful of participants use AI-powered chatbots for support.

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Industry 4.0 challenges

Every journey has its obstacles. We asked: "What's the main challenge slowing your Industry 4.0 progress?" We expected some common challenges, including data and system complexity, unclear ROI, cultural resistance to change, a lack of internal expertise, budget constraints, and uncertainty about where to start. In addition, respondents identified the following challenges: establishing robust data foundations, time/resource constraints, and harmonization and standardization.

Later, we had another question asking: "What areas of Industry 4.0 is your company currently struggling with the most right now?" We have grouped the responses into six key themes:

- **Strategy and priorities:** These issues encompass prioritizing projects, determining where to begin, and identifying AI use cases.
- **Business case and financial:** Some struggled to identify the value, the drivers for investment, or to secure a budget or have resources allocated to the initiative.
- **Organizational and cultural:** These issues include adopting a central or enterprise approach, coordinating efforts, collaborating across disciplines (e.g., data engineers and process experts), and building trust or overcoming resistance to change.
- **Data:** Some of these issues include extracting data from equipment, gaining value from data, ensuring it flows across the enterprise, handling manual data inputs, and achieving a common data model.
- **Technology and IT/OT:** These struggles tend to center around cybersecurity, machine connectivity, automation complexity, Process digitalization, and one mentioned APS, or detailed scheduling.
- **Combination:** Some of the struggles likely involve processes, technology, and organization, such as MES rollout, standardization/ harmonization, and scaling up from pilots to full production use.

This is a close match to what other research shows are some barriers to Industry 4.0 progress.[5] Lack of top management commitment, funding, inadequate training, and lack of IT infrastructure, along with many other dependent issues, are what we commonly see. Our experience shows that companies that perform best have management commitment and understanding that enable them to make appropriate investments in training, IT, and automation.

Participants shared their perspective in this topic:

"We're wrestling with scaling from foundational digital integration to intelligent, adaptive operations."

"Machine connection, Common data Model for Machines and Integrations. Missing MES and SCADA layer."

"Complexity of automation; Complexity of rolling out MES to 30+ factories; Moving from custom programs to an enterprise platform."

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The longstanding IT/OT divide

Most companies are probably struggling for one other reason: IT and OT are not on the same page. The question was: "Are your IT and OT teams aligned on digital initiatives?" None reported having a fully integrated digital IT/OT team. Only about a third have strongly aligned IT and OT teams with joint goals. Nearly half are working on some shared projects, but almost a quarter are just starting to collaborate or still work in siloes.

We expect that the other two-thirds will struggle until the IT and OT teams, as well as the data, come together smoothly for Industry 4.0.

Are your IT and OT Teams aligned on Digital Initiatives?

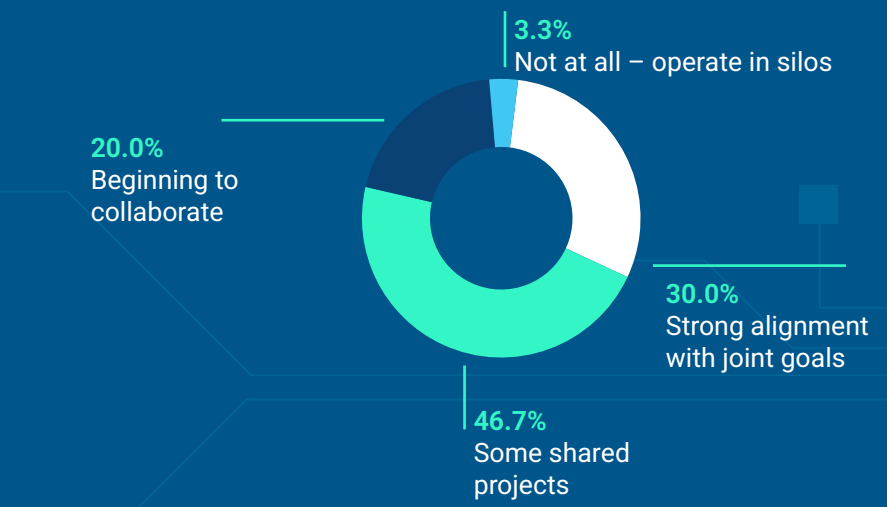

Figure 4: Are your IT and OT Teams aligned on Digital Initiatives

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Measuring Industry 4.0 success

Industry 4.0 is a complex journey for an enterprise; there are many ways to measure success. Our question was: "How do you primarily measure success for your Industry 4.0 efforts?"

In order of prevalence, this group of companies uses strategic value, operational metrics, and financial impact to measure success. Some use a combination of these types of success gauges. A few also use project-level metrics or adoption rates. There is also a group that's still figuring it out.

While metrics may not seem important, companies can often benefit significantly from consistently measuring their progress in Industry 4.0. Every company will have its own approach to match other metrics and methods. Note that each measurement approach may drive different behaviors, priorities, and outcomes for the company's Industry 4.0 projects. It is thus ideal to ensure metrics are aligned with the business strategy to achieve desired results.

As an attendee noted:

"Typically, [we measure Industry 4.0 success] on the level of improvement using multiple KPIs (e.g., scrap, delivery reliability, equipment effectiveness, ROI, etc.) Obviously, financial impact is the major measure."

How do you primarily measure success for your Industry 4.0 efforts?

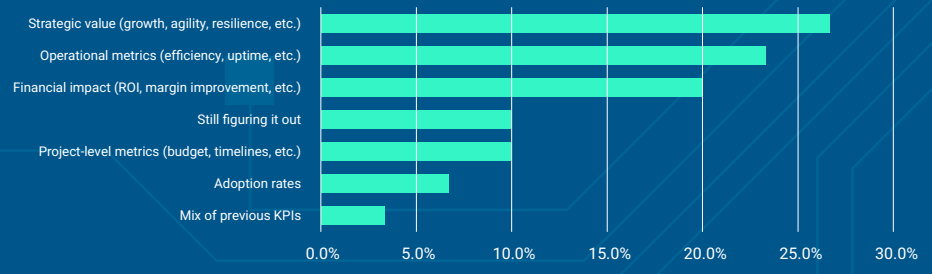

Figure 5: How do you primarily measure success for your Industry 4.0 efforts

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IT foundations

IT infrastructure and foundational elements are crucial to the success of Industry 4.0 efforts, as well as to the success of AI. We asked: "Indicate in production use cases for information systems and cybersecurity."

More than 60% of these companies have secure remote access solutions. Over one-third have an OT asset inventory and risk management system in place. After that, nearly a third have an industrial data lake or data fabric, a low-code/no-code integration layer, and patch and vulnerability management automation. Security Information and Event Management (SIEM) is in use by over a quarter of these companies.

Approximately one-fifth have DataOps and pipeline orchestration. Fewer than that have cyber resilience and backup systems, federated data governance frameworks, a Unified Namespace (UNS), or zero-trust security frameworks, but more than one in ten have each of these in place.

The complex landscape of systems can make these foundations challenging, particularly for brownfield operations and larger companies with many production sites. With manufacturing still the top target industry for cybersecurity breaches, enhancing security is vital for risk reduction. IT is an enormous and ever-evolving field, and manufacturers will likely always be updating their information technology foundations.

We recommend asking solution providers about their architectures, including both their latest offerings and those in their plans. Press them to discuss how they will support your cybersecurity, risk, and integration needs now and into the future. When selecting new providers, look for solutions that have a proven track record of staying ahead of or meeting the evolving needs of industrial IT.

IT and Cybersecurity Aspects of Industry 4.0 Currently Used in Production

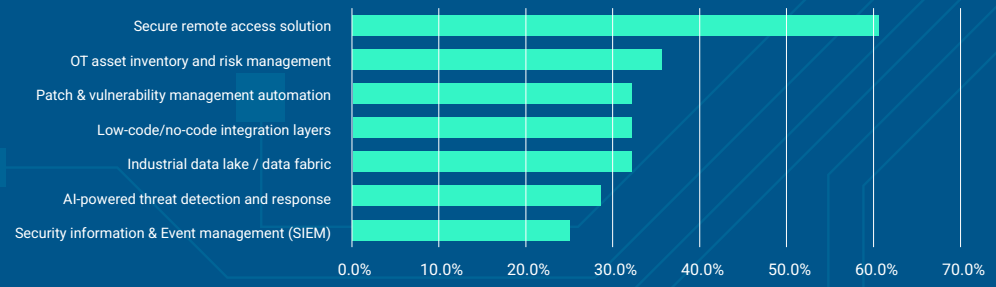

Figure 6: IT and Cybersecurity Aspects of Industry 4.0 Currently Used in Production

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Data collection and management

At the foundation of Industry 4.0 digitalization, automation, and analysis is data. How the data is collected, governed, and stored can be crucial to its usefulness. We asked: "How are you doing data collection, centralization, and contextualization for purposes of analytics? Please explain both the strategy and the architecture, if possible."

This group showed no predominant approach to data collection, centralization, and contextualization. In order of frequency, they use:

- Enterprise data lake strategy with structured ingestion pipelines for multiple functions
- Hybrid or transitioning from legacy to new architectures
- MES-centric with Power BI
- Data hub or UNS to integrate OT and IT
- Excel-centric legacy approaches are still in about an eighth of companies
- A few consider themselves to have a mature, advanced architecture with event streaming
- A few do not have an enterprise strategy, but only localized approaches.

Many companies are still developing an enterprise approach to standardize, contextualize, and centralize data collection and storage methods.

Part of the Industry 4.0 challenge is that the data that manufacturers ideally correlate and put in context is in many formats, some structured, but much is also semi-structured or unstructured.

In addition to the production data itself, plant operations often utilize data from the enterprise and reporting, as well as semi-structured design & engineering data, specialized spatial, video, visualization, and time series data that are unstructured.

We recommend careful consideration of data structures. Beyond modern approaches to real-time data collection, you need systems that ensure all data is collected and that the process requires valid data before proceeding. In addition, systems ideally put the data into a useful context, enable easy but secure access for integration, ensure sound governance, and deliver a view of provenance for full data traceability.

Companies report differing levels of advancement:

"We leverage AWS for data ingestion and Power BI for visualizations of the data collected from our various systems related to finance, sales, production, and quality. Our strategy is to establish a unified, automated, and standardized data framework that ensures accurate, governed, and accessible data for reporting and performance metrics."

"Through multiple layers and methods (including IOT), Event Streaming (Kafka), Data Platform (Canonical Objects)."

"Investing in machine-level (PLCs, gateways) software and standardization for new machinery/assembly lines. For legacy systems, investing in middleware that enables data collection and data harmonization."

"Digital twin architecture for manufacturing. Yield management system for inline metrology and test."

"Strategy is to get all data into a data lake in the cloud, build a contextualization layer, and then allow end users for data consumption."

"We are in an active transition phase. Data collection is currently handled through a mix of PLC interfaces, MES (Critical Manufacturing), and ERP (SAP ECC). … Our architecture is trending toward: OpenShift containerization, ClickHouse for high-volume analytics, MES as a structured data capture layer, and Eventual ERP-MES data contextual sync. This is a strategic evolution still underway."

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AI use: ML traditional AI

AI is the hottest topic in any digital discussion today, including manufacturing. Yet not all AI is new; manufacturers have been using Machine Learning (ML) for a long time. ML is a form of AI that learns from data, rather than explicit programming, to identify patterns, make predictions, and improve system performance over time.

The question was: "Where have you had the most success so far with Traditional AI / Machine Learning?" The largest portion states that their company makes minimal use of any form of machine learning or AI in its production operations. This may be because much of it is embedded in other existing programs. Often, algorithm-based systems do include ML and improve their performance over time.

The most common use case for ML is machine vision or optical inspection, used by nearly a quarter of those who report. A few also report using ML in scrap reduction and rework. This aligns with other industry research, which shows that AI and ML in manufacturing are most commonly focused on quality control, cybersecurity, and process optimization.

Participants also reported that their companies are using ML for process optimization, generating synthetic data for optimization, process automation, OEE, and scheduling. We often see ML pattern recognition delivering benefits in predictive analytics.

ML can be extremely valuable in production since it is good at handling complex, data-rich problems requiring pattern recognition, prediction, and adaptation. ML is far more dynamic than systems that use static rules. If you are not sure about your use of ML and other traditional AI, ask your solution providers if they use it in the software you have. Terms like algorithms, inferences, deep learning, regression, and models may or may not refer to ML, but often do. Do not underestimate the power of these existing capabilities to keep pace with your ever-changing operations.

Organizations stand at different points:

"AI and machine learning projects are implemented for the given use cases, where the 'projects' can be small and dedicated, gaining the biggest ROIs."

"So far, we haven't integrated any AI solution into our processes; nevertheless, we've used AI to generate synthetic data to do process optimization."

"Pilot projects are set up to support rework operations in production based on AI."

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AI use: GenAI & Copilots

Large Language Models (LLMs) and Generative AI (GenAI) have emerged strongly in the past year or two. GenAI is a type of AI that learns from vast datasets of existing information to create or generate new, original content, such as summaries, text, images, audio, and video. While models that utilize the Internet are widely used and well-known, manufacturers often prefer to train models on their company's data alone to ensure both security and a minimal risk of pulling incorrect or irrelevant data.

The question was: "Has your company developed a company-specific Gen AI tool or Copilot interface leveraging company data? If so, where are they being used, and what data is it accessing?"

One semiconductor and one electronics company are using a genAI copilot across their entire organization, but they are exceptions. Several others said yes, but did not elaborate.

Specific areas of GenAI success include manufacturing machine and process parameter value analytics, as well as the resulting automatic adjustment of machines, manufacturing engineering, and support functions.

For companies with software development, GenAI is used to automate the creation of user stories and test scripts, as well as other code generation tasks. One of these manufacturers is piloting GenAI for MES field documentation and decision support.

Most companies that use Copilot appear to utilize it primarily for office functions, rather than for manufacturing or production-related tasks. Some of these manufacturers have their own GenAI tool, while others use a generic one, such as MS Copilot or Enterprise ChatGPT.

If you plan to use GenAI and Copilots, be sure to limit the datasets they train on and use to respond, to achieve better performance and minimize risk. Your own clean data about the operation, including documentation from your equipment and software providers or external curated data, may be all you want. Some software providers have integrated these functions into their systems in a manner specific to industrial data sets and their unique needs.

Companies shared their perspective:

"Yes. Some examples are manufacturing machine and process parameter value analytics and resulting automatic adjustment of machine, or another example is analysis of administrative processes."

"It is being used, yes. In my specific area, we mainly use it around automating the creation of user stories, test scripts, etc..."

"We are actively exploring Gen AI use cases internally — particularly around documentation generation, knowledge base summarization, and system interaction assistants, but no company-specific tool has been deployed yet. Pilot efforts have included experimenting with Gen AI to assist with MES field documentation and decision support, but nothing has been formalized or integrated with company data."

"No AI solution has been integrated, but conventional solutions (for modeling and quoting) use company data (manually fed)."

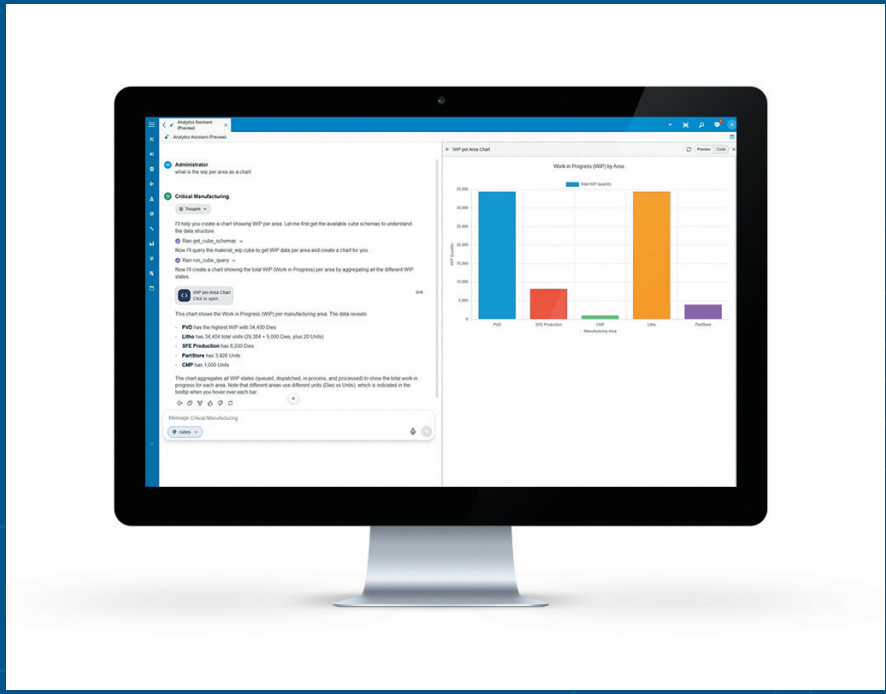

Figure 7: Critical Manufacturing's Analytics Copilot

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AI use: agentic AI

Agentic AI refers to autonomous, goal-oriented AI systems that can reason, plan, and act with minimal human oversight by accessing tools, data, and the internet to complete complex, multi-step tasks. Often, agents have a very narrow focus and are used in conjunction with other agents that may verify them or perform adjacent tasks.

Our question was: "Is your company using Agentic AI? If so, describe where and how." Only three companies in this sample report having agentic AI. One uses their own company flavor for repetitive tasks; one is creating a manufacturing framework with agents, and one did not elaborate.

Three more companies have implemented agentic AI pilots or are planning to do so. Most do not yet have a formal agentic AI approach.

Agentic AI is a technology that can be very useful in automating repetitive tasks that are low-risk to the operation and business; however, it is still in its early stages of development. Risk-averse manufacturers may adopt agentic AI slowly, even though it can take automation to the next level. As application software providers begin to weave it into their offerings, we see an opportunity for faster adoption and ROI with task-specific agents.

The use of guardrails, human-in-the-loop approaches, and employing agents to verify the work of other agents can all mitigate risks. Transparency in the data sources the system uses, as well as the reasoning behind responses, will also be necessary for safe adoption in industrial settings. Note that these are not deterministic, so where safety is involved, Gen and Agentic AI are not optimal choices.

Organizations are in different stages:

"Yes, we have a company-specific intelligent assistant that supports repetitive tasks."

"Some pilot use cases on the front end of the business."

"No formal use of Agentic AI is in place yet. We are in the early stages of exploring autonomous decision loops, particularly in the context of Real-time alerts driving automated adjustments and rule-based program dispatching to machines (e.g., Carel/HVAC systems). However, these are still governed by deterministic rules rather than autonomous agents."

"No, unless you include a chat collaboration robot for self-service under this definition. If you talk about self learning, neuro-logical network, context-aware, and distributed real-time...then no."

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Focus for current year

While Industry 4.0 is a many-faceted journey, most of these companies have some specific areas of focus for the year. We asked: "What is your company's biggest focus for the next year related to Industry 4.0?"

Topping the list, at about half, are items related to MES. These include deploying, stabilizing, rolling out, integrating MES with equipment and enterprise systems, and adding functions. Refer to the MES Buyer's Guide for guidance on this process.[8] While only a component of Industry 4.0, most companies regard MES as an essential foundation where an array of production data comes into context and automatically guides, monitors, and records production activities.

Data-related initiatives are also reasonably common, as this is a foundation. Specific focus areas include ensuring the accuracy of structures, contextualizing data, building trust in the data, and preparing data for use in optimization. All of these are critical data operations and governance tasks that will enable success with Industry 4.0 and AI.

Machine connectivity and IT/OT data flows are also relatively common focus areas for the year. Creating valuable, complete data sets in a manufacturing environment requires the IT and OT data to be in context. For most companies, this requires extraordinary effort.

Despite the hype, relatively few cited AI programs as a priority focus for the year. Working on foundations is an excellent approach for both Industry 4.0 and subsequent AI successes. Overall, this group of manufacturers has sound priorities.

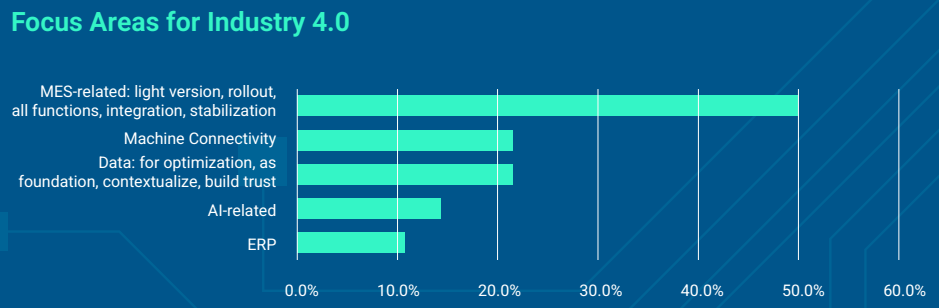

Figure 8: Focus Areas for Industry 4.0

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Summary of manufacturers progress

- Industry 4.0 is underway, even though only about half of manufacturers have a formal enterprise strategy in place.
- Typically, a cross-functional team or a C-level executive leads the Industry 4.0 efforts. These are both likely pathways to success, as the program can impact every discipline within an enterprise.
- The participating companies appear to be somewhat ahead of the averages in larger public studies, but are progressing and facing similar challenges.
- Challenges are diverse, but the lack of strong IT and OT alignment with joint goals for digital initiatives is likely to hinder progress for most. Every aspect of maturity – process, technology, and organization – contributes to overcoming challenges.
- Companies measure the success of Industry 4.0 in various ways. As long as progress is evident, any approach can be successful in maintaining momentum on the journey.
- There is still considerable work to be done on the IT foundations for Industry 4.0. Except for remote access solutions, no other element of modern IT in our survey is in use by over 40% of these companies.
- Data approaches are varied. The complexity of the manufacturing data set, which encompasses structured, semi-structured, and unstructured data from multiple domains, makes the overall data management and governance approach challenging. We expect manufacturing data management to continue to evolve.
- Successes using AI of any type in production operations are rare in this group of manufacturers. ML tends to deliver value in quality use cases. Very few use GenAI beyond some administrative tasks. Agentic AI is rare, but some have it in wide use and pilots.
- Manufacturers are planning and considering numerous issues related to Industry 4.0 and AI. This group of experienced practitioners is demonstrating the breadth of issues involved and the need to continue pushing forward on the Industry 4.0 journey.

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Jeff's key takeaways

Jeff Winter, who developed and led this workshop, is a recognized thought leader and influencer in the manufacturing software and Industry 4.0 market. This event left him with these thoughts.

- Industry 4.0 is still very much a hot topic, and everyone wants to know two things: 1) What can you do? 2) What is everyone else doing?
- The fact that every seat was filled, and it required homework to attend, shows this level of interest.
- People generally want to help each other on their journey, as shown by the collaboration, the "Can we have more time to discuss?" during the breakout sessions, and the exchange of business cards.
- Even the best company in the room is still only using a fraction of the total possible use cases, demonstrating that there is still considerable room for growth.
- Everyone wants to know what to do with AI.

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Workshop and survey background

The second MES and Industry 4.0 Summit (MESI 4.0 Summit 2025) was the largest event of its kind in the world. To help us prepare for this event, we requested that manufacturing participants complete some 'homework' in the form of an online survey. We analyzed their responses and presented them in a manufacturers-only workshop.
This understanding of where manufacturers are in their Industry 4.0 journey and what they are doing with AI was a foundation for the program's agenda. We used ChatGPT to help formulate some of the questions, illustrating our own use of AI.

Some of the questions were open-ended to get more flavor. We have included some of those responses as anonymous quotes throughout this paper. A half dozen of the participants also shared their learnings and best practices. We thank everyone who participated for making it such a rich learning experience.

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Citations

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