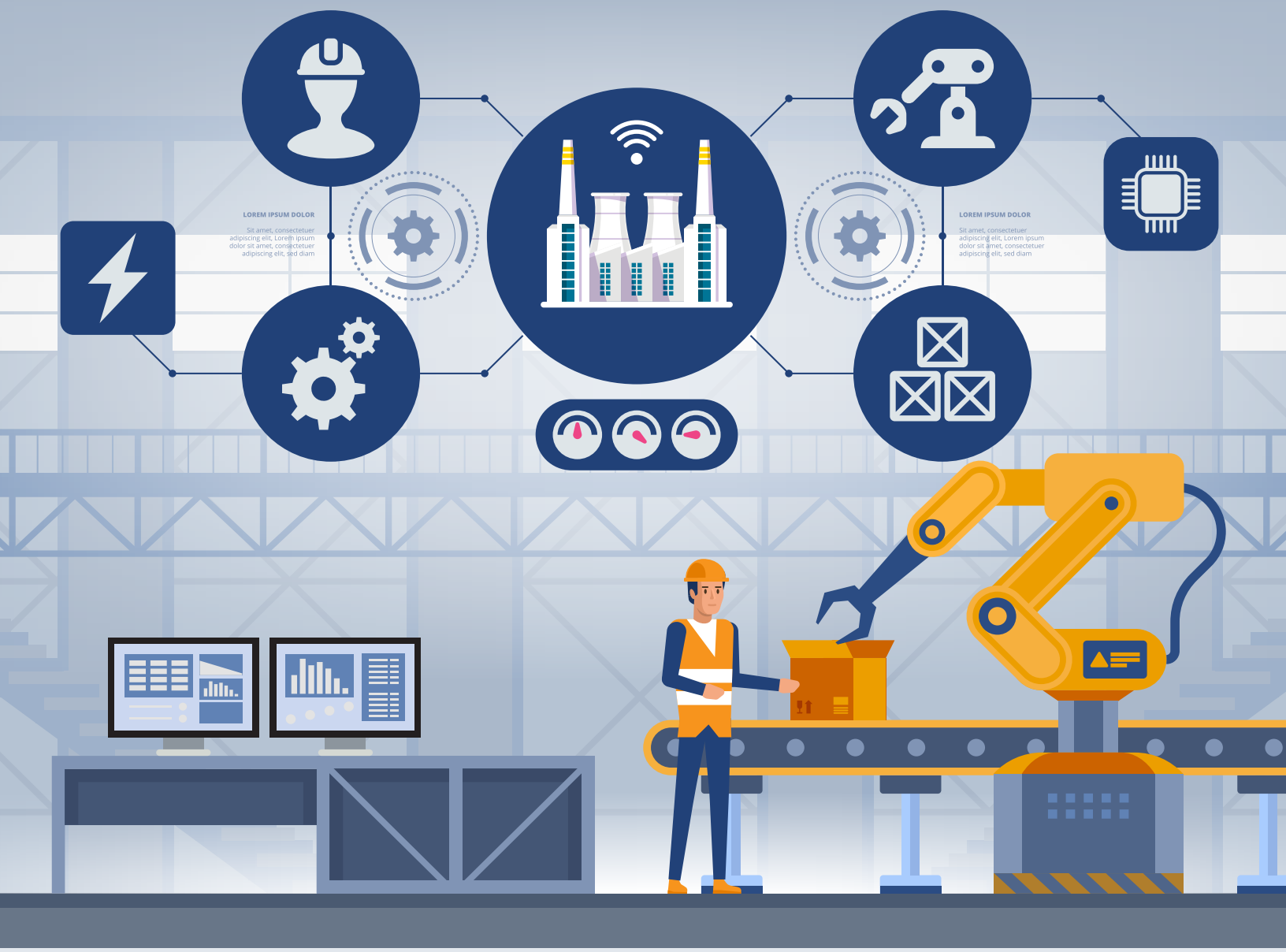
SMART INDUSTRY 4.0



The Building Blocks of Digital Transformation

LCE smartr

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Seven Readiness Steps to Accelerate Industry 4.0 Success

The constant buzz around digital transformation and Industry 4.0 is reaching a fever pitch. With it comes the growing assumption that asset-intensive organizations understand it, want it, and its success is assured. The reality, however, is more nuanced.

The concept itself is decidedly appealing: Who wouldn't want intelligent, self-optimizing digital manufacturing and maintenance solutions that simplify decision making, elevate performance and productivity, increase uptime, and slash costs?

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Yet, the prospect of transformational change can seem overwhelming. For executives and department heads, it is a multifaceted cost-benefit decision that weighs a potentially substantial return on investment (ROI) and key performance metric gains, the risk of missing out competitively, considerable technology and organizational culture change, and implementation complexity and costs. For front-line personnel, revolutionary advancements may be exciting for some and elicit concerns about skills adequacy, job security, and loss of control for others.

Early adopters of Industry 4.0 initiatives – whether limited pilot implementations, larger application or site deployments, or extensive greenfield projects – undoubtedly encountered stumbling blocks along the way. Anyone considering or beginning the strategy can avoid the obstacles with some foundational preparation. Even those already on the journey would do well to revisit the building blocks to accelerate and improve their results.

This paper examines the great promise of Industry 4.0, why it has been slow to catch on, its crucial relationship to asset management, and seven building blocks for digital transformation to accelerate the journey and maximize the outcomes. To lessen the load, trusted partners can help fill the gaps.

Why the surging attention?

Understanding the concept requires differentiating the terminology. Digital transformation, digitalization, and smart manufacturing are all aspects of Industry 4.0. In brief:

- **Digital transformation** applies digital technologies to existing or new processes and services, transforming how business is conducted.
- **Digitalization** is converting non-digital data and documents into a digital format so it can be processed by computers.
- **Smart manufacturing and smart factories** incorporate intelligent analytics, big data, digital technologies, and automation to optimize manufacturing processes.
- **Industry 4.0,** the fourth industrial revolution, merges machine and human capabilities through connected systems, real-time digital information, and smart and autonomous technologies to reimagine business models and enable transformational change throughout the organization.

Compared to the first three industrial revolutions (water and steam power for mechanization, electric power for mass production, and computers/automation), Industry 4.0 is distinguished by its choice of wide-ranging modern, disruptive innovations that are still growing in number and scope. No two implementations are exactly alike.

Industry 4.0's powerful, attention-grabbing elements range from cloud and edge computing to industrial internet of things (IIoT) sensors, real-time big data, advanced analytics, artificial intelligence (AI), machine learning (ML), digital twins, portable and wearable devices, robotics, vision systems, autonomous vehicles, drones, additive manufacturing, and augmented, virtual, and mixed reality (AR/VR/MR). The chosen connected, digitalized systems can communicate with one another, share data, and continuously self-improve.

The strategy's appeal is universal. Process and discrete manufacturers, energy and utilities operators, and third-party service providers alike are drawn to how Industry 4.0 improves agility and efficiency, boosts the financial bottom line, solves chronic problems such as skills gaps and workforce shortages,

and addresses needs such as remote learning and remote work (heightened during the pandemic and now embedded in the culture). It breaks down information silos across engineering, manufacturing operations, maintenance, the supply chain, customers, and management, and ultimately helps the organization to stay competitive.

Imagine how capabilities like the following could transform your workplace:

- **Intelligent operations:** Plant and field operations such as manufacturing, energy generation and distribution, water and wastewater treatment, and mining are controlled and optimized from anywhere by authorized personnel with a secure internet connection. Advanced automation systems with ML automatically adjust and improve the processes. Robots, cobots (collaborative robots), and autonomous vehicles operate safely alongside people and equipment. Digital twins of assets, processes, or sites enable simulation and optimization of planned changes or upgrades before they are deployed. Smart energy management systems keep electricity consumption and costs under control. Smart safety devices protect workers and reduce downtime. Drones supplement hazard monitoring and site security.

- **Smart maintenance:** Wireless IIoT sensors installed on critical assets stream real-time condition and performance data for analysis of patterns and trends. Drones map and inspect large infrastructure and remote sites. ML analytics automatically recommend asset adjustments, predict when faults or failures will occur, generate maintenance work orders with prescribed solutions, and alert the appropriate personnel who can initiate intelligent planning and scheduling. Digital twins enable validation and optimization of planned repairs or outages. Technicians use AR for contextual step-by-step work instructions and VR/MR for immersive, real-time simulation and consultation with remote subject matter experts. Wearable personal safety monitors help to keep workers out of harm's way and generate alerts when assistance is needed.

- **Advanced supply chain:** AI/ML continuously optimizes inventory forecasting, ordering, and safety stock decisions for production materials and maintenance, repair, and operation (MRO) inventory. Warehouse automation systems, robots and cobots, autonomous vehicles, and drones handle the storage and movement of goods. Strategic parts and products are 3D printed. Connected vehicles travel optimized routes based on real-time conditions. Blockchain tracks and traces goods. ML enables fraud detection.

- **Enhanced customer experience:** Suppliers are better connected to their customers, improving the customer experience and their overall satisfaction. Behavior patterns, preferences, and demand spikes are tracked with advanced analytics. Customer intelligence supports data-driven personalization and mass customization. Conversational AI agents and chatbots facilitate customer

communication and support. VR enables an immersive view of available products and interactive simulations. GPS and RFID enable real-time tracking and delivery updates. Improved coordination among all stakeholders drives efficiencies that enable performance guarantees.

- **Intuitive personnel development:** Digital training and workforce development tools are intuitive, interactive, and personalized. Remote learning and on-the-spot assistance are supported by images, video, audio, chatbots, and AR/VR/MR. There is integrated feedback for employees, data-driven feedback for their supervisors, and a direct line of communication with subject matter experts when real-time consultation or step-by-step guidance is required. Continuous learning and improvement are facilitated by the advanced technologies.

- **New business models:** Machines connected to the cloud provide a feedback loop from the product to the original equipment manufacturer (OEM). This enables new business models such as servitization – the shift from selling products to selling profit-stabilizing services. Aftermarket services such as remote monitoring and diagnostics and predictive maintenance contracts provide new revenue streams. Selling subscription-based outcomes-as-a-service with performance guarantees, instead of physical products, generates recurring, predictable revenue. The feedback loop also supports ongoing design engineering enhancements and new product innovations.

The next, obvious question

If the promised benefits are so strong, why are so many companies just getting started? This is somewhat of a paradox. Recent research has identified a variety of reasons for the hesitancy to adopt or advance the journey to Industry 4.0.

A 2020 research report from Accenture, titled The Race for Digital Operations Transformation, observes that more than 10 years have passed since the vision for Industry 4.0 was announced at the Hanover Messe trade fair in Germany, but progress toward the vision remains slow in most companies. The study found that the average digital maturity across the survey respondents is 39 percent (with 100 percent indicating full deployment).

> ***Significant attention should be paid to the key enablers of digital readiness: skills, leadership, and governance. For instance, digital capabilities must be staffed with the right number of people with the required skills; leaders must be trained to use analytics to help drive their decisions; and digital transformation must be driven at the highest level of governance possible, such as the executive committee or the board.***

The report identifies three reasons so many manufacturers are still working on proofs of concept or

pilots. The first is because the vision for the best solution set has taken time to emerge as manufacturers experimented with various tools and trends. Second, adopting new digital solutions across a real-world industrial enterprise is "simply very difficult." Third, Industry 4.0 still competes with Industry 3.0 initiatives in companies that lack basic lean manufacturing practices and operational excellence standards and believe more automation is needed.

The report concludes it is "time for manufacturers to stop experimenting and begin scaling so they're not left behind," showcasing that significant attention should be paid to the key enablers of digital readiness: skills, leadership, and governance. For instance, digital capabilities must be staffed with the right number of people with the required skills; leaders must be trained to use analytics to help drive their decisions; and digital transformation must be driven at the highest level of governance possible, such as the executive committee or the board.

Another study, **BDO USA's 2021 Industry 4.0 Survey** of manufacturers, classifies 76 percent of the respondents as "Legacy" manufacturers (developed an Industry 4.0 strategy but not yet implementing, in the process of developing one, have not started developing one, or have no plans to develop one). Only 24 percent of respondents are born or reborn in digital manufacturing (implementing against an Industry 4.0 strategy).

Meanwhile, the competitive advantage of "Re(Born) in Digital" manufacturers is growing. The survey revealed that "as use of digital tools and solutions accelerated during the pandemic, early Industry 4.0 adopters have begun to achieve breakaway performance. These organizations are more agile, connected and resilient than their less digitally advanced peers, who will be challenged to keep up."

Adoption concerns are addressed in the BDO survey as follows: "If their issue is a lack of success with previous Industry 4.0 initiatives, new leadership or a third party that has proven Industry 4.0 expertise should be brought in to ideate and implement an Industry 4.0 strategy. If the problem is a lack of buy-in from company leadership, a successful pilot project may help convince them to commit to a long-term initiative."

Perceived stumbling blocks also inhibit adoption. For example, some companies believe they need a high-band 5G network to succeed. Although it can improve the outcomes, it is not actually a prerequisite and therefore no reason to delay the assessment, planning, and initiation of an Industry 4.0 strategy. The

solution set for the vision can be expected to change over time as new and improved offerings become available.

"Many new software and technology companies introduced Industry 4.0 innovations over the last three to five years, and more are on the way. Each development provides a piece of the puzzle that builds up the promise of 4.0. At the same time, each new entrant adds to the choices and challenges of determining how to proceed down the journey," explains Rick Wheeler, executive director at Life Cycle Engineering (LCE) (www.lce.com).

Parallels in asset management

For asset-intensive organizations, nothing is more important than optimizing the maintenance and operation of the assets. Most rely on some type of asset management (EAM/CMMS) software and an increasing number are realizing the benefits gained from an asset management program or pursuing the ISO 55000 International Standard for Asset Management.

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> ***"Industry 4.0 is much the same way. Without putting the foundational building blocks in place, the solutions might solve a few of the problems but not all of them."***

Unfortunately, any challenges they had implementing EAM/CMMS can dampen their motivation to take on transformational change. Additionally, since the software is closely tied to Industry 4.0 success, any deficiencies in the underlying data and work processes will also diminish Industry 4.0 results.

Following are some common EAM/CMMS issues that asset-intensive organizations face:

- They don't yet have the full asset list, core equipment information, or failure modes in the system.
- They have not conducted a criticality ranking so they are unclear which assets matter more than others.
- They have not identified the critical spare part inventory or stocking strategies.
- Their maintenance strategies are not based on actual failure modes.
- They don't realize their EAM/CMMS software is not a complete asset management system; it is just one component of an overall ISO 55000-compliant asset management system.

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"Industry 4.0 is much the same way. Without putting the foundational building blocks in place, the solutions might solve a few of the problems but not all of them," he adds.

Companies in the best position for a successful journey to Industry 4.0 have a well-developed EAM/CMMS and a culture that prioritizes industry best practices. That is not to say others will fail. Rather, with some smart, strategic effort around the foundational building blocks, any company can achieve Industry 4.0 success. As a bonus, many of these same efforts will bolster the value of the existing EAM/CMMS.

Building blocks for digital transformation

Establishing the required building blocks will make transforming your organization easier. Readiness begins with stakeholder analysis followed by smart preparation of your data, processes, people, projects, technology, and reporting. The chosen enabling technologies will determine what specific groundwork is required.

1. **Stakeholder preparation** and analysis comes first so that your organization understands the needs and expectations of stakeholders. The specifics are spelled out in ISO 550001 Section 4.2: The organization shall determine:
    - the stakeholders that are relevant to the asset management system;
    - the requirements and expectations of these stakeholders with respect to asset management;
    - the criteria for asset management decision making;
    - the stakeholder requirements for recording financial and non-financial information relevant to asset management, and for reporting on it both internally and externally.

2. Data preparation is fundamental to digitalization and transformative change. Incomplete, uncleansed, or incorrect data pulled into AI/ML and analytics will not produce intelligent results. The adage "garbage in, garbage out" still holds true.

Ensuring data quality and integrity requires assessing relevant databases for completeness and accuracy and establishing a plan and schedule for improvements. Assets, asset hierarchies, work orders, inventory, bills of materials, etc., may need work. "We've seen plants where 50 percent of their assets are not even in their asset register. It shows they don't truly have a grasp of what their equipment is, let alone the manufacturer number, model number, and all those things you need for real analytics," says Wheeler.

Starting with data as clean as possible will accelerate the value of the intelligence produced and ML will ensure further improvements over time.

3. Process preparation covers any standard work process relevant to the Industry 4.0 initiative being implemented. Asset management, work management, materials management, reliability engineering, production processes, or a combination of these or other business processes may require assessment.

For example, asset and work management processes that are based solely on OEM recommendations are not nearly as timely and effective as having a deeper understanding of the component. When it fails, will it take out production by 50, 100, or some other percent? What is the relative criticality impact? Based on its criticality, what level of failure mode and effects analysis (FMEA) is needed? What should be the triggers or alert limits? Then, an Asset Management Plan can be developed that serves as the playbook for that asset or set of assets across their life cycle, and includes the maintenance strategy, operations strategy, and a capital strategy needed to ensure the system performs as expected.

In reliability engineering, knowing what is critical to the quality of the product, what variables matter to the process, and which parameters should be monitored is essential intelligence for the digital systems.

For predictive maintenance, knowing that a certain temperature is critical to quality and variations are a predictor of failure can lead to installing a condition monitoring sensor to measure and trend the parameter. The real-time readings, failure modes, threshold limits, who to notify when a threshold is crossed, and what to do about it, together enable corrective actions before failure occurs. With AI/ML analyzing the patterns and maintenance activity over time, the recommendations prescribed will be continuously fine-tuned.

4. People preparation involves putting good organizational change management practices in place. Organizational alignment starts at the top. Leadership must be willing to set the vision for the future state, making sure it is clear, specific, and understandable – not "We are going to do Industry 4.0" or "We are going digital and putting everything in the cloud."

It requires working through what the change means for the organization and its culture, how roles will change, and how to prepare people for new roles. It will likely include skills development and may potentially necessitate new talent acquisition, such as a reliability engineer or data scientist.

Selecting a trusted and supportive messenger for change is crucial to gaining buy-in. The messenger will actively engage the workforce throughout the journey, so they don't become scared, resistant, or withdrawn.

Establishing a systematic, structured change management plan will ensure sufficient attention is paid to budgeting, scheduling, communication, training, success criteria, and more.

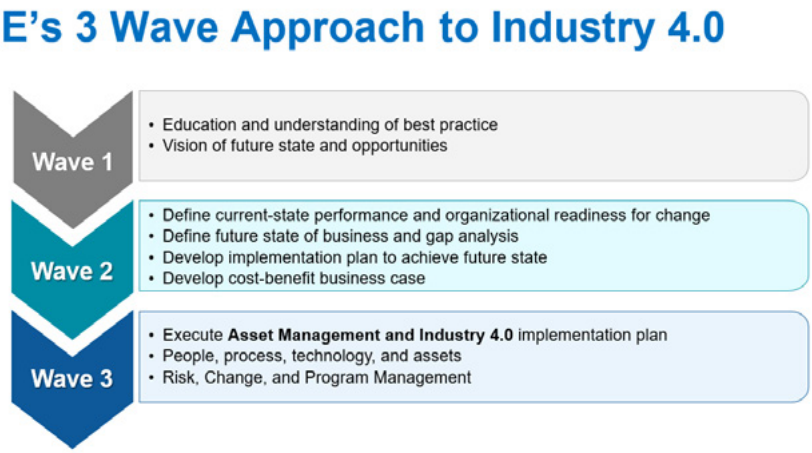
5. Project preparation includes assessing, selecting, prioritizing, and developing the roadmap for the desired Industry 4.0 initiatives. Assessing operational needs and gaps will help to determine what solutions are needed. From there, decisions can be made about the timing, scope, and resource requirements. For instance, will you start with a pilot project in a certain limited area with a handful of personnel, or go big?

6. Technology preparation includes conducting network and communications assessments and planning for upgrades to ensure the machines and devices will be able to talk to each other and with the enterprise systems. It also involves cybersecurity planning to ensure that only authorized personnel have access to the systems and data, and that their access is limited to the needs of their role. But be aware that Industry 4.0 is not an IT project.

7. Management reporting preparation involves identifying the essential business metrics and ensuring they will be captured and readily accessible on management dashboards and/or reports. This is a necessity for sustaining executive support.

Playbook planning and foundational work can be a partner effort

If you are considering or beginning a digital transformation, get educated on the topic and do an assessment of where you are and where you want to be. Only by tackling the foundational building blocks can you accelerate the effectiveness of the journey.



If you are actively pursuing Industry 4.0, take time out to assess whether your building blocks are in order, as that will be an indicator of the speed and degree of success that will be realized.
No matter your current state, professionals are available to help. Companies like Life Cycle Engineering can facilitate your journey with planning guidance and services such as assessments, training and cer-

tification, staff augmentation to bridge skills gaps, reliability engineering, change management, regulatory compliance, and more. We understand what "good" looks like, the order foundational elements should be built, and how to build intelligence, resilience, and agility into the process.

The bottom line is this: You can realize the potential of Industry 4.0 faster by establishing a solid foundation and plan. If you need help in doing so, all you need to do is ask.

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