



To move beyond the pilot stage and achieve scale with Industry 4.0, manufacturers must **adopt a financial-impact first approach** that can yield double-digit improvements in cost savings, capacity, and asset efficiency.

  
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# FINALLY, DOUBLE-DIGIT 4.0 IMPACT AT SCALE

W

ITH THE ADVENT OF THE FOURTH INDUSTRIAL revolution and the rise of Industry 4.0 (I4.0), manufacturers face a once-in-a-generation opportunity for significant value creation. However, too many digital transformation efforts languish and fail – along with their sponsors. At PTC, we’ve seen manufacturers who make financial impact the epicenter

of their transformation achieve the greatest long-term impacts along multiple dimensions.

Early adopters and innovators with successful I4.0 initiatives have realized substantial business value across many critical areas of their factory operations. Leading manufacturers are routinely seeing a 10% improvement in cost, capacity, and labor productivity, as well as significant improvements in the flexibility and agility of their global supply networks<sup>1</sup>.

By applying this double-digit improvement to cost per unit (CPU), one of the most essential manufacturing metrics, you can demonstrate digital transformation’s impact on manufacturing operations. Any I4.0 initiative must drive CPU improvement.

For example, a manufacturer with a CPU ratio of 1:1 that reduces costs by 10% at the same production volume can reach a new ratio of 0.9:1 and a CPU improvement of 10%. Another option is to increase unit production capacity by 10% at the same costs, attaining a new 1:1.1 ratio and a 9% CPU improvement. While either situation

is a major accomplishment, with I4.0, both cost reduction and unit increase are achievable. Simply put, in this example, the combined options produce a new 0.9:1.1 ratio and an 18% CPU improvement.

These compelling numbers demonstrate that the smart factory serves as a new driver of competitiveness. In our experience, we see customers moving from “What are factories of the future and why are they important?” to “Where should I start and how can I scale impact faster than my competition?”

The value potential is undeniable, yet many manufacturers fail to capitalize on it. It appears that while the notion of digital transformation has gained acceptance, doing so at scale still remains elusive for the majority of industrial enterprises. Research from Gartner, LNS, and recent status reports by PTC show that only about 25% of manufacturers are expected to be in the scale stage of digital initiatives<sup>2</sup>. To

**Many manufacturers are stuck in “pilot purgatory” because value is not at the center of their transformation efforts.**



capture competitive advantage and claim their position as a future leader, manufacturers should accelerate their I4.0 journey. The time to act is now.

#### *Avoiding Pilot Purgatory*

While there are promises of a bright, digitalized future, executing successful pilots is one hurdle while realizing value at scale is yet another and where future leaders will emerge. According to McKinsey, companies run, on average, eight digital transformation-related pilots, but less than a third are implemented at scale<sup>3</sup>. Why are so many manufacturers struggling to capture value with digital transformation initiatives that are stuck in the “pilot purgatory”?

At PTC we’ve had the benefit of working with 1000s of clients and the majority of stalled initiatives share a common theme – technology, rather than financial impact, is mistakenly at the center of transformation. Value, or cost per unit impact, is only achievable by focusing on and removing the production process constraints that create bottlenecks. If pilots focus on non-constraints, value is unattainable, and purgatory is inevitable.

Failure to focus on value means that companies can easily fall victim to a tactically focused, technology-first approach. Initiative sponsors often discover too late in the process that identifying, evaluating, and piloting emerging technologies as isolated projects create numerous obstacles, including:

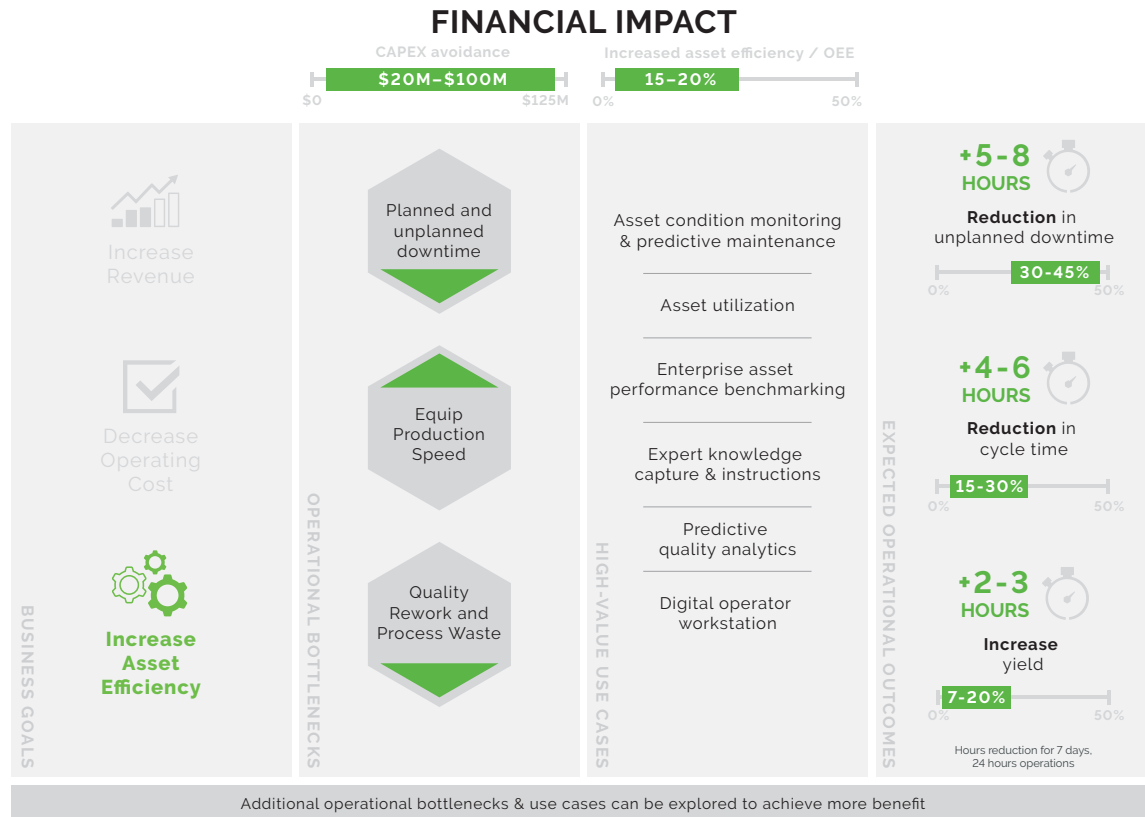
- Inability to achieve a strong ROI
- Lack of company-wide focus on the most impactful opportunities
- Dilution of resources
- Inability to scale
- Lack of organizational buy-in and user adoption
- Change management hurdles

These issues are echoed in Deloitte’s Smart Factory Study, which cites the main challenges as lack of experience; difficulty adapting; lack of a compelling business case; lack of strategy, governance and ownership; and lack of IT infrastructure<sup>4</sup>. The results are unimpactful business outcomes that present challenges when scaling digital benefits from one factory to tens or even hundreds of factories across the globe.

To pursue factories of the future and achieve double-digit impact at enterprise scale, today’s manufacturers need a sustainable process to position the company for



# FIGURE 1 An I4.0 Value Creation Framework



**FIGURE 1:** An example of the Value Framework: the blueprint for financial-impact first project mapping using a hypothetical \$5B discrete manufacturer. Source: PTC.

success now and in the future. Based on lessons learned from one of the largest customer bases of I4.0 initiatives, we assert that the successful transformation journey starts with laser focus on financial impact and prioritizing limited resources against high-value use cases that scale fast in an agile and iterative manner.

With the meaning of impact demystified, manufacturers can now consider its importance in tandem with two other major considerations: speed and scale. Together, these three components unlock value creation:

**1. IMPACT:** Identify value by getting broad, cross-functional senior leadership team involvement from the start with a focus on the financial-impact first approach and a commitment to prioritize resources and eliminate potential obstacles.

**2. SPEED:** Capture value by identifying production bottlenecks and prioritizing the most pressing problems that capture value in as little as just a few weeks.

**3. SCALE:** Expand value by building a foundation for enterprise scalability, including people, ecosystem, capabilities, and a digital backbone to iterate quickly and achieve high-impact value to scale within 24-36 months.

**Impact: Align with Executive Agenda**

**D**espite increased pressure and scrutiny at the C-level to commit to I4.0, most initiatives fail to gain strong executive support at enterprise scale. Why? Digital transformation leaders cannot

articulate how their initiative supports the company’s goals and how it will deliver financial impact—the top priorities of C-level executives. Results may be buried at the bottom of the organizational structure, with no transparency to enterprise impact and leadership. Lack of executive support and business justification leads to slower decision making and lengthy delivery. Ultimately, these initiatives do not deliver significant value and are deemed less worthy than perceived alternatives.

Based on PTC’s experience, we have first-hand observations of the benefits a financial-impact first approach can unlock. This approach enables a company to evaluate and pursue I4.0 initiatives aligned with its top-level financial strategies and corporate goals. Through this alignment, companies can involve a broad, cross-functional senior leadership team from the start and focus resources on aggressively pursuing the

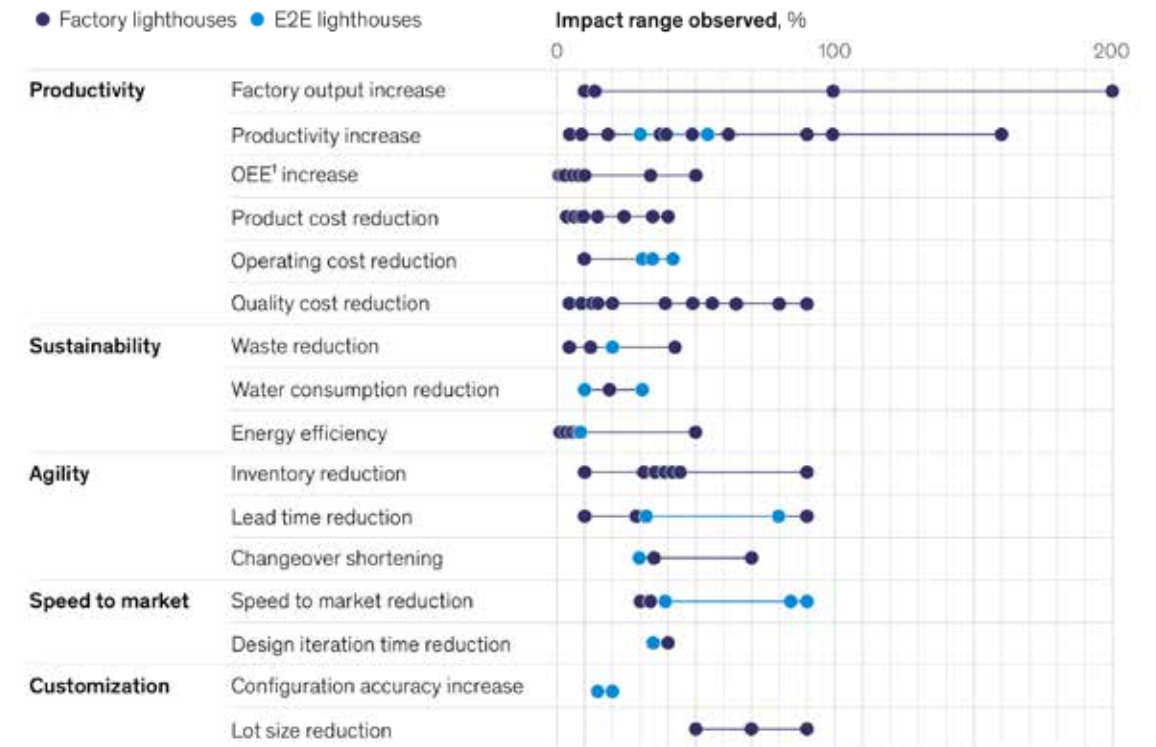
most impactful opportunities. Doing so provides the basis for increased deployment speed, business adoption, and success. To adopt this approach, manufacturers must articulately state the expected full financial impact of their I4.0 transformations and connect the manufacturing operational improvements from individually proposed projects to financial outcomes.

At PTC, we refer to this mapping as the “Value Framework”, as illustrated in Figure 1. It’s the core blueprint used to discover, capture, validate, and communicate value through the journey of digital transformation.

PTC’s digital transformation group uses the Value Framework with its customers to define, capture, and express attainable value from I4.0. In the absence of a personalized, in-depth analysis for a specific manufacturer, in this article, we provide generalizations of the extent of achievable value. Based on the profile of a typical manufacturer with \$5B in revenue and

**FIGURE 2:** World Economic Forum Lighthouse Implementations Reported Benefits. Source: McKinsey & Company.

## FIGURE 2 WEF "Lighthouse" KPI Benefits



of average maturity, I4.0 can yield revenue increases in the range of \$80-\$300M, cost savings between \$55-\$335M, and/or CapEx avoidance of \$20-\$100M. This is substantiated by results captured within PTC's customer base and echoed by Lighthouse manufacturers and the analyst community<sup>5</sup>.

**Focus on Cost, Revenue, and Asset Efficiency**

**N**o matter the industry, all manufacturing businesses share a common financial language in the form of the corporate P&L. Top-level financial metrics are:

- Revenue
- Operating costs
- Asset efficiency

This information is found in just about every 10K and annual report. I4.0 initiatives must express the impact of these financial elements in relation to overall corporate strategies.

Consider an I4.0 initiative that creates additional production capacity at a manufacturing plant. The decision on how to convert that extra capacity into financial value takes different forms based on corporate goals, which eventually has a major impact on cost per unit. One capacity-constrained company may use the extra capacity to produce more units, thus increasing revenue. Another may seek to reduce overtime shifts and the cost per unit manufac-

tured, thus reducing operating costs. A third may leverage the enhanced capacity to deliver more product variations to increase service levels without new CapEx investments.

Next, look across manufacturing plants to identify operational business outcomes that deliver the desired financial impact. Manufacturers commonly pursue increased throughput, reduced cost, improved asset utilization, improved quality, and reduced material usage. As part of a financial-impact first approach, companies must identify operational initiatives (value drivers) to support these outcomes. These value drivers include reducing downtime, increasing labor productivity, reducing rework, and reducing waste, among others. The full spectrum of I4.0 use cases, and the relevant project, can then be mapped to the digital transformation technology that achieves the desired operational improvements and financial impact.

**Applying the Value Framework**

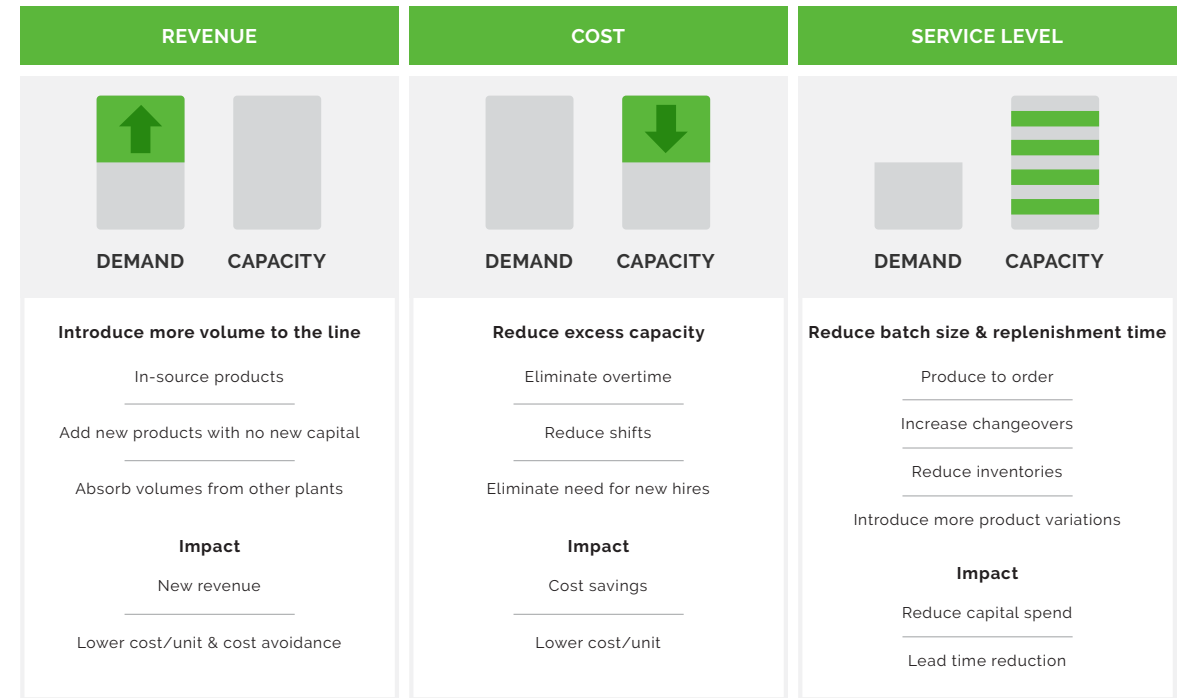
**E**ach use case needs quantifiable impact benefits tied to financial elements. One challenge for manufacturers evaluating new projects is difficulty estimating the benefits and outcomes delivered from use cases. From working with our industry-leading customer base, we have amassed a library of I4.0 use cases with proven operational impacts and validated financial outcomes. After a use case is deployed and operational improvements realized, the same framework can validate and express

All manufacturers share a common financial language in the form of the corporate P&L.



**A financial-impact first approach enables a company to pursue I4.0 projects aligned with corporate strategy and goals.**

**FIGURE 3**  
**3 Business Strategy Scenarios**



the financial outcomes achieved. This closed loop approach is critical to communicating value to the broader, cross-functional senior leadership team while providing evidence necessary to accelerate momentum and gain a greater competitive advantage.

**Speed: Solve Bottlenecks in Weeks, Not Months**

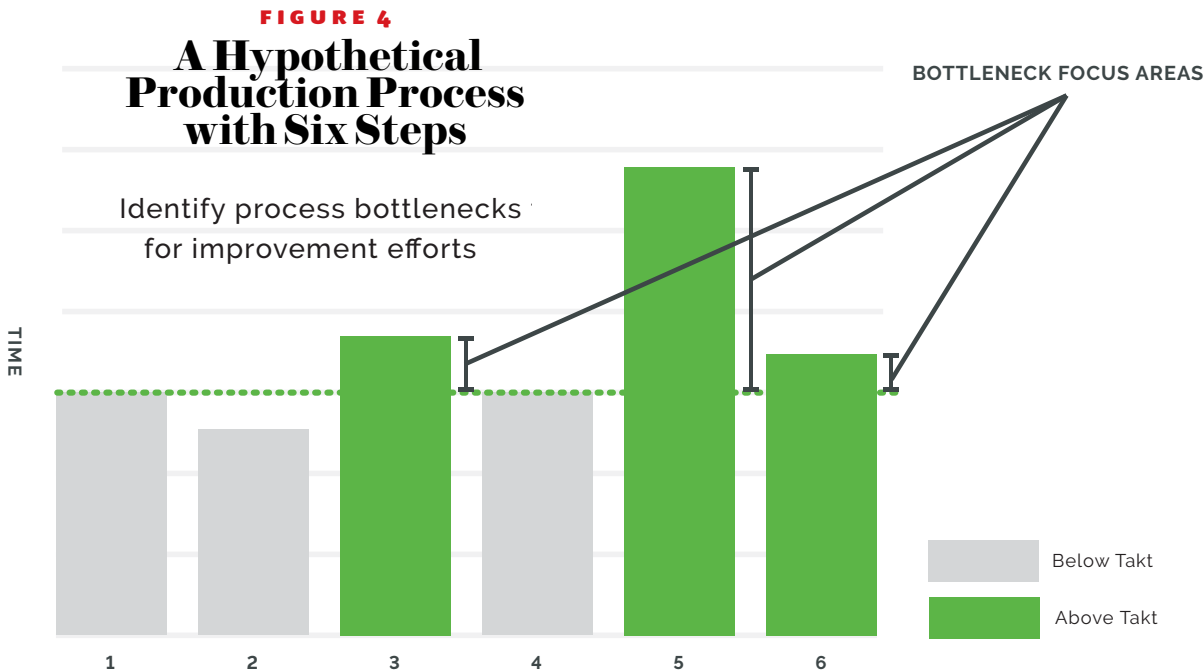
**U**pon adopting an impact-first approach and validating expected financial impact from select I4.0 use cases, speed and scale become the most important criteria for business prioritization and execution. With limited company resources, it's important to focus on the highest value use cases that can be rapidly scaled across the manufacturing network. Additionally, it's important to establish project governance with periodic reviews by senior leadership

to ensure enterprise impact is being achieved with speed and at scale and that organizational barriers to progress are rapidly eliminated.

However, as part of a use case selection, remember that not all factories, lines, and equipment share common constraints. While it's easy to generalize, for the sake of proving value in initial implementations, it is imperative to keep the focus of deployment on constrained resources. For example, if feedback and data show that unplanned downtime due to equipment failure is a major issue across plants, specific constraints within each plant may be linked to distinct asset types. The chain analogy is a great metaphor: any improvement to a chain that does not improve the weakest link does not improve the entire system.

Rather than focusing on the entire production system, experience from our most successful customer projects suggests

**FIGURE 3:** Example of how customers realize different financial impacts from extra capacity based on business strategy. Source: PTC



**FIGURE 4:** Steps above takt time reveal critical bottlenecks in this hypothetical production process. Source: PTC

identifying the process bottlenecks within each specific production environment. By focusing on critical bottlenecks, manufacturers are poised for quick wins in weeks, not months. Figure 4 shows a sample production process with six steps. The highlighted process steps 3, 5, and 6 are above takt time (the target production time) and, therefore, bottleneck. These steps are the production constraints responsible for additional costs, productivity losses, and even excessive CapEx spend.

After identifying critical bottlenecks, find opportunities for improvement through root cause analysis. Through real-time vis-

ibility into line performance, top-down metrics can identify bottlenecks and reasons for losses. Armed with this information, prioritize which opportunities to address first, based on financial impact and ability to scale quickly. From there, assign teams to make improvements by applying the appropriate problem-solving technologies. By focusing on the most critical bottlenecks and applying digital technologies, factories now can unlock tremendous value.

After implementing identified improvement initiatives, you can again leverage real-time visibility into the revised line performance to measure the improvement in

time for each step, which reflects the new baseline of performance. Your team can use this new baseline to identify the next round of prioritized bottlenecks to determine the next greatest opportunity for impact. This process represents a continuous problem-solving capability that is scalable within and across plants and creates a system for continuous improvement. Importantly, each I4.0 project and the whole I4.0 initiative under this model can be developed and deployed in an agile fashion and remain focused on areas of greatest financial impact. Meanwhile, applying this information into the Value Framework delivers validated financial impact that can be socialized to inform executives and get multiple plants on board.

**Scale: More Sites, More Value**

**W**hen solving for maximum impact, manufacturers must quickly apply relevant use cases across multiple plants. To emphasize why this is crucial, consider a sample manufacturer with 50 plants that each have 10 lines.

In a traditional, sequential deployment process, the manufacturer would first pilot digital technology on one line for three to six months. Keeping this pace, additional pilots on the plant's remaining nine lines would take three to five years. At that rate, it would take more than a lifetime to deploy across the global enterprise. Suffice it to say, a 100-year approach to digital transformation is a plan designed for failure. To accelerate pilot deployments and capture value quickly, manufacturers must resource and plan to simultaneously roll out the capabilities across multiple sites and continuously reduce the deployment time in subsequent sites, so that the length of time it takes to deploy enterprise-wide is reduced from decades to 24-36 months.

Game-changing transformative value only occurs when manufacturers achieve scale. A simple example of this is an I4.0 project deployment on one line that introduces 25% new capacity. Its value is noteworthy but not meaningful to the company overall. However, if that 25% capacity increase is scaled across all lines at four factories, new capacity equal to

**FIGURE 5:** Project prioritization based on bottlenecks in production environment and alignment with the financial-impact first framework. Source: PTC.



**To demonstrate the impact of digital transformation, any I4.0 project must drive a cost-per-unit improvement.**

the amount in a fifth factory is created—without investing hundreds of millions, or even billions of dollars, in factory construction.

To deploy digital capabilities across tens of plants simultaneously in two to three years, manufacturers need a strong foundation to scale and accelerate the journey. Companies that quickly pilot valuable I4.0 projects, while also creating a foundation for transformation across their manufacturing and supply chain operations, will benefit from com-

petitive advantage for decades to come.

A solid foundation to enable scale consists of the right team, management system, governance structure and digital backbone to quickly iterate and achieve high-value impact across the enterprise within 24-36 months. The right team necessitates identifying dedicated people and ecosystem partners with I4.0 expertise, executive sponsorship, and the ability to drive change across all factory personnel. It requires the right behaviors, mindsets, and capabilities to embrace the digital factory and the transformation it ushers in.

The management system is a digital per-  
*(Continued on page 00.)*

### CASE STUDY 1 Unplanned Downtime Cut by 30%

**C**hina International Marine Containers (Group) Co., Ltd is a \$13 billion annual revenue company principally engaged in the manufacture and sale of transportation equipment. I4.0 is a top priority initiative to enable its business strategy of “manufacturing + service + financing.”

CIMC took a value-first approach to decide which use cases and technologies are aligned with its growth strategy and generated impressive value. Two years ago, with value-first determined, the company chose the Internet of Things and augmented reality to modernize its factory operations. With support from corporate executives and the CIO, two factories signed on as pilot sites, focusing on the use cases of asset monitoring, energy management, process optimization, and safety inspection. It took less than four months

to implement the four use cases in the first pilot site, and only three months for seven use cases in the second pilot site.

Within just several months, the pilot sites reported a 30% reduction of unplanned downtime of the critical equipment and a 3% reduction of electricity consumption. Further, by optimizing the product manufacturing process, CIMC improved product performance and gained advantage in a highly competitive marketplace. Following both sites’ initial implementations, subsequent implementations of additional digital capabilities resulted in additional value capture. For example, the reduction in electricity consumption grew to 7%, and more than 10% recently. As of August 2019, the company has 12 value-proven use cases and was on plan to deploy the IoT platform and selected use cases in 15 factories by the end of 2019<sup>6</sup>.

**Game-changing transformative value only occurs when manufacturers achieve scale with I4.0.**



### CASE STUDY 2 Capacity Increased in 11 Production Lines

**P**activ is the world’s largest manufacturer and distributor of food packaging and foodservice products, supplying packers, processors, supermarkets, restaurants, institutions and foodservice outlets across North America. It provides a great example of a manufacturer that first identified its production constraints and bottlenecks. With this information, they prioritized their addressable opportunities based on financial impact. As a result, they ensured projects delivered quantifiable value. They also maintained broad, cross-functional, senior leadership team alignment with periodic updates. In terms of challenges and use cases addressed, Pactiv faced a high frequency of micro stoppages and machine failures, unnecessary process adjustments, suboptimal production capacity, and lack of real-time visibility into performance.

**Pactiv’s goals included:**

- Identifying innovation and optimization opportunities to improve plant capacity and cost per pound.
- Deploying digital manufacturing solutions across capacity-constrained processes to improve overall capacity and cost per pound.

Within its capacity constrained lines, Pactiv identified the major causes for constraints, as well as opportunities that deliver operational outcomes to support increasing capacity, optimizing costs, and improving quality. It prioritized use cases that solved its identified challenges, including asset intelligence, end-of-line display boards, paperless production tracking, and downtime reporting. After gaining executive support based on the financial-impact first approach, Pactiv built an aggressive plan to roll out its transformation initiative, aligned to its strategic objective to increase capacity.

**The impressive benefits experienced by Pactiv include<sup>7</sup>:**

- 50% decrease in downtime attributable to lack of material and blender issues
  - 11% decrease in downtime due to equipment failure
  - 11 lines increased in cases per hour against baseline after seven months of connectivity
  - Decrease in downtime attributable to quality defects across finished goods
  - Increase in throughput for relevant products
- See Pactiv webcast under Footnotes and Additional Resources, page xx.

### CASE STUDY 3 An Automation Firm Avoids CapEx by 30%

**R**ockwell Automation Inc., the world’s largest company dedicated to industrial automation and information, acts as one of the most advanced I4.0 transformation case studies<sup>9</sup>. Rockwell calls its transformation initiative “The Connected Enterprise” and includes three foundational pillars for success: people, process and technology.

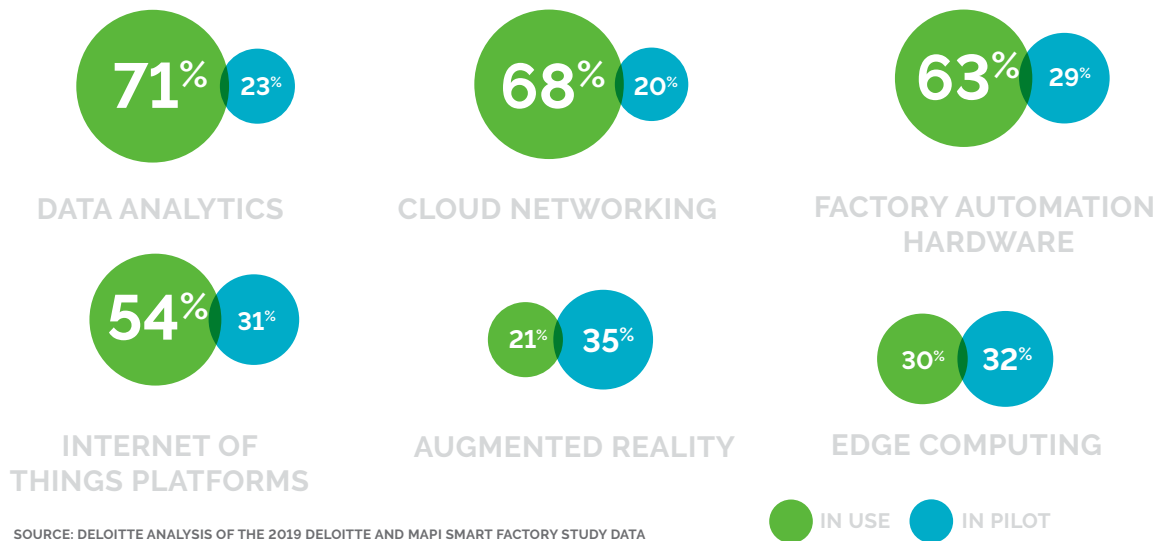
With a strong foundation in place, Rockwell scaled and deployed its Connected Enterprise

initiative across its 18 facilities, 704 work cells, and 6,000 users in six languages. The strategically beneficial results include:

- Productivity – 5% increase per year
- CapEx – 30% in capital spend avoidance
- Quality – 60% reduction in PPM
- Lead time – reduced by 50%
- Delivery – 82% to 90% on-time and in full
- Inventory – from 120 days to 82 days on hand

**FIGURE 6**

## Enabling Technologies for Smart Factories



SOURCE: DELOITTE ANALYSIS OF THE 2019 DELOITTE AND MAPI SMART FACTORY STUDY DATA

**Figure 6:** Deloitte analysis of the 2019 Deloitte and MAPI Smart Factory study data. Source: Deloitte.

(Continued from page 00.)

formance system that provides one source of truth and eliminates all waste in decision-making with analytics-powered, personalized actionable intelligence. The management system enhances, accelerates, and reinforces change management through the transformation journey. Underlying all I4.0 initiatives are key foundational and enabling technologies, like the Industrial Internet of Things (including connectivity and convergence of operations and information technology), analytics, automation, augmented reality, and hybrid cloud computing, as identified in Deloitte and MAPI's survey<sup>8</sup>. A digital backbone is necessary to democratize advanced technologies by providing universal connectivity, universal data modal, universal analytics, and a universal user experience. It is imperative to achieve scale with speed, and the digital backbone, foundational to transformation, is flexible while being able to normalize variable environments that each plant presents.

### Take Action: Deliver Double-Digit Impact at Scale

**T**he fourth industrial revolution in manufacturing creates incredible business value across the enterprise. Digital transformation is a tremendous equalizer and appropriate for any manufacturer of any size or maturity, with varying equipment and systems, to create step-change improvements like those realized at CIMC, Pactiv, and Rockwell.

This prescriptive framework enables manufacturers to deliver against business goals to reduce operational costs, support revenue growth, and increase asset efficiency. Manufacturers who take a financial-impact first perspective, prioritize use cases based on bottleneck analysis, and build a strong foundation inclusive of the right team and technologies will achieve double-digit impact at scale. These are the companies who will outpace their competitors and realize the potential of I4.0. **M**

### Footnotes and Additional Resources

- PTC Digital Manufacturing Solutions Suite.** [www.ptc.com/digital-manufacturing](http://www.ptc.com/digital-manufacturing)
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**James Zhang** is the Vice President of Market Development, Connected Operations Solutions at PTC. In this role, James works to build and deliver high impact solutions for factories of the future that incorporate PTC's industry-leading IoT, Analytics, AR and PLM technologies. His responsibilities include prioritizing market problems, pursuing product market fit and working directly with customers and partners to scale industry 4.0 transformations.



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PTC is a member of the Manufacturing Leadership Council.