WHITE PAPER

A Path to Smart Manufacturing

Checklist

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Executive Summary

Discover why top-performing manufacturers outperform the market, and find a checklist of practical actions taken by manufacturing companies seeking to start or accelerate industrial transformation initiatives, and affect key business outcomes like revenue, margin, and productivity.

Introduction

In 2020, despite a pandemic, economic headwinds, and constant disruption, a group of frontrunners outperformed the market by a whopping 17%. This 30% of manufacturing organizations invested in initiatives as part of a clear corporate strategy to gain and sustain innovation, create differentiation, and outperform the competition. Of the remaining organizations, 28% are classified as "chasers" and 42% as "followers," leaving most manufacturers behind the competition as frontrunners took market share, met stakeholder value commitments, and set their organizations up for continued success.

Of course, 70% of these other organizations are not idle—they too are attempting to transform people, processes, and tools. So, why aren't these other organizations as successful as the front runners? According to Boston Consulting Group, innovation is among the top three most critical strategic objectives for organizations. Despite this substantial increase in goal setting, only 50% of companies invest to meet those strategic objectives.

The lesson is simple. Action, discipline, and innovation pay off! It leads to market outperformance in the out-years, and it snowballs into an organization with the right focus, culture, skillsets, and the technologies necessary to execute over time.

It's still important to be realistic about digital transformation. Smart manufacturing isn't smart overnight. It's a long-term transformation that considers our workforce and business process. It intersects with new technologies affecting business systems and infrastructure. Most importantly, it fundamentally alters the way we work and our ability to scale, as it drives real sustaining productivity improvements that contribute to top and bottom-line growth.

So why aren't more manufacturers investing in the people, skillsets, and technologies needed to meet their goals? What are some of the specific contributors to organizations failing to meet their strategy?

First, only about 10% of manufacturers have a comprehensive strategy to succeed in smart technologies. Whether your organization follows a bottom-up or top-down approach, for smart manufacturing to be successful, it requires experimentation, investment into upskilling, foundational technology, and a long-term view of what these efforts will deliver for the organizations' ability to transform people, process, and tools. A lack of leadership support and clarity on the strategic role of smart technologies organizations will fall short of meeting corporate objectives. Employees will struggle to target the right initiatives, as well as to understand the business measurements associated with progress and success—or worse, those same innovators within may be discouraged from risk-taking.

When done correctly, organizations with a clear smart manufacturing strategy anchored by leadership support will outperform their competitors, leading to long-term change in their culture, foundational infrastructure and technology advancement, and the workforce readiness to drive actual results.

Checklist

The following checklist is intended as a guide. The list represents the table-stakes capabilities associated with smart manufacturing readiness, progress towards, and the ability to adapt and scale to a broad range of smart manufacturing technologies and use cases.

It should also go without saying, all manufacturing organizations are at different points in their industrial transformation. Each has a unique mix of people, process, and technology challenges that arise from corporate age, mergers and acquisitions, culture, existing technical infrastructure, and organizational readiness.

Read on to assess your organization's maturity and readiness for smart manufacturing.

Connect

Only about 10% of manufacturers have a comprehensive strategy to succeed in smart technologies.

It should be evident that connecting a heterogeneous operational technology (OT) environment would be the first step in industrial transformation. The real trick is how to approach it. What are these device types? What is preventing connectivity and scale?

Unfortunately, data indicates this planning is an afterthought for most manufacturers. In fact, 85% of manufacturing organizations reported that their smart manufacturing pilots are stuck in "pilot purgatory," or that state where pilots fail to scale and achieve the intended outcomes. Sometimes pilots are stuck because of poor bounding, no business measure of success, or failure to align with corporate objectives. Another reason for failure is that organizations have not fully aligned their organizational units and departments with IT.

The lack of a clear strategy and a united infrastructure to meet the needs of operational technology vs. information technology (IT) inhibits the ability to quickly adopt, connect, and leverage newer technologies at scale. Installing a game-changing solution at Plant #1 may not work in Plant #2. Or a sensor-based risk mitigation solution in Division A may not work in Division B because of their legacy networks, business systems, culture, or approach to Industry 4.0 pilots and program initiatives. This divergence isn't always about OT vs. IT—it can also be related to stark differences across business units, departments, and geography.

As simple as it might seem, the lack of mutual operational infrastructure and its integration with the enterprise technical estate impacts an organization's ability to scale and speed successful smart initiatives to the balance of the organization.

☑ Checklist #1: Industrial Infrastructure

The most straightforward first step for any manufacturer is to assess their entire infrastructure from edge to data center to cloud. Most smart manufacturing technologies available in the marketplace today depend on a diverse hybrid tech estate. For organizations to adopt and scale, manufacturers must establish enterprise architectures beyond IT only and integrate the OT environments such as factories, laboratories, and remote locations.

Unfortunately, most U.S. factories are an average of 25 years old, and their manufacturing equipment and devices are an average of 9 years old. This creates additional hurdles for organizations looking to pursue an integrated smart manufacturing strategy. Critical production equipment may lack modern communication and integration standards, further complicating efforts to connect and extract data from devices in the factory.

Lack of integrated infrastructure strategies is why 76% of manufacturing leadership seek to integrate communications, infrastructure, and process between OT and IT. To connect a heterogeneous mix of production technologies, an organization requires a holistic infrastructure view that considers the industrial nature of the technologies (both old and new), not just the IT-managed endpoints. It requires an industrial infrastructure strategy forcing OT leadership to rethink their technologies and IT leadership to do the same.

Lack of integrated infrastructure strategies is why 76% of manufacturing leadership seek to integrate communications, infrastructure, and process between OT and IT.

As a result, OEMs have developed and introduced new product offerings to mitigate the typical IT, OT, and security risks often preventing convergence. These include a new generation of solutions, including networking, power over ethernet, public or private cellular, cellular backup for resiliency, and access points that support both legacy and modern industrial devices. Many of these devices also simplify easy of deployment and management for IT, while unlocking new capabilities that advantage business.

For example, access points today combine traditional connectivity and unlock newer technologies like BLE or ZIGBEE protocols. This approach establishes a mesh network comprised of various industry standards and unlocks new value to both IT and business units. With a shared network supporting OT and IT technologies, smart technologies are quickly added anywhere with ease and scale, a concept previously limited by pilot purgatory.

☑ Checklist #2: Industrial Security

As manufacturers reassess their industrial infrastructure and alignment with the totality of the enterprise, security should be top of mind. The traditional IT landscape has seen more investment into cybersecurity rigor as compared to the industrial environments. In contrast, most industrial environments are comprised of automation, machines, and sensors—each introducing a host of unique risks associated with connecting legacy or modern technologies.

74% of OT professionals experienced at least one breach in the last 12 months, with an alarming cyber security attack success rate of 33%. With guards down or preoccupied with more significant issues over the past 18 months, we see a rise in industrial attacks taking advantage of the 50%+ unmanaged OT devices operating with little or no security infrastructure to protect them.

As manufacturers look to craft a smart manufacturing strategy, 55% of business leaders recognize increased security risks accompany industrial transformation. This shift in co-mingling industrial transformation with security is a result of escalating cybersecurity incidents, operational impacts, and the costs to mitigate.

Many products now combine industrial capabilities like support for industrial protocols, deep packet inspection, and integration with corporate SIEM/SOCs to ensure security teams have a holistic picture of the entire enterprise. Many of these solutions also deliver industrial-grade

speeds to maintain the high-performance demands of operations and conduct their threat analysis with little to no impact on production systems. Investing in next-generation industrial security will ensure your organization (as it stands today and into the future) will be capable of preventing, detecting, containing, and resolving cybersecurity events effectively, while also preserving the production expectations of OT.

Integrating modern infrastructure and security that extends IT infrastructure across the entire organization solves two problems. First, it creates a foundation for all devices—both IT- and OT-managed to connect to, lowers the total cost of ownership enabled by a shared connectivity platform, and simplifies the act of connecting technology. Second, the infrastructure itself becomes a catalyst to lower entry barriers for smart manufacturing and securely fuels a wide range of IT and OT business-process use cases to support business objectives.

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Integration

Establishing the necessary industrial infrastructure and security enables the next phase of value attainment. Those investments pave the way to connect industrial environments with the balance of the tech estate, whether that be integrating factory floor machine data with on-premises data centers, co-location or regional data centers, or the cloud.

At the end of the day, acquiring data, transforming it into a useful format, and integrating it with business systems, business intelligence platforms, or cloud-hosted services is where technology intersects to deliver real value. This is where you get actionable insight to power the workforce or ready the organization for more advanced capabilities like process automation or artificial intelligence.

☑ Checklist #3: Data Acquisition and Management

Manufacturers are made up of a highly diverse industrial landscape. Few facilities are comprised of a single brand, and most contain decades-old equipment, lack network capabilities, speak various industrial protocols, and support dozens of operating systems and applications. It's no small feat to integrate and acquire data from the typical operational environment. Possessing the ability to access, manage, and acquire data is a tactical but essential part of achieving higher Industry 4.0 maturity.

Fortunately, the industry has responded to these challenges and now provides several solutions that offer quick time-to-value, lower the customization and effort to connect and integrate devices, and ready data for vertical integration across OT, IT, and hybrid infrastructure. Unlocking access to any device prevents gaps in data and process visibility and control.

☑ Checklist #4: On-Premises Integration

Manufacturers have integrated machines with SCADA, or business systems, for a long time. The challenge has always been to do this consistently via common toolsets, and at scale across all factories, business units. and integrated with the enterprise environment.

Today's solutions simplify the act of acquiring and integrating OT with on-premises systems. Unlike in the past where OTs were isolated with limited touchpoints, modern manufacturers seek to integrate data across a wide range of processes, organizations, and business stakeholders.

45% of manufacturers are planning or acting on lift-and-shift to the cloud.

For example, CNC or PLC data is typically connected to SCADA and a historian for manufacturing engineers. But what about Leadership, QA, Supply Chain, Maintenance, Continuous Improvement, and R&D?

Each of these organizations is looking for a different context, frequency, formatting, and, most importantly, integration with their respective systems of record. To truly integrate all stakeholders, contemporary solutions must connect all devices from operations and integrate with all business systems to empower employees with visibility, actionable insight, and, most importantly, the ability to affect timely impact.

☑ Checklist #5: Cloud Integration

As organizations assess risk, look to new business models, and explore the best ways to procure new capabilities, the cloud is one of the top considerations in manufacturing. With 45% of manufacturers planning or acting on lift-and-shift to the cloud, proven benefits appeal to both IT and business leaders alike. Research demonstrates a larger shift with cloud playing a more impactful role and why 74% of CFOs view cloud as the most impactful technology initiative in support of business results. Such a shift is primarily driven by the disruptive nature of cloud technologies and their role in forcing people and process change.

For example, 8 in 10 organizations can reinvent business processes, invent new business models, or improve client satisfaction through the use of cloud-based applications or platforms. In addition to its business relevance, 60% of manufacturing business users now prefer cloud-based solutions. This makes cloud-based solutions a vital tool for change and employee acquisition and retainment.

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Regardless of the business justification, cloud-based infrastructure and services are here to stay. Each business must consider which processes and systems are a strong fit for the cloud. What is clear is that any smart manufacturing strategy must also include the ability to acquire data from the edge (whether in the factory, smart products, or in the field) and integrate that data efficiently and effectively with the cloud.

☑ Checklist #6: Visibility and Actionable Insight

Another meaningful component of integration is empowering visibility and actionable insight. This aspect of integrations aims to address how organizations will enable workers, whether at the point of use with frontline workers or downstream with support roles. Regardless of the target roles, it's essential to consider how connectivity, scale, and speed eliminate data silos, establish data governance, standards, transform and cleanse data, and drive visibility and actionable insight to their most valuable assets—employees.

With this in mind, we recommend a focus on improving access to information to empower frontline workers (i.e., mainly the point where work is performed and the individual is best equipped to affect outcomes). This approach also impacts engineering and support roles (who are largely affected downstream or could be more impactful without signal delays), as well as supervisory and leadership (who rely on data to benchmark, assess performance, identify, and scale excellence, or provide the necessary support and investment based on rational and informed decision-making processes).

For example, leveraging data in digital signage to communicate KPIs and progress towards attainment can help educate and aim workers in near real time. Integrating data with business-intelligence platforms with reliable dashboards can aim workers as well as provide access to the information that informs and drives change. However, job roles need to consume, connecting and integrating with visualization platforms will deliver impactful change to the organization and will assist employees in their daily efforts.

Automation

Automation isn't new. It's been around for decades. What is new is the toolsets, industry standards, a wide range of new devices in the marketplace, and new applications that make it easier to connect, integration, and automate business. Automation also takes on new forms, from the well understand and long-standing industrial controls automation to a fully integrated organization, where we can integrate across organizational boundaries, processes, and business systems, and even orchestrate across geographical boundaries with next generation hybrid tech estates made up of edge compute, data centers, and cloud services.

Two in three manufacturers (63%) are struggling to fill critical labor gaps.

In addition to the technological transformation underway, there is a more compelling reason to invest in automation. First, two in three manufacturers (63%) are struggling to fill critical labor gaps. This has long been an issue and will continue to be a business risk as manufacturers struggle to attract and retain the necessary workers. Second, 58% of manufacturing organizations experience short-staffed shifts, which further articulates the impact of both short- and long-term work shortages on the ability to keep production operational, meet customer demand, or support future growth. The result isn't just about how automation will improve operations or drive down costs. It's quickly becoming necessary to keep operations online.

☑ Checklist #7: Eliminate Non-Value-Added Transactions

This approach is as natural to manufacturing as anything, especially for lean six sigma cultures. The idea of identifying and eliminating wasteful activities is core to how most organizations continuously improve, reduce the potential for error, and drive productivity rates.

In a world where attracting and retaining a workforce is essential, manufacturers should look to how automation augments the workforce and eliminates monotonous activities. Top talent isn't interested in repeating the same mundane tasks over and over. Ensure talent is focused on actions that can't be easily replaced by automation or machines, and where human cognition and action can support continuous improvement and optimization.

With talent shortages, it's vital to map out non-value-added transactions. This is more important following a pandemic. It's not just about eliminating waste to drive productivity. It's also about ensuring that wasteful transactions don't systemically disrupt operations due to absenteeism, workforce shortages, or catastrophic scenarios like a pandemic.

Examples of meaningless tasks include eliminating paper, manual handoffs, reducing long manual feedback loops like empowering workers with real-time performance against goals, manually updating whiteboards and lists, and manual transactions or transposing into corporate business systems. For organizations dependent upon paper, 15% of a companies revenue is spent creating, managing, and distributing paper-based documents, and for every 12 filing cabinets, one additional employee is required to operate.

Eliminating these unnecessary tasks allows manufacturers to reduce the hidden, routine, and wasteful functions, while also reducing the number of workers necessary to operate. These digital integration actions will free already-stretched manufacturers to position their people assets on jobs that matter and bring value.

☑ Checklist #8: Device to Device

"Machine" is probably a poor term in today's smart manufacturing environment. Arguably, with a fully integrated environment, a manufacturer could connect and incorporate any device. This includes devices such as sensors, location tags, vehicles, tablets and scanners, industrial control systems, products, and even relevant data from facilities systems like HVAC systems—all with the intent to integrate, inform, automate, and optimize the process.

46% of leaders believed that their existing business models wouldn't be relevant in the next two years.

Device-to-device communication of closed-loop industrial control systems has long been integrated. However, the future will entail the capacity to integrate everything to drive automation or other higher-value activities from end-to-end. To successfully pursue this approach over time, manufacturers will need to rely on partner solutions that speak to a wide range of drivers or industrial protocols, modern IoT protocols, and leverage standards to integrate a vastly evolving tech estate.

For example, the ability to integrate anything implies that manufacturers may take multiple sources of data including, environmental data from sensors, employee feedback loops on mobile devices, specifications and production data from PLM and ERP, and combine it with industrial controls device data to make real-time automated decisions that signal and improve processes at the edge. This might result in fewer defects, improved compliance to design and regulations, and ensure that production is more resilient and optimized.

AI/ML

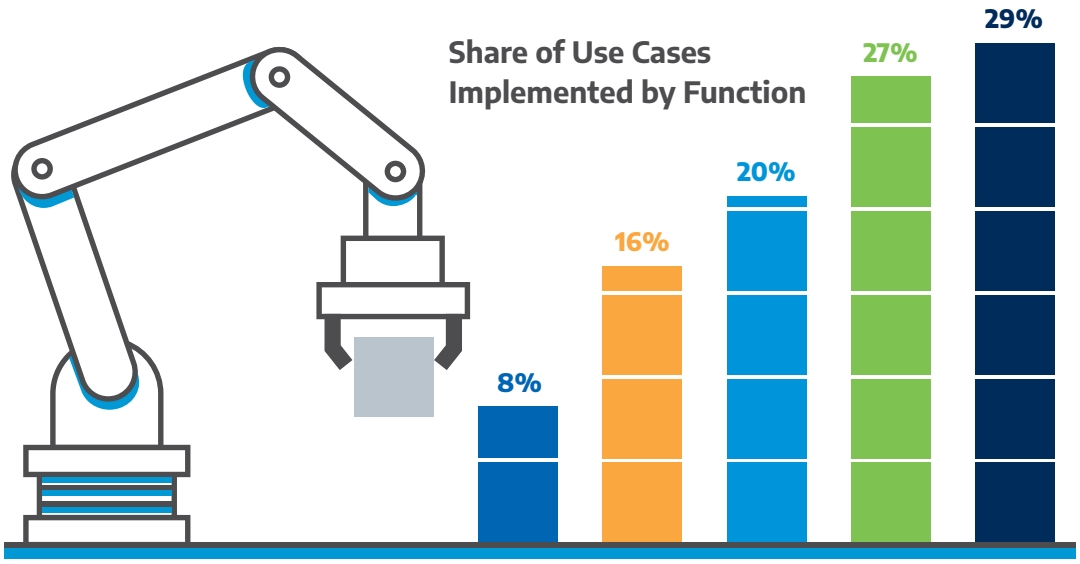
In a survey of U.S. manufacturers, 46% of leaders believed that their existing business models wouldn't be relevant in the next two years. It's a testament to the sector's challenges, the acceleration of digital transformation throughout the pandemic, a focus on how employees want to work, new client expectations in their buying cycles, and a need to deliver tangible value.

As this checklist has articulated, connectivity, integration, and automation are just part of the transactional actions expected in the modern smart manufacturing organization. Employees, clients, and stakeholders' expectations are also shifting, leading to changes in how these groups wish to consume and action information, disrupt the marketplace with differentiation in process or business models, or improve productivity levels not seen since the 1995–2005 period.

Despite an interest in AI/ML technologies, organizations should take stock of their readiness. This includes resources with the necessary skillsets, technologies, and access to cleansed, reliable, and trusted data. Manufacturers with little AI experience and resources should start with proven, repeatable, and scalable use cases to allow for early success, upskill the workforce, and initiatives that set a foundation for continued experimentation, scale, and exploration into progressively more complicated ones or differentiating use cases.

☑ Checklist #9: Leverage Proven AI Solutions

When starting with AI, there is no need to reinvent the wheel. Many everyday use cases have been deployed in manufacturing and yield consistently reliable business outcomes. In addition to the efficacy, leveraging turnkey or low-effort solutions lowers the barrier to entry, speeds time to value for organizations, and demonstrates the value of AI. These are all critical elements to attain early success.



Sources: Capgemini Research Institute. Artificial Intelligence in Operations, Secondary research of top 75 companies by revenue from Industrial Manufacturing, Automotive Manufacturing, Consumer Products, and Aerospace and Defense. *Supply Chain Management includes supply chain, logistics, inventory management, and warehousing Percentages depict the share of use cases implemented in a given function

Why Start with Proven AI Use Cases?

- Use cases have consistently been proven and generally repeatable across multiple manufacturing subindustries
- Access to data is more typical and reliable as they depend on high volume data repositories typical to most implementations involving ERP, QMS, or CMMS platforms
- Ease of implementation by depending upon turnkey or low-effort solutions
- Access to existing services and technologies readily available in the marketplace

For example, the two most common functional categories make up 56% of proven use cases in manufacturing. These include Maintenance (29%) and Quality (27%), which exist in all manufacturing organizations, have a significant impact on controlling productivity, cost management, and customer satisfaction, and by focusing on just one key strategic focus, you can quickly adapt to 25% of the most relevant deployments of AI.

The following are some of the most common use cases:

Maintenance	Quality and Production
• Intelligent Maintenance Management • Preventing Unplanned Downtime • Energy Management • Worker Safety • Machine-based Scrap and Waste Reduction • Increasing Operational Equipment Efficiency	• Product Quality Inspection • Minimizing Quality Escapes and Customer Defects • Optimizing Production Schedules • Reducing TAKT Times

Of course, there are many additional business use cases from theft protection and security management with machine vision and machine learning and customer engagement with chatbots.

What matters is selecting use cases that align best to your organization's top pain points, drive towards corporate business objectives, and bring value. Focusing on AI solutions like these will improve the likelihood of success and increase the long-term potential of achieving AI competencies, eventually leading to added maturity and market differentiation.

☑ Checklist #10: Differentiate with AI

Finally, the pinnacle of Industry 4.0 is the concept of autonomous, fully optimized, lights-out manufacturing. As with any vision, realization is not easily accomplished and aspirational in nature. While some frontrunners may be closer to this goal, most organizations cannot create, train, deploy, and monitor their own AI programs to deliver unique intellectual property and market differentiation.

Don't let that distract your organization from its pursuit. As this checklist has attempted to convey, all organizations are at a different point in the journey towards Industry 4.0. Value is perceived, and of course, incremental value pursued and achieved with each step. The maturity gained will create the necessary organizational and technical capabilities required to execute more complicated initiatives.

Manufacturers can also build upon the lessons associated with turnkey AI use cases. Organizations that start with bounded and achievable use cases benefit by enabling their organization to better understand AI/ML concepts, level of effort, and the value it returns in terms of ROI. This longer-term growth in organizational readiness will aid in building business justifications to leverage third-party automation services or developing internal resources to handle some or all of the AI lifecycle.

Reaching this stage in your Industry 4.0 maturity, a manufacturing organization may chase higher forms of continuous improvement and tackle the most impactful business or marketplace challenges. As with any business change, ensure those problems align to corporate and business unit objectives, identify the right KPIs to baseline and measure success, and develop new AI

models that will benefit the organization in the long-term. Examples might include furthering operational exellence, improving customer experience, or augmenting the workforce in a manner that accelerates research and development, transition to production, or factory optimization. Whatever the use case, putting in place the lower-level investments associated with this checklist will enable future AI initiatives, proof of concepts, and scale across the enterprise.

Conclusion

62% of manufacturers are forging ahead with smart manufacturing investments to drive operational efficiencies, create new business models, differentiate in the marketplace, and mitigate some of the most pressing headwinds facing the manufacturing sector post-pandemic.

With a comprehensive smart manufacturing strategy, organizational alignment, and adequate investment, digitally integrated factories can achieve 5-20% revenue impacts. Pulling only the most impactful business levers can result in significant business outcomes. These improvements will drive leaders to take action and support investments into the necessary skillsets, resources, and foundational technologies that enable businesses to become more digitally integrated and achieve the long-term benefits of leveraging data with purpose and precision.

One thing is clear, manufacturers have a sense of urgency to transform post-pandemic, advance their competitiveness in the marketplace, and offset the many headwinds bearing down on manufacturing organizations. Will your organization adapt and thrive?

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