Bringing human ingenuity and machine intelligence together to enable next-generation IOT solutions with Industry 4.0

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Introduction

Manufacturers of all types are leveraging technology to improve efficiency, reduce cycle and design times, enhance quality, and become more competitive. One of the most important technology trends in manufacturing is the integration of human ingenuity with machine intelligence to enhance the value of new internet of things (IoT) manufacturing initiatives. This e-book explores how manufacturers can better leverage the digital and the physical.

This e-book details how Industry 4.0 approaches, including hyper-automation, will help the manufacturing industry at large. It also provides information on practical ways to support the integration of digital and human intelligence, understanding, and innovation. Finally, it includes case studies and real-world examples of manufacturing firms that have implemented Industry 4.0 and found success.

The sponsors of this e-book, Cognizant and Microsoft, have the experience, processes, and underlying technologies to assist any manufacturer with a comprehensive plan for taking the next steps. The companies have staked out leading positions for intelligent technology-empowered manufacturing processes that are a step-function improvement over legacy approaches.

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How Industry 4.0, advanced intelligent processes, and hyper-automation are empowering manufacturing

The concept of Industry 4.0 is not new. Successful execution, however, requires a combination of new technologies, experience, and the requisite skills, intelligence, and hyperautomation. The maturity and capabilities of technology are improving at a significant pace. At the same time, the industry is facing a more volatile and dynamic business environment that has necessitated rethinking the benefits technology adoption can provide.

A major contributor to Industry 4.0 is hyperautomation, defined as a business-driven, disciplined approach that organizations use to rapidly identify, vet, and automate as many business and IT processes as possible. Hyperautomation involves the orchestrated use of multiple technologies, tools, or platforms. Automation makes it possible to integrate the needs of the stakeholders in a seamless way.

As noted in a recent Cognizant **report**, "Our research shows that across industries, intelligent automation is a top driver in the future of research shows that across industries, intelligent automation is a top driver in the future of work. While its impact was underscored by the pandemic, most businesses have yet to shift from isolated to widespread deployment."

Many manufacturing organizations use Industry 4.0 as a competitive differentiator. **Fortune Business Insights** sized the 2021 market at more than $110 billion. And it's estimated that investments in Industry 4.0 initiatives will continue to grow at 15% per year. Innovative use cases are continually delivering improved benefits and results. One of the more noteworthy use cases is the "digital twin" concept of virtually modelling physical processes. Firms using this technology not only can spot and resolve problems faster and at lower cost but can also optimize processes before they are implemented.

This is just one example of an Industry 4.0 solution that is increasing the speed of business. According to Cognizant, there are important benefits that come from intelligent, modern manufacturing systems:

- Significant reduction of operating costs
- Revenue enhancement
- Improvements in operational efficiency and agility
- Better process and quality control
- Stronger compliance and governance
- Ensuring healthy and safe environment
- Enablement of new business models

How Industry 4.0, advanced intelligent processes, and hyper-automation are empowering manufacturing (contd)

The adoption of Industry 4.0 continues at a rapid pace. According to a study by the MPI Group, two-thirds of all manufacturers say it has had significant impact on their business, and 61% say it is a competitive differentiator. This study also found that the three most important strategic goals in manufacturing—improved quality, increased production, and lower costs— are seen by approximately half the firms thathave adopted Industry 4.0.

But as organizations look forward, a reliance on technology alone is starting to seem inadequate. Many leading manufacturers are now focusing on merging human and machine intelligence to realize an even greater impact. Humancomputer interaction (HCI) is a major focus of Industry 4.0. At present, digital systems autonomously make many decisions and interact with other systems directly; adding human intelligence will require new approaches. This e-book discusses some of these new strategies and how they can take Industry 4.0 to the next level, or what is commonly referred to as Industry 5.0.

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Evolving Industry 4.0 to 5.0: Strategies for combining machine intelligence and human ingenuity

At the most basic level, human intelligence and machine intelligence possess different attributes and strengths. The focus of Industry 4.0 was on adding intelligence and collaboration to the machines and systems that are the foundation of manufacturing activities. Industry 5.0 is focused on combining human and machine intelligence. Industry 5.0 is a design solution that combines human resources and autonomous manufacturing solutions for effective collaboration. Industry 4.0 put smart technologies at the center of manufacturing and supply chains. Industry 5.0 takes things to the next level.

Industry 5.0 moves beyond a focus on the manufacturing process to what intelligence can do for the worker—and the customer. This includes extending intelligence from Industry 4.0 to improve experiences or enhance abilities, using intelligent devices that are worn by or are in proximity to the user, and even employin virtual environments The possibilities are as broad as the imagination. One way to understand the scope of this evolution is to realize that the collaboration of humans and machines goes beyond the factory floor (or the processes aligned to it) to embrace the collaborative use of these solutions across traditional applications.

The concept of Industry 4.0 started with the expectation of a smarter environment that would be constantly learning and making decisions autonomously. The initial focus was on reducing cost, increasing efficiency, and enhancing visibility and transparency to improve speed of delivery and product quality. In some ways, processes and decisions were handed over to machines. With Industry 5.0, the goal is to combine the unique capabilities of machines and people. Further, as a larger number of sentient and artificial intelligence is essential to the successful deployment and optimization ofIndustry 4.0.

Each of these types of intelligence, human and machine, has its own value. There is value in human ingenuity and the ability to view data through a creative lens. That stands in contrast to the current data/analytics approach of machine intelligence, which focuses only on what can be quantified or known. There are numerous ways this creativity can bring new ideas to an Industry 5.0 environment.

One example is how people can often see relationships in disconnected, orthogonal data points that would be nonsensical to digital systems. In general, the human ability to think and conceive "outside the box" is an important addition to the processes around creating Industry 5.0 solutions.

Artificial Intelligence and machine learning also add value. Machines have a big advantage in the amount of data that can be processed and the speed at which that processing can occur. Using digital intelligence to assess huge datasets and develop initial analyses helps things move more quickly. This speed comes with unmatched accuracy, ensuring dependable results. Advanced software can be used for predictive analytics to reduce the number of options that need evaluating.

Evolving Industry 4.0 to 5.0: Strategies for combining machine intelligence and human ingenuity (contd)

Considerations for Integrating Digital and Human Intelligence

Integrating human and digital intelligence in Industry 5.0 is a complicated process that requires a conceptual framework. The approach must recognize the fundamental speed difference between humans and machines. Intelligent digital systems make hundreds of recommendations for improving business processes every week, a pace no number of reviewers can match. The framework must ensure that the digital systems do not overwhelm people and deliver information and analytics that have gone through a greater review and are more likely to have value.

Fortunately, intelligent digital systems can be enhanced to better deliver results that are aligned with the actions and outcomes that people desire.

Documenting processes and roles helps machines to identify attributes that can be used to do second-or third-level refinement of analytics, and that reduces the amount of noise machines produce in the form of unusable recommendations.

The collaboration process can be broad, so it might be beneficial to start by focusing on three ways that machines and people will work together on initial Industry 5.0 projects. The people will add value to intelligent digital systems by teaching them, evaluating their results, and improving and refining both the systems and the results. In effect, people will match the life cycle of intelligent digital systems: creation, operation, and modification. This framework leverages the uniquely human skills of judgment, ability to learn from experience, and inherent tendency to include different types of input, particularly from external factors that are not part of the data input stream for the digital system.

Effects of bringing human ingenuity and machine intelligence together

Industry 5.0 will fundamentally change how manufacturing organizations operate. The benefits delivered by the collaboration of human and machine intelligence will topple the status quo, much as of the wave of intelligent automation in the 1990s did.

The changing landscape of manufacturing employment

The most obvious changes will be to jobs. As new processes that combine human and machine intelligence enhance manufacturing processes, some roles will be eliminated—but new ones will emerge. To take full advantage of the benefits of Industry 5.0, manufacturing firms should develop and document new job descriptions and roles, and proactively train workers to fill them.

The use of digital twins and virtual environments will improve worker safety by reducing the need to put workers into dangerous environments, but workers will require new skills to operate those environments, skills that will be in high demand. There will also be new roles for staff who can evaluate automated processes and identify ways to make them better based on their ability to include nonlinear data inputs and think more creatively and widely than an intelligent system can. Further, as manufacturers move to mass customization and new business models, such as the "as-a-service" approach, they will need employees who can support these initiatives.

Manufacturing firms need a transition plan to help staff adapt to this changing reality. Trying to adapt in real-time will bring chaos. Many Industry 4.0 projects that were not wellplanned caused disruptions and resulted in poor results, with time frames for achieving goals that were much longer than expected. For Industry 5.0, a plan that talks about humanassisted automation will help set staffers' minds at ease with the knowledge that they and machines will necessarily be working together to be effective.

Environmental benefits of connecting human and machine intelligence in manufacturing

One often-overlooked benefit is the ability to meet sustainability goals, and thus reduce their impact on the environment. Industry 5.0 is well-positioned to support the key goals of the so-called "circular economy," which aspires to more efficient and sustainable use of resources. More and more, voluntary efforts to conserve resources and energy while reducing carbon footprints are being supplanted by governmental mandates, and meeting those mandates is easier when human and machine intelligence are integrated.

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Effects of bringing human ingenuity and machine intelligence together (contd)

With Industry 5.0's more capable and intelligent systems, support for the six Rs of the circular economy—rethink, refuse, reduce, reuse, repair, and recycle—is embedded in the manufacturing systems. That is important because some new mandates require manufacturers to look beyond the basics of reducing carbon, being "green," and being more efficient. They need a broader perspective of the entire life cycle of both the manufacturing process and the end products.

With a strategic approach that goes deeper than sustainability, the future will include a focus on environmental responsibility that can best be achieved via the numerous second-level benefits of Industry 5.0. Some of the more common benefits include:

- **Increased hybrid and remote work:** The benefits of working remotely are welldocumented, but it has been hard for manufacturing firms to extend the model to a large percentage of staff. With intelligent visualization tools and digital twins, it will be possible for some factory staff to work remotely on certain tasks.

- **Development of micro-factories:** When manufacturers use smaller, more efficient factories that are closer to markets, they reduce carbon emissions by slashing the distance covered in transporting goods. In addition, on-demand production reduces waste, and micro-factories have a smaller ecological footprint.

- **Reduced impact from packaging:** Reducing the amount of packaging and materials is an area ripe for improvement. Using machine intelligence to create new packaging options and tapping human evaluation to ensure changes don't negatively impact the out-ofthe-box experience is a natural use case.

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Cognizant has the capabilities, expertise, and intellectual property to support the journey to Industry 4.0

Cognizant couples proven skills and processes with experience to help organizations design, deploy, and operate game-changing IoT and Industry 4.0 solutions. Its reference architectures speed the pace of Industry 4.0 projects ("greenfield" as well as "brownfield") and ensure that they deliver as promised. Cognizant is wellpositioned to take human-machine collaborative intelligence to the next level.

Cognizant's full-stack solution has the capabilities organizations need so they don't have to self-integrate missing pieces postdeployment. Chief among the models and frameworks that Cognizant uses to ensure project success are:

- **OnePlant™:** This framework enables manufacturers to achieve unified operations by integrating technologies on the factory floor with IT systems that support business processes. It encompasses road map definition, system/product selections, implementation/ deployment, user adoption, change management, and ongoing support.

- **Cognizant® Asset Performance Excellence:** This proprietary IoT solution allows remote monitoring and predictive maintenance of assets. It provides data and insights that enable organizations to understand equipment performance in ways that can drive cost efficiencies.

- **IoT Nerve Center:** This managed service refines knowledge models for continuous improvement and scalability across plants. It is available on an output-based pricing model or a pod-based, fixed-capacity basis.

- **Cognizant Connected Factories:** CCF creates a platform-agnostic blueprint to drive convergence between information technology and operational technology (IT/OT) systems, with seamless integration between the physical world of machines, the environment, products, and the utilizing smarter processes and assets to build smarter products while achieving greater efficiency, quality, and savings.

- **Manufacturing Service Bus:** This framework enables seamless shop floor (OT) to top-floor (IT/ERP) systems integration. It simplifies adding new capabilities to build advanced analytics and increase agility and efficiencies at scale, with real-time supply chain visibility.

Besides these documented frameworks and services, Cognizant has created additional intellectual property (IP) that ensures successful project outcomes. One of the most valuable is its process for moving from proof of concept to production quickly and efficiently. This is important because production is where payback and benefits are gained.

Another skill set is focused on the topic of this e-book: combining human and machine intelligence. Cognizant is a leader in understanding where the most valuable interaction points are, how to structure digital systems to better align them with people, and the unique capabilities each side brings.

Cognizant's focus on full-stack solutions makes it stand apart from other services. It ensures that when systems go live, they deliver all the expected benefits immediately.

Cognizant has the capabilities, expertise, and intellectual property to support the journey to Industry 4.0 (contd)

In the case studies below, you will find how Cognizant's Industry 4.0 solutions are helping clients in multiple industrial verticals. Connecting everything in a digital thread, from supply chain to engineering, enterprise resource planning (ERP), manufacturing execution systems (MES) and workflow systems, enables autonomous, agile, and efficient manufacturing processes and operations. Cognizant's solutions use industry-specific AI algorithms to improve human-machine collaboration and data-driven decision-making.

- A Fortune 500 manufacturer with six divisions and 800 plants worldwide is continuously looking for efficiencies and flexibility to remain competitive. The challenge: Each plant had its own siloed MES, making it impossible to gain a unified view of operations and difficult to transfer production from one plant to another. The company needed a single, advanced MES design that would work across all manufacturing environments and product lines. An off-the-shelf solution that would work with the company's planned SAP upgrade didn't exist. Cognizant offered a daring alternative: Build a new, custom MES from scratch.

The Cognizant solution delivered:

- 80% reduction in support costs
- Seamless roll out of 60,000 products globally
- Real-time visibility of global shop floors

- A global tool manufacturer with multiple lines of business and more than 100 factories worldwide lacked visibility into production metrics. With machines varying in age and complexity, and two fundamentally different types of facilities, few assets could be instrumented with sensors that provided data analytics to management. This Cognizant client knew it had a greenfield opportunity to transition cleanly to digital. Its objective was to create significant value—running to hundreds of millions of dollars—in the next five years as it moved from a focus on efficiency improvements to an Industry 4.0 platform promoting connectivity and digital visualization. Here's some of what Cognizant managed to do:

- Scaled the IoT platform to over 100 facilities, and thousands of machines and production lines

- Realized $100 million in cost savings and profitability gains in five years
- Implemented the IoT platform in four plants in just 12 weeks

- A global pharmaceutical manufacturer needed to reduce the complexity of its enterprise systems to increase the visibility of multiple plant floor systems and lower costs. It chose to partner with Cognizant to unify its processes and systems while charting a road map to improve operational efficiencies across 70 locations. The results of working with Cognizant are compelling:

- 20% increase in throughput
- 50% decrease in batch review efforts
- 10% decrease in inventory costs
- 15% decrease in rework
- Over 4,000 person-hours saved
- ROI realized within six months of rollout

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Microsoft technologies and solutions empower Industry 4.0

Microsoft is a major contributor to intelligent manufacturing. The Azure IoT platform is the basis of many solutions jointly delivered by Cognizant and Microsoft. The key elements of the Azure IoT platform include:

- **Azure IoT Central:** This readymade environment for IoT solution development is built on trusted Azure PaaS services. It reduces the burden and cost of developing, managing, and maintaining enterprise-grade IoT solutions and delivers built-in disaster recovery, multitenancy, global availability, and a predictable cost structure. IoT Central's customizable web UI and API surface let you monitor and manage millions of devices.

- **IoT Plug and Play:** This schema describes device capabilities. Manufacturers can use the device-capability model to configure a cloud-based solution such as an IoT Central application.

- **Azure IoT Hub:** This service enables reliable and secure bidirectional communications between millions of IoT devices and a cloud-based solution. It provides zero-touch, just-in-time provisioning of devices to the right IoT hub without human intervention. These capabilities enable customers to provision millions of devices in a secure and scalable manner.

- **Azure Digital Twins:** An IoT service that enables you to model a physical environment, Azure Digital Twins uses a spatial intelligence graph to model the relationships between people, spaces, and devices. By correlating data across the digital and physical worlds, you can create contextually aware solutions.

- **Azure Time Series Insights:** IoT devices typically generate large amounts of time-series data. This software can connect to an IoT hub, read the telemetry stream from devices, store that data, and help query and visualize it.

- **Azure IoT Edge:** Many advanced manufacturing systems require very low levels of latency and uninterrupted access to infrastructure resources. This service provides edge infrastructure that is fully compatible with Azure and operationally seamless.

Microsoft also provides IoT security expertise, resources, and solutions. IoT devices and systems often create new attack surfaces that need cyber-defences specifically designed to protect them. Microsoft has strong IP and processes for building threat models, the starting point for developing effective cyber-defences, in addition to proven IoT security best practices. Microsoft's documented IoT security approach is built on three key pillars: device security, connection security, and cloud security.

Summary

Intelligent manufacturing systems that leverage both machine and human intelligence are game changers. They provide manufacturers with more agile, efficient, and higher-quality manufacturing processes, dramatically enhance sustainability, and include the voice of the customer. The future will be nothing like the past.

These compelling benefits make it a strategic imperative to adopt advanced manufacturing capabilities that leverage both Industry 4.0 and 5.0 frameworks. Firms that ignore this imperative are much more likely to suffer major competitive losses. The time to move from investigation to implementation is now.

Taking this important step often requires partnering with technology and services firms who have the proven skills and processes to move ideas into reality. The frameworks and solutions Cognizant and Microsoft provide make it much simpler to deploy proof-of-concept and production projects. Manufacturers need to look for partners with a stellar track record that bring the skills and resources necessary to move forward with alacrity.

Schedule a briefing

For more information on how Cognizant and Microsoft can help your organization progress to a full implementation of Industry 4.0, visit Industry+ IoT Solutions | Cognizant, or contact us at **https://www.cognizant.com/us/en/services/iot-solutions** to schedule an executive briefing.

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World Headquarters

300 Frank W. Burr Blvd.
Suite 36, 6th Floor
Teaneck, NJ 07666 USA
Phone: +1 201 801 0233
Fax: +1 201 801 0243
Toll Free: +1 888 937 3277

European Headquarters

1 Kingdom Street
Paddington Central
London W2 6BD England
Phone: +44 (0) 20 7297 7600
Fax: +44 (0) 20 7121 0102

India Headquarters

#5/535 Old Mahabalipuram Road
Okkiyam Pettai, Thoraipakkam
Chennai, 600 096 India
Phone: +91 (0) 44 4209 6000
Fax: +91 (0) 44 4209 6060

APAC Headquarters

1 Fusionopolis Link, Level 5
NEXUS@One-North, North
Tower Singapore 138542
Phone: +65 6812 4000