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Autonomous AI-powered operations will transform industries to be more efficient, resilient, and secure while augmenting the workforce.

Progressing Industrial Organizations Toward Autonomous Operations Using AI and Data

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Introduction

Today's operations are on the verge of the next industrial revolution. Industry 4.0 introduced the concepts of operational connectivity and data-driven operations. Digital transformation has encouraged companies to collect data for process improvements for years. The movement introduced data collection to gain insights into machine operations, resource management, waste reduction, and energy efficiency, and Internet of Things (IoT) networks have implemented sensors, edge devices, cloud computing, and data storage solutions to create new efficiencies.

Industry 5.0 marks the next phase of industrial operations, led by data analytics and AI advancements. Industrial settings are moving toward autonomous functions as they confront constantly evolving supply chains, rising operational demands for sustainability, and a growing skills gap amid a shrinking workforce. Companies aim to utilize AI, simulations, and data-driven methods to boost efficiency, safety, and sustainability. To reduce the skills gap, autonomous systems can support workers by boosting their efforts, providing data insights, and helping with daily tasks.

AT A GLANCE

Autonomous AI-powered operations will transform industries to be more efficient, resilient, and secure while augmenting the workforce.

KEY STATS

According to IDC's 2024 *Future of Industry Ecosystems Global Survey:*

- 32% of companies plan to leverage AI for supply chain efficiency.
- 25% of companies will use AI for workflow automation and predictive analytics.

KEY TAKEAWAY

AI-powered autonomous operations will introduce new work processes that will augment workers, maximize asset output, and increase process efficiency.

The purpose of autonomous operations is to enhance the quality of operations, eliminate errors, create resilient supply chains, maximize performance, and leverage advanced automation technology. Enhanced control systems with AI and machine learning look to enable smarter, more adaptive operations. Depending on an organization's particular needs, the use of autonomous operations must be tailored to the specific intricacies of a company, so that these technologies can help improve asset utilization and ensure greater process stability, leading to increased efficiency and reliability across various industries.

Trends

Leveraging AI for Industrial Operations

Research indicates that inefficient operations are prevalent in most industrial companies. According to IDC's *Future of Operations Survey,* the cost of production ranks as the highest challenge against an organization's operations at 45%. This is closely followed by organizational effectiveness at 40% and product quality and access to data at 39%.

Data insights have the most significant impact on revenue. According to IDC's 2024 *Future of Industry Ecosystems Global Survey,* efficient data sharing and strategic insights have the greatest positive impact on revenue. This is the benefit that AI and automation can bring to industrial operations.

AI's ability to analyze structured and unstructured data at a large scale is one of the key developments on the road to Industry 5.0. AI is delivering on the promises that were founded in Industry 4.0. Today, with AI, it is possible to leverage the data that IoT networks and sensors collect to provide prescriptive rather than predictive or reactionary actions.

Over the past decade, companies have invested in connectivity. Industry 4.0 drove organizations to collect data to provide deeper insights into operations. That investment led to benefits such as predictive maintenance. The next generation will use AI to dive deeper, act, and assist operators. AI will leverage the data that industrial organizations have gathered.

Efficient Operations via AI and Data

Operational efficiency and productivity are the main drivers for organizations to modernize operations. IDC's *Industry Insights Survey* reveals that manufacturing companies identified productivity (40%), technology advancement (39%), and cost reduction (38%) as the top business drivers for operational efficiency. AI and autonomous operations aim to help transform operations, increasing output and maximizing performance.

According to IDC's 2024 *Future of Industry Ecosystems Global Survey,* the main reason companies are leveraging AI and machine learning algorithms is to improve supply chain efficiency (32%). Workflow automation and predictive analytics each accounted for 25%.

AI transforms operations by automating both predictable, rule-based tasks and more complex, knowledge-intensive work. Agentic AI and GenAI systems can facilitate contextual decision-making, allowing human workers to focus on higher-value tasks. For example, in manufacturing, AI-powered quality control agents autonomously detect defects and schedule maintenance, while predictive maintenance agents analyze sensor data to prevent downtime.

Security for Industrial Operations

Cybersecurity remains a primary concern for industrial systems. Linking physical operational systems to digital control platforms can boost productivity through advanced computing, but it also creates new vulnerabilities that malicious actors may target.

According to IDC's April 2025 *Future Enterprise Resiliency and Spending (FERS) Survey, Wave 2,* 47% of manufacturing and energy organizations cited cybersecurity requirements as their biggest challenge in infrastructure modernization. As operational technology (OT) environments become more digitally connected, OT operators will need to take responsibility for securing these areas. This includes developing incident response plans, improving network visibility with

active monitoring, installing firewalls and antivirus software, securing remote access, deploying zero trust protocols, and applying industry-specific risk-based vulnerability strategies.

Companies may find this overwhelming, primarily due to a shortage of personnel. IDC's *FERS Survey* highlighted that a lack of required internal IT skills and tools (30%), regulatory compliance issues (28%), and the number and scale of legacy systems and applications (27%) were barriers to modernizing infrastructure.

AI plays a crucial role in enhancing operational security by facilitating effective data governance, improving data access, and streamlining data management. It automates threat detection through pattern analysis, identifying malicious software and phishing attacks proactively. This autonomous detection supports continuous, 24 x 7 surveillance, adaptable for OT environments. In addition, AI tools can seamlessly integrate with security operations center workflows to deliver actionable insights, automate alert prioritization, and coordinate incident response across diverse security solutions. Agentic AI further empowers systems with autonomous decision-making capabilities, enabling them to adapt to changing situations and environments.

Augmenting and Upskilling the Workforce

Industry 4.0 brought enhanced layers of connectivity between operational technologies and IT systems. However, these efficiencies focused on the process, improving operations via resource planning, predictive maintenance of equipment, and energy efficiencies. At the same time, the workforce faces growing challenges, including talent shortages, an aging population, and a scarcity of skilled labor — issues that AI can help address through upskilling and augmentation.

The potential of AI lies in its ability to bridge the gap between the operational benefits of Industry 4.0 and human labor, propelling Industry 4.0 into the new era of Industry 5.0, where AI and automation work together to aid workforce performance through training and upskilling.

One of the main challenges facing the current workforce is the knowledge gap between experienced and new workers. Operational continuity is vital for maintaining stability and efficiency in industrial and operational settings. By adopting advanced technologies and strategies, organizations can reduce the impact of workforce turnover and knowledge loss, ensuring that essential operations continue without interruption. AI-guided decision support systems serve as a bridge to close skills gaps, allowing less experienced staff to perform effectively and make well-informed decisions.

Remote operation capabilities improve safety and reduce risk by enabling personnel to control and monitor systems from a distance, minimizing exposure to hazardous environments. Predictive analytics are crucial for proactive incident prevention because they identify potential problems before they become serious, creating a safer workplace. AI-powered autonomous systems assist early-career operators by offering real-time, contextualized recommendations; supporting their learning; and helping retain essential expertise within the organization.

As mentioned previously, the lack of IT skills and tools hinders security adoption in industrial operations. Agentic AI tools can help automate security practices, supplementing the workforce in managing security tasks and easing the burden of detecting and monitoring systems. By delegating repetitive tasks to AI, cybersecurity staff can focus on decision-making critical to securing operations.

Sustainability Initiatives

Sustainability initiatives run parallel with efficiency gains. IoT systems are designed to monitor and identify emission levels in real time, allowing for the early detection of potential environmental hazards. Addressing emissions proactively helps

prevent them from escalating into more significant issues. In addition, the system supports cleaner, more efficient operations across various facilities, contributing to environmental sustainability and regulatory compliance. Energy monitoring and regulation also enable more efficient operations. According to IDC's *Sustainability Software Survey,* 82% of organizations consider high-quality data crucial for achieving sustainability goals, and 72% can automatically extract sustainability data from systems such as ERP and CRM, highlighting the growing importance of automation in managing sustainability information. By tracking which areas of the facility are drawing more power, organizations can cycle power as necessary to optimize operations.

In today's industrial landscape, sustainability efforts are crucial for boosting operational efficiency. Companies that effectively oversee energy, cut waste, and optimize inventory tend to perform better and reach higher efficiency levels. Employing autonomous systems to monitor resources, materials, and waste helps enhance supply chains and streamline production processes. The IDC's 2024 *Sustainability Readiness Survey* reveals that 39% of organizations view AI and related technologies as the most critical for achieving sustainability goals, with smart automation and carbon monitoring software also ranking high at 34–35%. By harnessing advanced technologies and integrating AI into operations, autonomous systems can substantially advance sustainability across various sectors.

Benefits

Advanced AI-driven technologies are revolutionizing industrial settings by significantly enhancing operational performance. These innovative systems are designed to increase throughput, improve yield, and ensure greater reliability in manufacturing processes. A key focus is also on safeguarding human safety, achieved by integrating AI and digital twin models into traditional control systems to enable real-time monitoring, predictive maintenance, and safer operational protocols.

Digital twins provide nearly real-time insights into asset and process performance and health. By consistently gathering and analyzing sensor data, they can detect problems early, forecast failures, and plan maintenance proactively, minimizing downtime and prolonging asset life span. They integrate data from various sources and offer user-friendly visual interfaces, enabling operators and managers to make well-informed decisions swiftly. Digital twins merge real-world data, historical information, and theoretical models to simulate scenarios and aid strategic planning.

Principal methods of employing AI within industrial operations to improve productivity and performance include:

- **Intelligent user experience:** A new interface that offers actionable recommendations to operators, enhancing decision-making and minimizing errors
- **Reasoning engine:** Merges analytics, digital twin models, and AI to identify gaps between actual and optimal operations, providing suggestions based on historical data
- **Agentic AI:** Allows autonomous agents to handle routine tasks, enabling human personnel to focus on more critical responsibilities

To optimize plantwide operations, AI technologies extend beyond control systems to support planning, maintenance, and reliability. This includes:

- **Production intelligence:** AI-driven causal analysis to interpret process and asset data, providing well-founded recommendations for operational improvements
- **Asset performance management:** AI predictive insights into equipment health through connected sensors, assisting in identifying what to repair and when
- **Integrated field worker system:** Empowering field operations and maintenance by offering technicians and supervisors AI-driven tools and guidance for safer, more efficient task completion

Beyond individual plants, AI-powered platforms support enterprisewide decision-making. They function as a centralized system for integrating data and applications across multiple assets, turning fragmented decisions into a cohesive process that boosts agility and profitability. Simulation and digital twin models are the tools that facilitate predictive maintenance, improved decision-making, and scalability. AI assists in contextualizing data, providing actionable insights to identify failures before they occur, schedule repairs, and plan operations for consistent performance while increasing efficiency. Digital twins foster cross-functional collaboration by connecting traditionally siloed departments and systems. They provide a shared, up-to-date view of assets and processes, enabling teams to work together more effectively on design, engineering, and operational improvements.

Considering Honeywell

Honeywell's Industrial Autonomous solutions leverage advanced digital and AI technologies to help increase plant performance through closed-loop operations with minimal human intervention. This approach directly addresses key challenges in the process industry, including the need for sustained optimization and skilled worker shortages. By moving toward autonomous operations, industrial plants have the opportunity to improve production and empower personnel to perform at their highest potential.

Building the Autonomous Framework

Honeywell's autonomous operations framework leverages significant computational power at the edge and in the cloud, utilizing advanced AI tools to transform vast data into actionable insights executed through OT tools. It can help establish a closed-loop system that reduces the need for human intervention by implementing closed-loop workflows. These workflows enhance activities within the control room and connect field operations directly to it, enabling a seamless and efficient flow of information.

Honeywell's six-stage road map to autonomy includes:

- **Manual/semi-manual operations:** Basic controls and limited automation
- **Advanced control-based operations:** Automation of routine tasks using sensors and controllers
- **Intelligent onsite operations:** AI-powered digital twins that provide predictive insights
- **Remote operations:** Distributed intelligence that enables remote monitoring and control
- **Adaptive operations:** Systems that learn and self-adjust to changing conditions
- **Autonomous operations:** Fully self-healing, self-optimizing systems with no human intervention

Challenges

Implementing advanced technology solutions can significantly enhance organizational efficiency and competitiveness. However, these initiatives often encounter various challenges rooted in both technological obstacles — such as integration complexities and cybersecurity concerns — and the challenges of reskilling and upskilling workers to meet today's operational challenges. For Honeywell to successfully assist organizations in transitioning toward more advanced operational systems, the following should be considered:

- Overcoming workforce challenges such as resistance to change, training time, and service support costs is essential for organizations aiming to adapt to technological advancements and market changes. The existing workforce is necessary to help maintain current systems and ensure continuity.
- The incoming workforce requires appropriate training to ensure a smooth transition between employees, minimizing disruptions. AI can play a pivotal role in capturing existing organizational knowledge and facilitating the transfer of that knowledge to inexperienced staff, thereby preserving institutional memory.
- Organizations should explore options to upgrade physical assets featuring embedded upgrades. Hardware in certain facilities may be outdated, which can hinder the adoption of more advanced, efficient technologies that could improve operational capabilities.
- Enhancing existing technological infrastructure is also crucial. This includes initiatives to collect data for AI and data-driven analysis, such as digital twin technology and simulation analysis, which can optimize processes and identify potential issues before they occur.
- Furthermore, integrating AI with humans-in-the-loop is vital to augment decision-making. This approach ensures that AI functions as a supportive tool rather than a replacement for human operators. It empowers personnel, improves accuracy, and maintains a balance between automation and human judgments.

Conclusion

The path toward autonomous systems represents a significant milestone in the evolution of manufacturing and industrial operations. Industry 5.0 underscores the importance of integrating advanced AI and automation technologies to complement and augment the human workforce, fostering greater efficiency, precision, and innovation. Technology providers are positioned to play a crucial role as catalysts and partners in facilitating this transition. However, they will encounter challenges such as aligning new systems with existing infrastructure, overcoming workforce adaptation hurdles, and ensuring cybersecurity. Despite these obstacles, organizations that invest in leveraging data-driven insights and AI can achieve sustainable competitive advantages. The shift to autonomy will empower organizations by removing the mundane and repetitive tasks of industrial operations. Embracing this transformation not only enhances productivity but also paves the way for a more resilient and adaptable manufacturing ecosystem, solidifying Industry 5.0 and autonomous operations as defining elements of future industrial success.

IoT systems have always relied on data to improve operations. AI-enabled tools will enable autonomous operations to act on collected IoT data.

About the Analyst

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Carlos M. González leads IDC's industrial IoT and intelligence strategies. He is responsible for research on the IoT hardware and software innovations that transform operations within and across industries. In addition to assisting clients in maximizing the value of their technology investments and minimizing technology risk, he provides guidance on the human evolution and process changes required for digital transformation.

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