BRINGING THE FUTURE OF AUTOMATION INTO FOCUS

Technology is rapidly transforming automation and empowering new ways to work.

Rockwell Automation

A Powerful **Tomorrow** Is Within Sight

New industrial paradigms. An increasingly competitive global marketplace. Accelerating expectations for personalized products. More regulatory mandates. A shrinking workforce and unpredictable supply chain.

The challenges facing today's manufacturers are both multifaceted and complex.

To meet dynamic production demands, industry leaders have embraced digital transformation – and are building data-centric, insight-driven organizations.

The next hurdle? Digital technology must evolve to enable functionally complex automation systems that are not only smarter, but easier to design, operate and maintain.

Throughout this decade and beyond the 2030s, we believe that automation technology will advance to:

- **Simplify production environments and unleash extraordinary innovation** with more unified control disciplines, modern tools and flexible compute technologies.
- **Improve system lifecycle management** by exploiting advances in modern design principles, cloud platforms, simplified management of distributed automation assets, and dynamic digital twin and simulation technology.
- **Mitigate risk** through better ways both to improve production safety and security – and to address environmental, social and governance (ESG) concerns.

KEEPING IT SIMPLE(R)

Innovation in control technology has always been focused on making inefficient processes more efficient – and more responsive to marketplace demands.

More than 50 years ago, the first programmable controllers revolutionized manufacturing by providing a simpler, more flexible alternative to relay logic. And in the world of process automation, distributed control systems (DCS) were introduced to control continuous or batch-oriented production.

More efficient, open network environments replaced hardwired systems. But control technology developed almost exclusively within respective discipline silos, based on application type. Separate systems for discrete, motion, coordinated drives, process and safety applications proliferated.

Creating a combined system for more than one type of control was an integration challenge requiring expensive communication gateways and software. And a highly skilled workforce proficient in network technology – and multiple programming environments.

Integration was especially challenging in large, fragmented systems – and any system that incorporated batch processing, instrumentation, safety, robotics or other technologies based on closed networks and proprietary protocols.

Fast-forward to today. Controllers have more processing power than imaginable even 20 years ago. And automation platforms have become more unified – and manage systems that are more complex and often distributed across remote locations. For example, **this control platform** delivers multidiscipline solutions using a common engineering environment – along with modern network and communication standards that ease interoperability and support system security.

But now, digitalization and advanced technologies have introduced additional levels of complexity. The challenge? Unleashing the true potential of those technologies within increasingly converged IT/OT plant architectures in simpler and more manageable ways.

"Making the complex simple is how we innovate."

Bob Buttermore, Vice President & General Manager,
Power Control, Rockwell Automation

TAKING UNIFIED CONTROL TO THE NEXT LEVEL

Today's control systems promise more unification and simplification – and industry-wide standards ranging from ISA95 to module type package continue to evolve to support easier plant to enterprise integration. But that does not mean all manufacturing companies are evolving their technology in the same way. Machine and equipment coordination still often relies on the challenging integration of multiple, disparate systems sourced from third-party suppliers.

For the OEM, this scenario adds complexity across their portfolio and at every stage of the lifecycle. Design efficiency is difficult to achieve and customer support is more challenging when workers must master multiple systems. Performance gains are elusive when communication lags and synchronization stand in the way.

Integration challenges are even more complex for machine and equipment suppliers who provide end-to-end offerings, such as modular chemical production systems or end-of-line packaging solutions.

End users also fear the complexity that multiple systems introduce. Indeed, to address this fear, companies have often specified process skids with minimal or "dumb" controls – and automate with a standard, plant-wide system later. But in the end, "dumb" skids delivered without control systems before factory acceptance testing can cause significant coordination issues – and for some industries, validation challenges.

Today there's a better way. Automation platforms are evolving that can simultaneously improve production flexibility for manufacturers – and the native intelligence of OEM skids and machines.

For manufacturers and OEMs alike, the key is nimble, scalable control platforms. These platforms feature enhanced processors that not only run advanced and integrated control disciplines such as discrete, general motion, robotics, safety, batch and many others, but also provide an open ecosystem that seamlessly integrates many new and third-party applications. As a result, a whole new set of automation disciplines such as vision, machine learning, analytics, and integrated equipment visualization can capture the value of an integrated automation platform – and simplify design, operation and maintenance for manufacturers and equipment builders.

Technology Imperatives for Productivity & Flexibility

According to a recent study[1]:

- **88% of executives** think their customers are changing faster than their businesses can keep up.
- **64% of consumers** wish companies would respond faster to their changing needs.

To remain competitive, companies must find better ways to both bolster productivity – and enable more plant-floor flexibility. Automation control platforms are a critical part of that equation.

Many modern disciplines enable production to evolve from a purely automated process to a fully autonomous system.

Following trends we have seen in everyday products, this powerful control technology is increasingly available in not only scalable, but more compact and cost-effective options. As a result, machine and equipment suppliers can take a unified approach to control: one control platform, one integrated design environment for discrete, process, batch, motion, safety, drives, robotics and other advanced technologies.

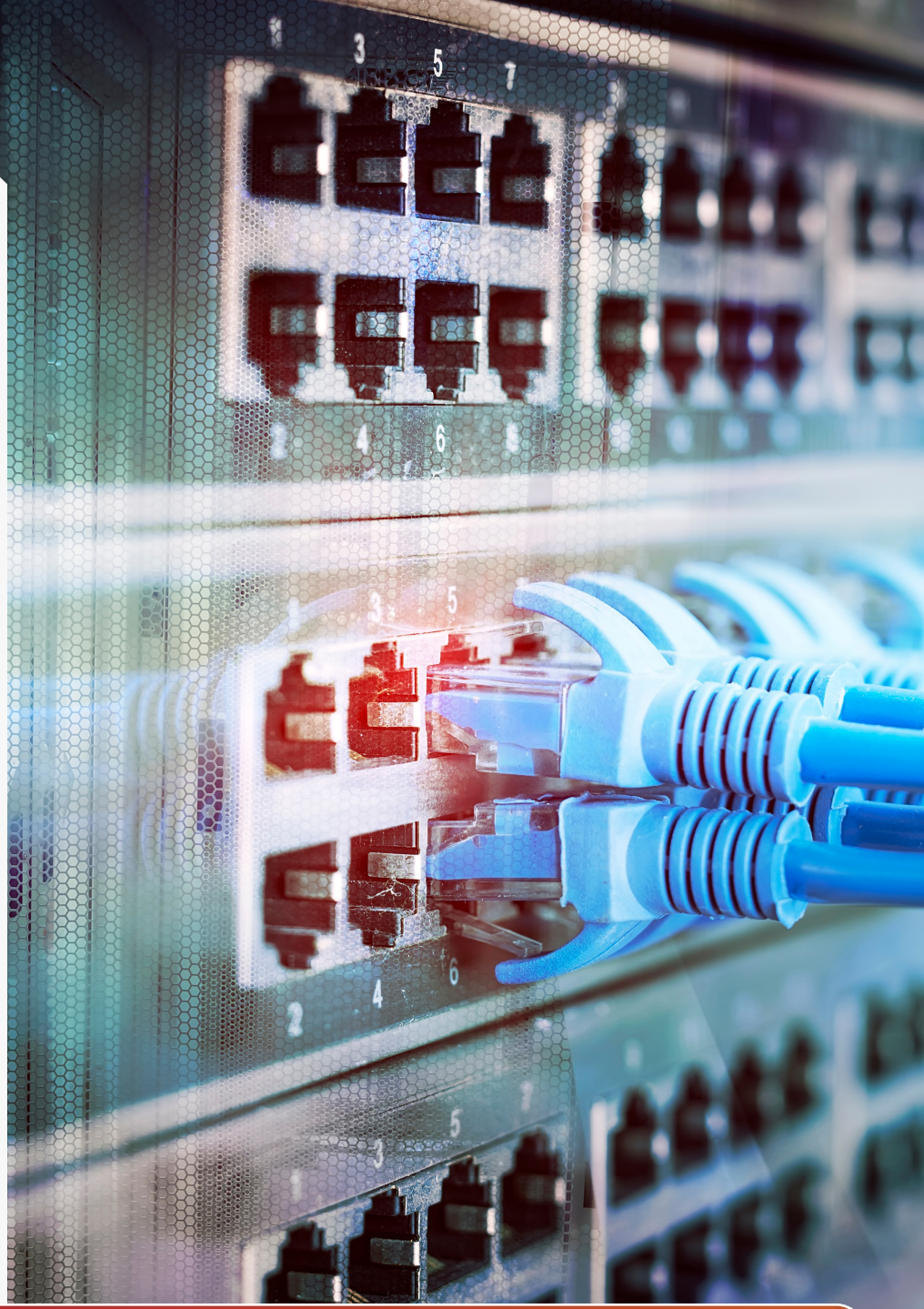
For OEMs, a unified control platform drives more efficient engineering and lifecycle support. But just as important, unified control opens new paths to innovation for system developers who can more easily and simply integrate diverse technology into their designs.

Unified control also translates into easier integration, operation and maintenance for the end user, who can work across a diverse collection of machines and equipment using a single control platform.

But unified control can achieve more. The integration of IIoT technologies, such as emulation, analytics, machine learning and augmented reality is truly transformative and takes industrial testing, decision-making, performance and skills training to the next level.

What's next? A new generation of control technology based on the concept of edge computing – computing done near or at the source of data. For example, cost-effective, embedded edge compute platforms are on the horizon. These platforms place the power of an industrial CPU directly in the controller chassis. In other words, an embedded compute module can host business logic that interacts directly within the process control logic.

Built on an open-source edge operating system, an embedded compute surface enables distributed edge computing that can address a wide range of use cases through IT/OT oriented applications.



Because the compute surface brings artificial intelligence (AI), virtualization and other IT/OT disciplines directly to the controller platform, it supports a new level of application innovation. Exactly what applications are developed is limited only by the requirements of the industrial manufacturing use cases – and the imagination of the developers. Data analytics, HMI dashboarding, communications, low-code applications and more are all possible.

And to simplify design and operation, embedded compute will deliver a user software experience consistent with the control platform – and any I/O module.

The vision? Embedded edge compute will ease the development of industry-specific applications – and open the door to remote deployment from a repository or marketplace to support new installations. In addition, it will provide a simpler way to deliver new technology and modernize existing systems.

The Power of One:
This is the concept of unified machine design, collapsing multiple processes into one – mechanically, electronically and programmatically.

EXPANDED ENTERPRISE-WIDE COMMUNICATION OPTIONS

To enable optimal performance, a truly simpler, more unified control environment also requires network connectivity – and communication protocols that share and use the "big data" that has proliferated in industrial environments.

Industry has long recognized the critical need for real-time communication in networked industrial environments. To achieve this objective, various industrial Ethernet solutions entered the marketplace in the early 2000s, including EtherNet/IP™.

Built on the Common Industrial Protocol (CIP™), EtherNet/IP allows users to deploy standard Ethernet technology in industrial automation environments. And to integrate and harness data from a broad array of applications – including control, safety, energy, motion, information and network management.[2]

While communication networks born in the industrial environment – like EtherNet/IP – remain critical, manufacturers are increasingly turning to efficient ways to enable secure communication and interoperability among IIoT devices, automation platforms and the enterprise.

OPC UA (Open Platform Communications United Architecture) is one way to take data integration a step further. OPC UA is platform independent and eases secure communication between open communication networks like EtherNet/IP – with devices operating on other industrial platforms, including field devices and sensors from multiple vendors.[3,4]

While many manufacturers are adopting OPC UA, some are using other ways to ease application programming interface (API) design and management. Options include methods that originated in the IT environment, such as the messaging protocol MQTT (Messaging Queuing Telemetry Transport) and REST (REpresentational State Transfer), a standards-based architecture that uses HTTP protocol.[5]

Some companies are using MQTT and REST along with OPC UA to interface with control environments. Others are bypassing OPC UA and prefer to bring these IT-based protocols directly to the doorstep of the controller – no gateway required – to speed communication and data access.

In addition, producers are contemplating emergent wireless technologies including Industrial 5G networks – to capture the promise of faster communication speeds and lower latency. Industrial 5G and other wireless technologies can simplify the deployment of mobile equipment, integrate physically disparate assets – and ease the connectivity of plant equipment to the cloud.

For manufacturers and machine builders navigating this environment, an interoperable control platform that can support multiple approaches is critical to reducing messaging complexity – and building a unified data network.

> **"Digital capability is at the heart of IT/OT convergence** where data, security, and industry-specific knowledge merge with analytics to drive outcomes."
>
> Rachael Conrad, Vice President & General Manager, Services, Rockwell Automation

REMOVING BOUNDARIES. ACCELERATING OUTCOMES.

IT/OT convergence and smart, digital technology have enabled extraordinary ways to use data from the plant floor throughout the enterprise.

But it has also changed the way people work in what was once two distinct arenas. Operations managers need the support of their IT colleagues to make data meaningful and accessible across the organization. And IT teams recognize the potential of OT and a connected plant or factory to achieve business goals.[6]

As a result, the need for collaboration across IT and OT – and software development disciplines – has accelerated. Automation platforms that deliver context-rich data will play a pivotal role in simplifying cross-team, multi-user communication and cooperation.

Fortunately, control systems and software deployment solutions are evolving in parallel. To keep pace with manufacturing demands, developers need tools that help them create faster – and provide the contextualized data manufacturers require. In addition, they need secure access to these tools around the clock and around the world.

"Manufacturers are increasingly putting data at the center of the production system. They need a way to bring their data together, from everywhere, put it in context, enrich the data, **and make it easily accessible to create value.**"

Brian Shepherd, Senior Vice President, Software & Control, Rockwell Automation

THE SIMPLE BEAUTY OF MULTI-USER COLLABORATION

In today's world, more system developers with computer science/IT backgrounds are assuming roles in the OT space. Regardless of background, workers must collaborate. But they often approach tasks with divergent skill sets.

For example, the veteran controls engineer is thoroughly conversant in ladder logic. But the recently hired IT developer is likely more comfortable in text-based code.

For production automation suppliers, the riddle is threefold:

- How do you create a user experience that makes the most of OT expertise?
- How do you capture the advantages of contemporary IT software design?
- And how do you remove systemic barriers to design productivity?

Modern production systems must bridge the gap between divergent users – and simplify multi-user collaboration.

One example? Software that enables developers to use a text-based project structure, but then dynamically renders that code graphically in ladder logic. For example, this solution empowers a multi-user workforce. All developers work in the same design environment – using their preferred approach. And can work concurrently on the same project, bolstering productivity across the system lifecycle.

Of course, multi-user collaboration also requires integrated version control. When built into the design environment, a version control system (VCS) allows multiple developers to work separately without having an impact on the work of others.[7] It tracks changes in the source code during software development, maintains a project's change history – and enables tighter collaboration.

SOFTWARE-DEFINED DESIGN

Conventional system design centers on the controllers where the code is executing. Typically, developers lack information about how the components in the system actually behave and react in the real world. Therefore, their ability to create system models that truly reflect real-world performance is limited.

Production systems are more complex than ever – and include a plethora of smart devices that promise to inform better system models. But device data is typically disorganized, undefined – and undiscoverable by information systems. Without structured context, data has limited value.

Modern software-defined design uses object-oriented programming to deliver context-rich data for defined objects – automatically.

How? With contemporary system design software, machine builders and system developers can configure "smart objects" that become part of the control system tag structure. Smart objects automatically trigger data collection from devices based on conditions detected in the control system. Information gateway software automatically finds and maps collected data to a model – and enables information applications to access it in database form.

Like user-defined data types (UDTs) and add-on instructions (AOIs), smart objects support standardized, modular code and can be integrated in shared libraries for reuse in multiple projects.

ENABLING SYSTEM DEVELOPERS TO THINK DIFFERENTLY

Software-defined design enables machine builders and system developers to leverage data in better ways – and to focus less on the controllers and more on what is being controlled.

In modern control platforms, this "system first" approach also extends to applications that expand beyond a single controller.

Latest software enhancements enable developers to model a complete multi-controller system before making any decisions about exactly which controllers will be used and what I/O will be integrated. In other words, designers can build logical project content before defining hardware platforms. Then map the code to controllers to create execution.

This move toward software-defined architectures promises to simplify and speed design – and provides machine builders and manufacturers with more flexibility when it comes to hardware purchasing decisions.

BRINGING THE AGILITY OF DEVOPS TO AUTOMATION SOFTWARE ENGINEERING

Modern software development practices, such as DevOps, rely on proven patterns that aim to identify issues earlier and lower the risk of large complex software integration. Concepts such as continuous integration and deployment, automated testing, and frequent build and regression cycles are known for improving quality and reducing time to market.

Automation systems – and automation software engineers – lagged in the adoption of DevOps concepts and techniques. But thanks to new enhancements in engineering environments, system developers can rapidly catch up.

For example, this engineering environment exposes open APIs – and leverages multi-user collaboration and integrated system simulation – to bring the benefits of modern software engineering practices to automation application development.

TAKING SOFTWARE TO THE CLOUD WITH SAAS

To better support modern control system design, the automation marketplace is offering more software deployment options. Specifically, more automation suppliers are adding cloud platforms to their portfolios.

One reason why? Manufacturers recognize the benefits of managing IT business software, such as Microsoft® 365, through a cloud-based service. And they are interested in exploiting these advantages in the production environment – using the same hyperscale infrastructure as their business platforms (e.g. Microsoft Azure, Amazon AWS or Google Cloud).

> **" Time to value is accelerated with cloud-based software.** It speeds software deployment, maximizes collaboration and simplifies how you design, operate and maintain systems – which means increased profitability for manufacturers."
>
> Julie Robinson, Director of Product Management, Rockwell Automation

When delivered as a software as a service (SaaS) offering, cloud platforms for visualization and manufacturing software provide significant benefits across the lifecycle of a project:

- Allows access to production systems from anywhere in the world.
- Maximizes collaboration and innovation across all stakeholders – including automation providers, machine builders, system integrators and end users.
- Enables users to easily scale systems and add or remove compute power on-demand.
- Reduces the need for onsite hardware, software and IT expertise and related costs.
- Improves the user's overall security posture by avoiding unpatched software, using centralized management, end-to-end encryption and role-based access controls.

At its core, a cloud-based approach to control helps solve a fundamental challenge in automation systems – simplifying the lifecycle management of control assets. Much of this problem is resolved with centralized, cloud-based engineering environments that can manage an entire system without compromising the performance, resiliency and safety of the control functions that remain running on premise.

Given the increasing requirements for low latency, high-performance control systems and functional safety, it is not advisable to control production equipment from a cloud environment at this time. However, cloud applications are emerging that extend from automation system design to the entire lifecycle management of the automation platform, including remote maintenance. These applications deliver the benefits of SaaS – and provide an uncompromising solution to the fundamental need for simpler and better system lifecycle management.

Advances in Simulation/Emulation Improve Engineering Efficiency

Advanced technology enables simpler operation on the plant floor. But adding new technology to a machine portfolio or production system also introduces a certain amount of risk. When system design and control systems come together for the first time, there is always the risk that something will not operate as expected.

In conventional engineering, roadblocks to success might not be uncovered until the factory acceptance test (FAT) or on-site commissioning. And put simply, last-minute design changes are costly and can delay projects.

Advances in **simulation/emulation software** improve operational certainty and engineering efficiency. These tools deliver dynamic models – or "digital twins" – that can solve technology challenges in the virtual world early in the equipment development cycle. The software easily incorporates ICT, robotics, functional safety and other technologies into the model.

Much more than a 3D representation, digital twins enable designers to run, modify and rerun designs in essentially any scenario before equipment is built. System developers can also connect the literal controllers and SCADA system to the model, emulate operation in real time – and validate the automation application before arriving on site.

SMARTER WAYS TO MITIGATE RISK

Risk in modern production environments takes many forms. First and foremost, companies must create work environments that support employee health and safety. But manufacturers must also help safeguard machines, equipment and processes, a task that is more complex in light of increasingly converged IT/OT environments and ever more sophisticated cyber threats.

Finally, addressing environmental, social and governance (ESG) issues is a critical consideration for all industries – not only resource-intensive industries such as oil and gas and mining. Across the board, companies are challenged to develop an ESG stance that meets customer and shareholder expectations for responsible manufacturing, satisfies evolving global reporting structures – and improves plant-level productivity.

We anticipate digital technology and information-enabled automation platforms will continually evolve to mitigate safety, security and ESG risks in smarter and more efficient ways.

> **Only 13% of legal leaders** surveyed are confident in managing cross-functional risks.[8]
>
> SOURCE: Gartner

THE FUTURE OF MACHINE SAFETY

Historically, "productivity" and "safety" were at odds in most industrial facilities and viewed as opposing forces. Safety was traditionally associated with compliance while productivity was associated with competitiveness. Both took separate, sometimes divergent, paths to meet their individual goals, which were reflected in separate control and safety systems.

Over the past decade, manufacturers have begun to change this equation by using integrated safety solutions along with contemporary international standards to optimize machinery uptime and plant productivity.

Specifically, integrated safety systems – systems where machine control and safety monitoring are performed on the same automation platform[9] – enable machine builders and producers to implement a "design-for-recovery" strategy. This strategy treats human and machine collaboration, and interactions with safety systems, as expected and focuses on machine designs that recover as quickly as possible.

Today's integrated safety solutions leverage the advantages of digital transformation – and benefits of smart devices – to take productivity to the next level. A smart safety solution contextualizes data from both standard and safety devices in a converged environment to speed diagnostics and issue resolution.

What's next? A safety risk assessment will always inform the appropriate architecture for a specific application. And safety relays and individual safety controllers will continue to be appropriate in some cases. However, as IT/OT convergence accelerates, automated processes become more autonomous, human and equipment collaboration increase, and industrial applications become more complex – we expect integrated safety solutions will increasingly become the preferred and most cost-effective choice.

PROCESS SAFETY CONSIDERATIONS

When process safety systems are compromised, the impact to people and the environment can be significant. And even if these incidents are quickly contained, negative publicity is often the result for the company involved.

Unfortunately, while process safety management (PSM) systems have become more robust in recent years, the number of catastrophic incidents has not decreased at the expected rate.[10]

Why? Like all producers, oil and gas, chemical and other heavy process industries face a skills gap that can lead to human error. In addition, many resource-intensive industries operate in harsh environments characterized by unpredictable weather conditions and natural hazards that can impact process safety.

Perhaps most important, critical technical decisions are often left to plant or operations management without the benefit of a thorough risk assessment.[11]

To best manage risk and achieve compliance with current standards, fault-tolerant process and safety instrumented systems (SIS) must be based on a risk assessment. And contemporary control platforms.

We expect process control platforms will advance in the near term to achieve tighter DCS and SIS integration – and a simpler way to achieve high availability and fault tolerance to meet industry-specific requirements.

> In the oil and gas industry,
> **44% of safety instances are the result of inadequate specification.**[12]
>
> SOURCE: Sensia

Industrial Cybersecurity Matters

Integrating Industrial Automation and Control Systems (IACS) with enterprise-level systems enables better visibility and collaboration, which help improve efficiency, production and profitability. But IT/OT convergence and greater connectivity also exposes control systems to additional cybersecurity risks.

Indeed, the focus on industrial cybersecurity continues to accelerate, thanks to an ever increasing number of large-scale breaches. In response, one recent study predicts the global industrial cybersecurity market will expand at a compounded annual growth rate (CAGR) of 7.7% during the current decade (2022-2032).[13] And chief information security officers (CISOs) will be under increasing pressure to stay on top of the latest threats while maintaining an agile and robust security strategy.[14]

For industrial companies seeking to improve their cybersecurity posture, a process that begins with a **security assessment** and aligns with the **NIST Cybersecurity Framework** remains the gold standard. Automation providers must be prepared to play a part in mitigating risk with solutions that are easy to use and operate – and with a level of cybersecurity up for the task. Simplifying the application lifecycle management of security controls in automation systems will increasingly be the defining criteria for equipment builders and producers when selecting automation suppliers.

Simultaneously, automation systems must support strategies new to industrial operations, including Zero Trust architectures,[15] which are expected to become increasingly important in critical infrastructure applications.

Many control disciplines benefit from integration into one simplified automation system, and security is no different. We expect automation systems will continuously evolve to incorporate increased levels of integrated security functionality – and to support proactive risk mitigation measures for production systems. Capabilities such as continuous threat detection, secure communications and content protection are becoming core requirements for many systems.

STEPPING UP TO HIGHER ESG EXPECTATIONS

There's no doubt the importance of ESG concerns in the industrial and commercial marketplace is increasing. More than 90% of S&P 500 companies now publish ESG reports in some form,[16] including Rockwell Automation.

And regional requirements for climate-related disclosures are ramping up. Two examples: In 2021, the European Commission released the Corporate Sustainability Reporting Directive (CSRD)[17]. In 2022, the U.S. Securities and Exchange Commission (SEC) proposed new rules for climate disclosures.[18]

As a manufacturer ourselves, we understand the challenges around creating an ESG proposition that both satisfies emerging reporting structures – and creates value for customers, employees, partners and investors.

We also understand that automation technology will play a pivotal role in minimizing ESG risk – and driving value to a company's bottom-line:

- **Managing ESG data is critical to meeting disclosure requirements and reducing regulatory and legal interventions.** Information-enabled automation platforms within converged IT/OT environments capture, contextualize and analyze data from multiple sources to support ESG audits and reporting – and identify opportunities for improvement.
- **Manufacturing efficiency and visibility across the value chain are essential to achieving climate-related objectives and lowering production costs.** Companies will increasingly leverage the digital thread and supporting automation solutions, such as MES and traceability, to design and manage sustainable production across value chains.

At the same time, evolving technologies like predictive analytics, machine learning and emulation will provide better ways to reduce water and energy consumption, optimize the use of chemicals and rare minerals – and decrease emissions and waste.

- **Automation innovation will increasingly focus on ways to minimize environmental impact.** Digital technologies – most notably artificial intelligence (AI) and augmented reality (AR) – will continue to spark ESG innovation in the automation space. A recent study indicates that AI may act as an enabler on 79% of the sustainable development goals (SDGs) established by the United Nations 2030 Agenda for Sustainable Development.[19] Automation and digital technology will be an important part of the sustainability equation both in scaling new infrastructure and in developing innovative solutions to support the clean energy transition and circular economies.

> **"The expectation for tangible, auditable, measurable results has increased around everything** from energy, emissions management and responsible supply chain to ethics, compliance, product quality and health and safety."
>
> Becky House, Senior Vice President,
> Chief People and Legal Officer, Rockwell Automation[20]

EMBARKING ON THE JOURNEY

Unified control platforms. Modern approaches to design, deployment and simulation. Powerful digital technologies and analytics. More visibility, communication and collaboration across the enterprise. Better ways to support and help protect people and the environment.

The future of automation promises impactful, simpler ways to achieve an extraordinary level of innovation, flexibility and performance in increasingly complex industrial environments.

At Rockwell Automation, we are relentlessly focused on bringing this future to light. **We can take you there.**

> **“ If we remember that this is a fundamentally human process, we can become more intelligent, more connected, more productive and more sustainable.”**
>
> Blake Moret, Chairman and CEO, Rockwell Automation

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