

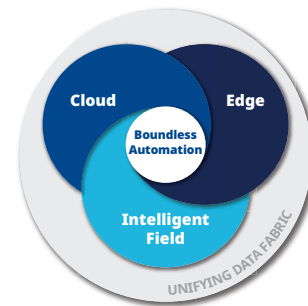
# A Journey to Boundless Automation in Life Sciences

## Introduction

The life sciences industry is at one of the greatest inflection points in history, where groundbreaking scientific discoveries, emerging therapeutic modalities, and rapid technological advancements converge. At the same time, the industry faces the dual challenge of meeting stringent regulatory standards while driving operational efficiency and innovation. However, siloed and inaccessible data often hinder progress.

The new industrial computing architecture is more open – yet secure, with computing capabilities everywhere and data shared across the organizational silos. It provides a transformative solution, enabling seamless data integration, fostering collaboration, and enhancing efficiency across organizations. Seamless data sharing unlocks the potential for collaboration and innovation, though realizing this vision requires careful consideration of legacy system integration and effective organizational change management.

Emerson characterizes this new industrial computing architecture as “Boundless Automation”. It is the combination of three computing domains - the intelligent field, the edge and the cloud. And these three computing domains are connected by a unifying data fabric, where information is shared in context and software computing happens everywhere and anywhere. Digital Transformation is possible when these three computing domains are integrated effectively, enabling the creation of smart factories and supply chains.



## Key Aspects Explored

- **Data Accessibility:** Breaking down silos fosters collaboration, improves data sharing and streamlines workflows.
- **Value Chain Optimization:** Eliminating silos enhances commercialization, technology transfer, maintenance, and production.
- **Timely Data Access:** Ensures compliance and supports sustainability goals.
- **Addressing Adoption Barriers:** Overcoming challenges to adopting new technologies unlocks advancements and drives progress.



## Opportunities and Challenges

Siloed data remains a significant barrier in life sciences, limiting collaboration and innovation across R&D, manufacturing, technology, and compliance teams. Traditional hierarchical architectures intensify this issue by restricting access to critical data. For example, data stored in the DCS may only be easily accessible to engineering teams, despite its value for modeling, process optimization, and deviation investigations.

Boundless Automation addresses these barriers by leveraging advances in computing to securely share data, fostering real-time collaboration between functions and streamlining workflows. For instance, production data allows scientists to refine formulations, and centralized data simplifies regulatory processes. By eliminating silos, Boundless Automation accelerates time-to-market, enhances efficiency, and enables organizations to scale effectively.

## Cloud-Enabled Collaboration Across the Commercialization Value Chain

Seamless collaboration between R&D and manufacturing is critical for life sciences organizations, particularly as new therapies transition from the lab to the production floor. Traditionally, this handoff has been slow, paper-based, and prone to errors due to fragmented systems and varied manufacturing processes. While many pharmaceutical companies have adopted enterprise solutions, these often replicate existing data silos, resulting in inefficiencies and increased costs.

Boundless Automation addresses these challenges with cloud-enabled enterprise operations. Platforms like Emerson's DeltaV Process Specification Management create shared environments for collaboration, enabling seamless transitions from lab to production. By standardizing product and process specifications, organizations reduce manual interventions, enhance efficiency, and achieve faster commercialization.

## Self-Optimizing Plants for Process Optimization

Precise process control is critical for producing complex molecules with the required physio-chemical and biological properties. Whether optimizing chemical reactions in drug development or managing biotech manufacturing, the ability to adapt processes in real time significantly enhances both research outcomes and product quality.

Boundless Automation enables the concept of the self-optimizing plant by leveraging real-time data, advanced analytics, and AI-driven automation to continuously refine processes. Dynamic insights into variables such as temperature, pH, glucose concentration, or oxygen levels allow scientists to adjust experiments, accelerating discovery and development. Manufacturing operations insights ensure production consistency and quality.

While implementing self-optimizing plants in life sciences regulatory challenges must be addressed. Starting with lab and pilot environments can pave the way for broader adoption where scalable, AI-powered plants will dynamically adapt to changing conditions enabling organizations to efficiently meet evolving production demands while maintaining rigorous compliance standards.

## Predictive and Prescriptive Maintenance

In the life sciences industry, equipment reliability is critical for uninterrupted lab operations, clinical manufacturing, and commercial production, especially in continuous manufacturing. Unplanned downtime can delay life-saving therapies from reaching the market or approved treatments from reaching patients.

Boundless Automation leverages data accessibility and predictive maintenance technologies, utilizing AI and machine learning to monitor equipment health and predict failures before they occur. Equipment such as bioreactors, filter dryers, centrifuges, and incubators can be continuously monitored, reducing downtime, labor, and material costs while ensuring seamless operations.

By integrating predictive capabilities with self-optimizing plant concepts, Boundless Automation enables prescriptive maintenance. In this advanced approach, AI not only predicts issues but also schedules repairs to optimize productivity. This proactive strategy enhances operational reliability, helping organizations meet the rigorous demands of lab operations and both, batch and continuous manufacturing with greater efficiency.

## Sustainability and Compliance

Sustainability and regulatory compliance are essential priorities for life sciences companies as they strive to reduce their environmental impact while meeting stringent regulatory standards. Whether in the lab or on the production floor, balancing sustainable practices with compliance is essential to both scientific and operational success.

Boundless Automation's access to advanced sensor data, combined with cloud-based monitoring solutions, enables life sciences companies to track product quality, energy usage, and resource consumption in real time. For R&D teams, this means monitoring the environmental impact of experiments to ensure sustainable practices are followed while meeting the quality target product profile. For manufacturing, this enables real-time product quality control, energy optimization, waste reduction, and emission management, helping companies achieve both regulatory and sustainability goals.

A Boundless Automation strategy also offers the potential to advance real-time product quality monitoring and enhance sustainability practices, including the development of carbon-neutral manufacturing plants equipped with both advanced sustainability and compliance systems. These systems ensure alignment with current and future environmental and regulatory standards, reinforcing the industry's commitment to sustainability, compliance, and innovation.

## Addressing Remaining Challenges

Adopting Boundless Automation comes with challenges, including:

1. **Cloud Costs:** The costs of storing and analyzing vast data sets has prompted organizations to optimize cloud strategies for better cost control.
2. **Brownfield Integration:** Upgrading OT systems in regulated environments requires careful planning to minimize disruptions.
3. **Compliance and Change Management:** Self-optimizing plants require alignment with quality standards and stakeholder engagement. Industry collaboration and pilot programs can help overcome these hurdles.

## Conclusion

As the industry faces increasing pressures to accelerate innovation, improve efficiency, and meet stringent regulatory compliance, Emerson's Boundless Automation strategy offers a transformative solution. By breaking down data silos, integrating advanced connectivity, and delivering real-time insights, it empowers operational and scientific teams to achieve their objectives with greater precision and effectiveness.

This strategy combines cloud-enabled collaboration, AI-driven tools, and prescriptive maintenance to accelerate time-to-market, decrease cost of quality, enhance reliability, minimize downtime, and support sustainability efforts. While challenges such as regulatory constraints, brownfield complexities, and cloud computing costs persist, Emerson's collaborative approach—partnering with customers and technology suppliers—helps organizations navigate these hurdles through phased implementation and pilot programs.

By enabling data driven decision making, Boundless Automation positions the life sciences industry to achieve pipeline acceleration, flexible manufacturing, real-time release, and sustainable operations, driving the next era of innovation and efficiency.