

AUTOMATION **2024**

MAY | VOLUME 2

SUSTAINABILITY

- ▶ ESG: More than Disclosure and Regulation
- ▶ ExxonMobil Champions Energy Transformation
- ▶ Energy Management Starts with Monitoring
- ▶ When Automation Means Empowerment
- ▶ Smart Plant Modernization of Core Process Control
- ▶ TSN for Transformative Change
- ▶ The Power of Modern Simulation
- ▶ Controlling Nonindustrial Processes
- ▶ MQTT for Smart Manufacturing



Table of Contents

AUTOMATION 2024 | MAY VOLUME 2
SUSTAINABILITY

Page 6

Sustainability Beyond Disclosure and Regulation

Jack Smith, Automation.com

How mandatory ESG reporting, and automation can improve manufacturing operations and increase the bottom line.

Page 13

The AND Equation: ExxonMobil Champions Energy Transformation

By Melissa Landon, Automation.com

Alternate sources of energy are playing an increasing role in the global energy mix, but oil and gas will continue to be significant. Reducing emissions is key.

Page 19

When Automation Means Empowerment

By Jan-Henrik Svensson, Beamex

How technology, data, and calibration can help eliminate global poverty.

Page 24

TSN Accelerates Plant Floor Transformative Change

By Jack Lin, Moxa

Time-sensitive networking improves IT-OT convergence, which is necessary for successful digital transformation.

Page 28

Energy Management Starts with Energy Monitoring

By Daniel White, Opto 22

By reducing energy consumption, organizations can save thousands on electricity, maintain machine health, and reduce their carbon footprint.

Table of Contents Continued

AUTOMATION 2024 | MAY VOLUME 2
SUSTAINABILITY

Page 32

Smart Plant Modernization of Core Process Control

By Jonas Berge, ISA Fellow, Emerson

Follow these recommendations to reduce emissions, improve energy efficiency, and stop overconsumption.

Page 43

Leveraging the Power of Modern Simulation

By Rick Kephart, Emerson

Digital twin technology is critical to navigating the new, more complex energy generation landscape.

Page 51

MQTT: The Path to Smart Manufacturing Sustainability

By Ravi Subramanyan, HiveMQ

MQTT-based strategies consider the manufacturing environment and continually seek opportunities for improvement.

Page 55

Controlling Nonindustrial Processes to Mitigate Climate Change Effects

By Renee Bassett, Automation.com

Bela Liptak's new book, "Controlling the Future," describes how automation professionals can help tackle the effects of climate change.

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Introduction

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Digital Transformation for Sustainability

Environmental responsibility is increasingly being seen as fundamental to business success and growth, and automation professionals are often called upon to help companies achieve corporate social responsibility (CSR) and sustainability goals. The International Society of Automation (ISA) is committed to “making the world a better place through automation” regarding sustainability by supporting new ways to accelerate environmental, social, and governance (ESG) activities across manufacturing, industry, and infrastructure. A position paper, [Achieving Sustainability Goals with Automation](#), discusses balancing economic opportunity and environmental responsibility.

Whether you're helping customers reach their ESG goals or are looking for ways to support your company's activities related to energy use, carbon emissions management, and other initiatives, you'll find inspiration in this issue of AUTOMATION 2024. The authors show how and where industrial operations can be leveraged to mitigate the effects of climate change or support an end to global poverty. Others highlight the role automation plays in the global energy sector's shift from fossil-based systems of energy production and consumption—including oil, natural gas and coal—to renewable energy sources like wind and solar.

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Sustainability Beyond Disclosure and Regulation

How mandatory ESG reporting, and automation, can improve manufacturing operations and increase the bottom line.



Data—whether financial or operational, is at the heart of environmental, social, and governance (ESG) regulation and reporting. So while sustainability may be a corporate objective, the mandates related to ESG both depend on and affect operations on the plant floor. Because of that, the automation professionals working to create and optimize plant floor operations have an important role to play in corporate sustainability efforts.

By Jack Smith,
[Automation.com](https://www.automation.com)

In his session at the IoT Solutions World Congress in Barcelona, ISA Past President and Executive Board member Carlos Mandolesi spoke about how automation can help companies achieve sustainability goals. “I think there’s a missing opportunity for the automation professionals related to sustainability initiatives,” he said. “There are a lot of business consultants and finance people involved with ESG reporting, a lot of Board- and C-level discussions, and lots of PowerPoints. There is a lot of talk but no real action. The automation professionals are the ones who can make a real impact because they know their plants and processes, and they know the cause and effect, so they use automation technologies to help companies make an impact.”



Mandatory ESG reporting is a reality for more than 3,000 U.S. companies due to the EU's CSRD.

ESG reporting requires data

The Corporate Sustainability Reporting Directive (CSRD) took effect for eligible EU entities in corporate fiscal year 2024. Organizations were to start implementing ESG reporting capabilities and infrastructure in 2023 to prepare their CSRD reporting for 2024 and beyond. According to an October 2023 article by Jim DeLoach, managing director host of The Protiviti View, mandatory ESG reporting is a reality for more than 3,000 U.S. companies due to the EU's CSRD.

“CSRD compliance requires substantial data collection, cross-functional collaboration, and, potentially, new reporting infrastructure. Organizations should begin crucial preparatory work immediately to improve the sophistication and rigor of their internal controls and governance oversight related to data collection.”

DeLoach also said the data that feeds the CSRD disclosures must be trusted, accurate, complete, and well-defined. “Satisfying this need represents a massive challenge for most companies given that ESG data is predominantly unstructured, stored in many different formats, and pulled from numerous systems, applications, and sources

throughout the company and its third parties. For most organizations, financial data governance and management likely is far more sophisticated than their current ESG-related data governance and management processes.”

While much of the ESG emphasis is aimed at investing and financial considerations, the focus on reporting (mandatory or otherwise) cannot be ignored. “Companies are facing a considerable increase in the demand for standardized ESG disclosure rules and reports,” said Carol Johnston, global vice president for the energy, utility, and resources industry at enterprise software company IFS. “It means companies are really facing increased demands for high quality data disclosure—and data itself—and not just from stakeholders.

●●●●● **For most organizations,** financial data governance and management likely is far more sophisticated than their current ESG-related data governance and management processes.

Measurement delivers data

Data reporting—whether financial, which information technology (IT) departments are really good at; or operational, which encompasses almost everything else—is at the root of ESG requirements. Operational technology (OT) is (or should be) responsible for accurate data captured from enterprise resource planning (ERP), manufacturing execution systems (MES), enterprise asset management (EAM)—including computerized maintenance management systems (CMMS)—emissions records, and more. Organizations must embed sustainability throughout the entire company to unlock relevant data hidden within their infrastructure, which will future-proof organizations and ensure obligatory compliance and therefore cost savings.

In July 2023, the International Society of Automation (ISA) released its position paper, “[Achieving Sustainability Goals with Automation.](#)” As

the paper describes, automation has a significant role to play in achieving sustainability goals, and offers new ways to accelerate ESG activities across manufacturing, industry, and beyond. From the position paper:

“Measurement is a great example of how automation can offer immediate, accurate monitoring directly in production, rather than in a laboratory facility—making it easier for companies and [regulators] to monitor for compliance. Data is increasingly available and is transparent to stakeholders, often with a layer of analysis powered by machine learning [ML] or artificial intelligence [AI] to identify potential areas of concern. This removes the potential for bias in analysis—where one engineer’s threshold differs from another’s interpretation. It further produces data that focuses on the skills of employees rather than their

For “born digital” facilities like this PureCycle plastics recycling plant in Ironton, Ohio, not only is ESG reporting automated, so is the entire plant.

Courtesy: PureCycle



identities—especially important as companies have increased their strategic efforts on diversity, equity, and inclusion.”

Digital transformation of industrial systems means more and better data is available. And some new companies are building in both data capture and sustainability goals from the start. PureCycle Technologies holds a global license for the patented solvent-driven purification recycling technology developed by The Procter & Gamble Company designed to transform polypropylene plastic waste into a continuously renewable resource. James Haw, vice president of program management and digital strategy at PureCycle Technologies [described](#) applying digitalization from the ground up when building new plastic recycling facilities.

Haw said the new facilities are “born digital like a planned community” so all aspects of the production facility and business are fully digitized from the beginning, and all data is held within a common data lake. This includes all systems that contribute to and draw from the data lake, whether on premise or cloud-hosted including process automation, maintenance, engineering, operations, HSSE [Health, Safety, Security & Environment], building automation and business systems. That means, “not only is ESG reporting automated, so is the entire plant,” said Haw.

New value chains: green hydrogen, CCUS, lithium batteries

In an ISA Connect technical forum, ISA Fellow Jonas Berge, who is also senior director of applied technology at Emerson, had much to say in response to the question, “Can you provide examples of successful automation projects that have significantly improved sustainability in a manufacturing setting?”

Berge said plants deploy multiple automation solutions to enhance sustainability, such as the monitoring of heat exchangers, cooling towers, air-cooled heat exchangers, steam traps, pressure relief valves (PRV), industrial light, emergency relief vents, thief hatches, seals (methane leaks), energy management metering and submetering, pilot-operated PRVs, and advanced process control (APC). (See Berg’s

full article on the topic, Smart Plant Modernization of Core Process Control, elsewhere in this issue.)

“In addition to that,” Berge continued, “there is all the specialized automation that goes into building plants for “the new value chains” including green hydrogen, lithium battery manufacturing, and carbon capture, utilization and storage (CCUS):

- ▶ Hydrogen value chain plants apply automation to electrolyzers, reformers, compression, liquefaction, pipeline, transportation, storage, hydrogen blending into natural gas, and hydrogen refueling stations.
- ▶ The lithium battery value chain encompasses mining, concentration, refining, battery chemicals, and cell manufacturing.
- ▶ The carbon capture value chain encompasses membrane/PSA/VSA/amine, compression, pipeline, storage, injection well, and more.

Berge also commented on the most common barriers to integrating automation for sustainability. He noted the lack of versatile wireless sensor network infrastructure and sensors, and that deploying standards-based wireless infrastructure and sensors can overcome this situation. He said standards-based architecture can overcome the lack of unified architecture for data and industrial software. In addition, he advocated using ready-made apps instead of attempting to code your own software, and instead of attempting to use machine learning, use first principles, he said.

“The technology and innovations to improve sustainability are already here but are futuristic to many plants as they have not yet deployed them,” Berge said. They include:

- ▶ Wireless sensor network infrastructure and sensors: WirelessHART (IEC62591).
- ▶ Standards-based architecture for data and industrial software: OPC-UA (IEC62541).
- ▶ Ready-made apps: mechanistic AI.
- ▶ First principles (1P) apps: mechanistic AI.

“Sustainable energy and sustainable goods require new infrastructure, and this infrastructure requires automation,” added Berge. “Without automation there is no sustainability. As the population and the middle class within that population grows, we will need more automation to keep up.”

Moving sustainability forward

How should organizations implement new technologies to help use collected data to drive change and comply with regulations? Caitlin Keam, senior director of sustainability applications at IFS, said, “Get your data into systems. Once it’s in systems, you can do a lot with the data that exists there. Once the data is in, the next step is ensuring data quality, then you can start doing anomaly detection and so on.

“As we go on, [the data] gets better defined and consistent,” Keam continued. “Once you have the right data foundation, there’s lots of technology that you can use to support you through automation, understanding the data, having the right insights, and having the insights on a more granular level.”

Added ISA’s Mandolesi, “Organizations and entities that focus their attention on sustainable automation will benefit tremendously. Cost reduction, increased safety, and greater workforce development opportunities are the immediately apparent benefits, but leaders must also recognize the opportunity to demonstrate their ESG leadership in a climate where environmental responsibility is fundamental to business success and growth.”

ABOUT THE AUTHOR



Jack Smith is senior contributing editor for [Automation.com](https://www.automation.com), the news and insights subsidiary of the [International Society of Automation \(ISA\)](https://www.isa.org). Jack is a senior member of ISA, as well as a member of IEEE. He has an AAS in Electrical/Electronic Engineering and experience in instrumentation, closed loop control, PLCs, complex automated test systems, and test system design. Jack also has more than 20 years of experience as a journalist covering process, discrete, and hybrid technologies.

The AND Equation:

ExxonMobil Champions Energy Transformation

By Melissa Landon,
Automation.com

Alternate sources of energy are playing an increasing role in the global energy mix, but oil and gas will be significant. Reducing emissions is key.

Wade Maxwell, vice president of engineering, at ExxonMobil Technology & Engineering Company, delivered a keynote about ExxonMobil's efforts toward energy transition at the 2024 ARC Forum. He introduced "The AND equation," which asserts the importance of not only meeting society's energy and product needs but also reducing emissions at the same time.

“Alternate sources of energy like solar and wind are playing an increasing role in the global energy mix,” Maxwell noted. “However, under most credible scenarios, including the net zero pathways, oil and gas will continue to play a significant role for decades to come. With that in mind, we are continuing to work in multiple areas to meet the needs of society today for reliable and affordable energy products while working to reduce our own greenhouse gas emissions as well as helping others do the same. That’s the ‘AND’ equation.”

ExxonMobil recently established a central technology and engineering company called EMTech that’s designed to scale capabilities across the corporation. “Watching the collaboration and innovation of our scientists, engineers, and project managers who are uniquely called to take on the challenges of today fills me with confidence and excitement about what these advancements mean for the future,” Maxwell said.

●●●●● **ExxonMobil currently produces** about a million tons of hydrogen per year and is working to develop new technology to produce it at a lower cost.

‘The AND equation’

For more than 140 years, ExxonMobil has delivered energy and products to meet society’s needs to increase living standards and drive economic growth. The key to success in that period of time has been the company’s ability to evolve and meet society’s needs that have changed over time. Underpinning that is the development of new tech, Maxwell explained.

“As the population grows and becomes more prosperous, the call on energy increases,” Maxwell said. “Getting on a pathway to net zero in that context is an immense challenge that will require unprecedented innovation and collaboration at an immense scale.”

“The AND equation” involves using various projects to balance the call to provide society with reliable and affordable energy products and reduce greenhouse gas emissions. Responding to this challenge will involve innovating new technology across multiple disciplines. Maxwell described some of ExxonMobil’s current initiatives working toward these goals.

●●●●● **Recent IEA Net Zero and IPCC Scenarios** estimated the world needs around 400 million to a billion tons of DAC CO₂ removal capacity per year by 2050.

Carbon capture: Direct air capture. Last year, ExxonMobil announced the first three agreements to capture, transport and store CO₂ from third parties on the U.S. Gulf Coast as part of its Low Carbon Solutions business. The first of those projects is expected to begin in 2025. These projects involve the fertilizer industry, an industrial gas producer, and a steel manufacturer.

Direct air capture (DAC) is a new technology that uses absorbent material to remove CO₂ directly from the atmosphere. DAC is slated to become one of the pivotal technologies in the energy transition. “Recent IEA Net Zero and IPCC Scenarios estimated the world needs around 400 million to a billion tons of DAC CO₂ removal capacity per year by 2050,” Maxwell said.

Some people identify trees as an alternative to DAC. While trees are cheap and easy to implement, they present challenges in rate and capacity. “As a rule of thumb, one tree can absorb about four tons of CO₂ over the course of 40 years,” Maxwell explained. “Compare that with a world-scale DAC plant that can remove about one million tons of CO₂ every year.”



“Just outside of Houston, we have recently completed construction of our first DAC pilot plant,” Maxwell said. “We are working with researchers and engineers who are using that pilot plant to develop commercial scale DAC, which will provide a low-cost solution.”

Hydrogen: A carbon-free, low-cost opportunity. “When I started as a process engineer, hydrogen was everywhere,” Maxwell said. “It is carbon free, so it’s a great low-cost opportunity to reduce emissions in the high-emitting industrial sectors. We expect it to play an important role in the energy transition.”

ExxonMobil currently produces about a million tons of hydrogen per year and is working to develop new technology to produce it at a lower cost. “We are well advanced on developing a project that we think will be the world’s largest blue hydrogen facility in Houston,” Maxwell said. “The facility will create about a billion cubic feet of hydrogen per day from natural gas. That’s enough to power 1.5 million homes.” As an added bonus, ExxonMobil will capture 98 percent or more of the CO₂ from that facility, which equates to 7 million tons per year.

Plastics: Processing a billion pounds of plastic waste per year by 2026. Plastics are everywhere: phones, laptops, vehicles, packaging, personal protective equipment, and surgical devices rely on it. “The AND equation” applies here because it’s a challenge to balance society’s need for these plastic products with the responsibility to deal with the global plastic waste problem.

“We are addressing plastic waste through a process called Advanced Recycling,” Maxwell said. “Unlike traditional recycling, Advanced Recycling doesn’t limit itself to materials you can grind up and melt into recycled plastic. The process converts plastic waste back to its molecular building blocks that can be used to manufacture other useful products.”

In 2022, ExxonMobil started up an Advanced Recycling facility, which has processed more than 40 million pounds of discarded plastic as of October 2023. “We are working to build our global capacity to process about a billion pounds per year of plastic waste by year-end 2026, assuming supportive public policy,” Maxwell explained.

Lithium production project. ExxonMobil’s planned lithium project in Arkansas would present a new source of lithium production through a new technology called direct lithium extraction, which will have a significantly lower environmental impact—approximately two-thirds less carbon intensity when compared with hard rock mining. The goal is to begin production in 2027.

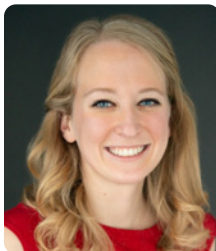
Final thoughts

“We announced that we plan to invest more than 20 billion dollars in lowering emissions between 2022 and 2027,” Maxwell said. “About half of that investment is intended to reduce emissions from our own operated assets. The balance is reducing emissions from other companies. We are delivering on both sides of the ‘AND’ equation.”

Maxwell emphasized that no single technology or magic bullet can carry the energy transition on its own. “We need advances in multiple technologies at the same time,” he said.

Sustainability, particularly through energy transition and decarbonization, was a major theme at this year’s ARC industry forum. Leading end user executives shared their plans for increased investment in sustainability related initiatives, all of which will require advanced forms of technology to make them happen as well as new thinking around legacy investments. Find out more from the [ARC Advisory Group](#).

ABOUT THE AUTHOR



Melissa Landon is senior content editor for [Automation.com](#), a subsidiary of [ISA](#), the International Society of Automation. Automation.com is a news, new products and technical information website focused on industrial automation, manufacturing and engineering in all vertical industry segments and all global regions.



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When Automation Means Empowerment

How technology, data, and calibration can help eliminate global poverty.

By Jan-Henrik Svensson,
Beamex

Vinice Mabansag. Remember that name. Born on 15 November 2022 in the Tondo district of Manila in the Philippines, this baby girl has the honor of being the eight billionth resident of our planet.

She is also an indicator of just how productive human society has been. With the global population increasing by one billion in just more than a decade, advances in science, agriculture, medicine, and technology mean that human beings are living longer and enjoying a better quality of life today than at any point in history. But these benefits have not been shared equitably.

According to the most recent estimates shared by the World Bank, around 689 million people live on less than EUR 1.8 per day and struggle to access essential services including quality health care, clean water and sanitation, and proper education. Recognizing the need to bridge this gap, the UN made eliminating poverty by 2030 one of its main Sustainable Development Goals (SDGs). Ambitious? Yes. Will we manage to meet this target? Maybe not. Is it impossible? No.

Let's not forget that global poverty rates have been steadily coming down. From a high of 1.9 billion people in 1993 to around 689 million in 2017, the reduction in extreme poverty is a success story that must inspire us. China, for example, reduced its extreme poverty rate from 57 percent in 1993, to just under 1 percent. India too halved its poverty rate between 1993 and 2011. Economic growth has helped pull millions out of poverty.

●●●●● **The vast amount of data and measurements** that we collect will allow us to target goods and services more effectively to those most in need.

Tech will reshape delivery of goods and services

I foresee this trend growing, fueled not just by economic growth, but also by technological innovations and data. Industry 4.0, artificial intelligence (AI), Internet of Things (IoT), and advanced sensors will play a big role in reshaping how goods and services are manufactured, ensuring more sustainable use of the planet's resources while boosting efficiency and productivity dramatically. Meanwhile, the vast amount of data and measurements that we collect will allow us to target goods and services more effectively to those most in need.

For example, consider agriculture. The use of sensors and AI can help track and predict weather patterns and yields, ensuring secure and stable food supplies. In the case of manufacturing, IoT will allow companies to build more predictive and sustainable supply chains, getting their products closer to different population groups, and reducing the risk of

supply chain delays. When it comes to welfare schemes, AI and wearables can help governments identify at-risk sections of society and drive targeted development and health care efforts.

Several real-world examples already exist. In Tajikistan, under a World Bank initiative, smart survey boxes were installed to monitor energy use. Meanwhile, in Somalia, GPS trackers were used for tracking the migration patterns of nomads, while Mexico used satellite imagery to estimate how many people live below the poverty line down to the municipal level.

Such technologies will also be of use in more developed regions, which are not immune to poverty. In the West, the use of IoT and machine learning will allow us to lessen the burden on existing systems, while the use of digital twins and predictive technologies can help create more resilient and future-proof infrastructure to meet the food, shelter, and healthcare needs of our citizens.

Calibration will help empower people

Tech and data's potential to help the world do more with less is huge. But if we are going to make decisions based on this data, we must ensure that the data collected is of the highest quality possible. Measures such as kilos, pressure, humidity, etc. remain constant in the physical world, but when a sensor converts it into digital, we must be sure that it is able to measure the data correctly and verify that no errors exist in its collection. Any model we build to combat poverty or any of the world's challenges must take that into account.

Here is where I see calibration playing a critical part: You can calibrate sensors and use data to understand if a specific sensor measurement is wrong or use big data to understand how off these measurements are on a larger scale. Being able to measure accurately and verify your measurements will have a two-fold benefit. One, it helps reduce the problem of waste and leakages in the delivery of goods and services to the public; and two, it will help build trust in the system. The latter goes a long way in assuring that people in different parts of the world are getting equal and quality access to different resources.

The importance of calibration will only grow as more rapid digitization occurs, and different processes are continuously tested and improved upon.

The outcome I am betting on here is empowerment. The use of these devices and trusted data will mean greater empowerment along the entire ecosystem. People aware of their rights will be empowered to demand equal access to resources and services, while governments and other organizations will be empowered with the knowledge to standardize the production and distribution of goods and services, while reducing waste.

Empowerment will lead to transparency, which in turn will lead to greater trust, efficiency, and sustainability.

At Beamex, we have been in the business of accurate measurements and precision calibration for decades. Empowerment is at the heart of everything we do. The solutions we provide help different industries in sectors as varied as food, pharmaceuticals, and energy comply with regulations and improve productivity. If you too want to help build a safer and less uncertain world, feel free to reach out to me directly.

More about this topic:

[8 billion and counting: How will we care for the growing global population?](#)

[Ensuring equal access to health care with technology](#)

ABOUT THE AUTHOR



Jan-Henrik Svensson is CEO at Beamex. He has nearly 30 years of industry experience with more than 16 years at [Beamex](#). He has a keen interest in regulation, smart data, and sustainability, and strongly believes that calibration is critical for creating trustable measurement data and that a sustainable and safe future depends on such measurements. Throughout his career Svensson has held several roles within the global automation industry, initially as an automation and electrical engineer and later different leadership roles in Finland, Panama, Germany, and Switzerland. He has a BSc in electrical engineering, has studied international business and finance, and sits on the board of several organizations. Svensson is also a keen reader and goes through more than a hundred books per year.

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TSN Accelerates Plant Floor Transformative Change



Time-sensitive networking improves IT-OT convergence, which is necessary for successful digital transformation.

By Jack Lin, Moxa

The lure of time-sensitive networking (TSN) is drawing interest from a cross section of businesses that recognize its important benefits, which include high determinism and bandwidth, short cycle times, and better synchronization when compared to classic fieldbus technology. TSN also benefits sustainability by enhancing energy and resource efficiency.

This article presents another benefit: TSN's role in improving convergence between information technology (IT) and operational technology (OT) that is helping usher in the transformative changes of Industry 4.0.

One network, multiple benefits

One unified network converging both IT and OT networks means modern IT technologies, such as artificial intelligence (AI) and machine learning (ML), can be incorporated to give stakeholders greater control over assets. TSN also empowers companies to evolve from selling products to selling services, offering more customization and reducing minimum order quantity (MOQ) without compromising profitability or wasting resources.

TSN enables the integration of control systems to achieve reduced cycle times. A few years ago, it might have required weeks to shift an entire production process to producing a new product. But by integrating different control systems, it now only takes a few days, making flexible, more agile production not only feasible but also profitable.

●●●●● **TSN enables the integration** of control systems to achieve reduced cycle times.

TSN in the real world

There remains a misunderstanding that TSN is still an unproven technology—more theory than reality. To dispel this notion, Moxa demonstrated several real-world TSN applications at Taipei Automation 2021, partnering with CLPA, Mitsubishi Electric, Intel, port GmbH, Orisol, and Sumyen Automation to showcase proof of concept of one unified network across different automation scenarios. Moxa is actively helping customers leverage TSN to connect multiple applications and diversified systems, significantly improving operations and efficiencies while requiring less equipment and cables at the field level.

An appliance manufacturer in Asia recently adopted TSN for its network infrastructure. The company collaborated with Moxa experts to integrate TSN into its existing automated production line by deploying Moxa TSN switches. By harnessing TSN, the company achieved real-time,

highly reliable, and deterministic communication, leading to improved operational efficiency and productivity.

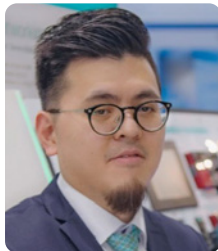
To enable mass customization of commercial-off-the-shelf (COTS) products, a manufacturer deployed Moxa switches to build a TSN-capable network combining existing proprietary networks into one unified network. This simplified the amount of training required to understand the many protocols in use and applied a network design that decreased cabling and maintenance expenses. Now, the company can adjust entire production processes with substantially lower cycle times to manufacture customized products as needed at a lower cost.

Moxa recently assisted a hydropower plant in China to increase its efficiency and ability to adjust total power output to the grid, giving rise to lower costs, easier maintenance, higher efficiency, and improved use of natural resources. Moxa connected different control systems to create a network providing ample bandwidth and low latency to support large volumes of data for a new AI system on its control network.

Final thoughts

TSN overcomes many challenges. As demonstrated in these real-world case histories, TSN is poised to accelerate industrial growth and help its early adopters realize improved outcomes.

ABOUT THE AUTHOR



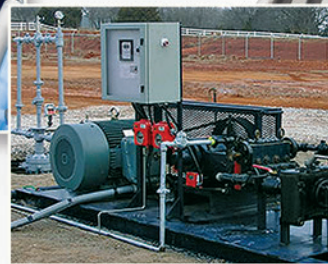
Jack Lin is global project lead, TSN initiative at [Moxa](#). He is an experienced product manager working in the industrial automation and communication industries. Lin is skilled in new product development, product lifecycle management, analytical skills, smart grid and smart factory, go-to-market strategy, strategic alliance/negotiation/contracting, team building, cross department/team communication, advanced technology, and market research. He has an MBA focused on telecommunications management from National Cheng Kung University.



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Energy Management Starts with Energy Monitoring



By reducing energy consumption, organizations can save thousands on electricity, maintain machine health, and reduce their carbon footprint.

On the surface, it's difficult to know where to begin. The best place to start is analyzing your energy data. But unfortunately, you can't find that data on your electric bill—it's barely a summary. To manage your energy, start by measuring it. Once you determine where, when, and how that energy is consumed, areas for improvement become obvious.

By Daniel White,
Opto 22

How energy monitoring can help you

Unstable pricing. Did you know that in many districts, the price of power changes during the day? It spikes during peak hours and drops during off-peak hours. Don't blame the utility companies. They are just trying to manage the grid to avoid overload.

But variable energy pricing created an opportunity for Opto 22, a manufacturing company that uses more than 500 kWh daily. Adding a few *groov* RIO Energy Monitoring units (EMUs) (Figure 1) gave the company the data to see easy ways to save tens of thousands of dollars each month.

Powerful predictions: Unlocking machine health insights. Energy is used in every industrial process and is usually fairly predictable. But add energy monitoring to a process, or even just a single motor, and new insight emerges. At some point, that motor's electric current consumption will change because of a bad motor winding, inadequately lubricated bearings, a clogged cooling fan, fluctuating incoming voltage, and so on.

One thing is certain: a sudden change to the baseline operating current indicates a problem that could cost time and money. That's why

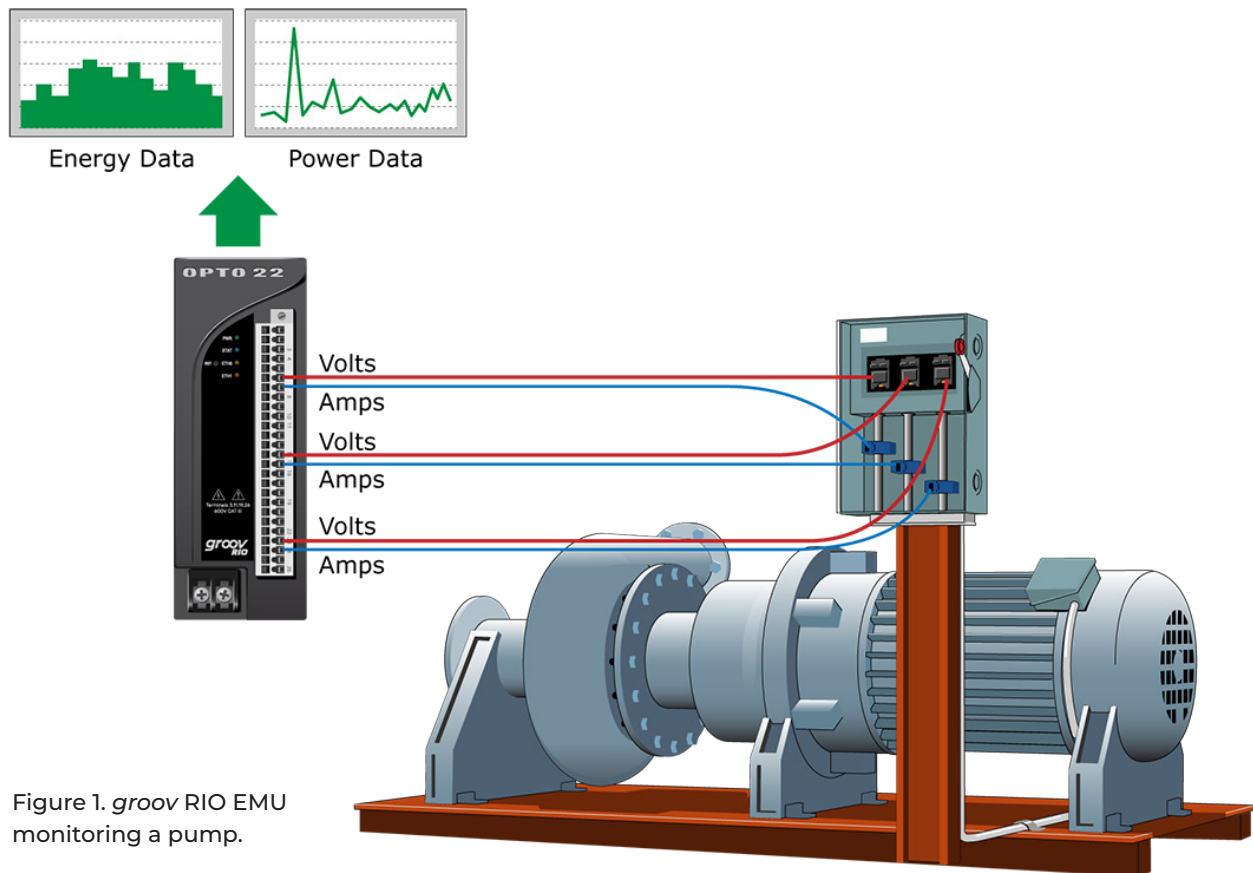


Figure 1. *groov* RIO EMU monitoring a pump.

industrial original equipment manufacturer (OEM) [Alta Refrigeration](#) includes a *groov* RIO EMU in every system they build and install at customer cold storage sites. Cataloging energy usage in 10-minute intervals provides insight to help keep refrigeration running at peak performance. As Peter Santoro, controls engineer at ALTA, explained, “Often, we know what the problem is before the customer calls.”

Pricing per part. Most organizations consider energy costs part of overhead—ongoing expenses of running a business that aren’t directly tied to a specific product or service. The bill gets paid by accounting, and most production environments never see a detailed breakdown of where their kilowatts are going. That makes it easy to pass blame onto other departments and hide energy inefficiencies.

You may be surprised how quickly you can start reducing energy expense, tracking machine health, allocating costs, and meeting ESG goals.

But [Mercer Technologies](#), an OEM of heat treatment furnaces, took a new approach. “In our most recent design, we’ve used the *groov* RIO EMU to monitor energy consumption of a particular furnace,” said Cody Young, Mercer’s controls and automation engineer. “With energy monitoring, we can calculate in real time how much it costs to heat treat parts, and we can now accurately assign the cost of energy to the production of a particular component.”

Environmental, social, and governance. Businesses now have to balance profitability with environmental impact. Products and brands that uphold environmental, social, and governance (ESG) principles tend to experience stronger growth compared to those that don’t, and government regulations and incentives for reducing carbon footprint are on the rise.

The State of Indiana recently launched its Energy INsights Program. Sponsored by the Indiana Economic Development

Corporation (IEDC), the program offers smart manufacturing starter kits to small and medium manufacturers with the goal of reducing energy costs by 5 to 15 percent.

Each kit contains the energy monitoring equipment a company needs to get started: an Opto 22 groov EPIC processor preloaded and licensed for use with [Inductive Automation's Ignition SCADA](#) and a few *groov* RIO EMUs equipped with I/O points and current transformers to measure power consumption in real time (Figure 2).

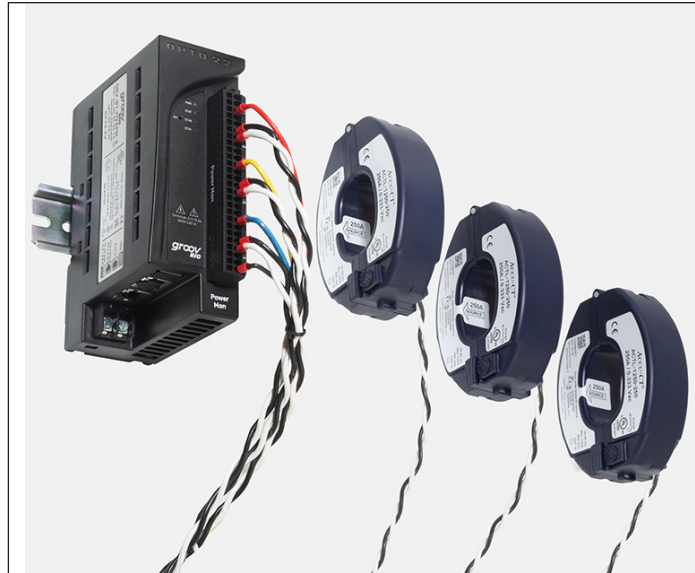


Figure 2. *groov* RIO EMU with current transformers.

Plug into power awareness

Are you ready to get started? [Watch the IntegrateLive! Webinar](#) to see how easy it is to wire up a *groov* RIO EMU to a field device, commission it with your web browser, and immediately start monitoring the data flow with the SCADA software of your choice. You may be surprised how quickly you can start reducing energy expense, tracking machine health, allocating costs, and meeting ESG goals.

ABOUT THE AUTHOR



Daniel White has worked at [Opto 22](#) for more than a decade. His Tufts Engineering background, MBA in International Business, and prior industrial controls experience give him a unique edge on automation. White enjoys staying active through biking, basketball, skiing, and keeping up with his three young kids.



Smart Plant Modernization of Core Process Control

Follow these recommendations to
reduce emissions, improve energy efficiency,
and stop overconsumption.

A lot has been said in the past 10 years about adding automation to plants for digital transformation of manual work. But the automation for the core process control (CPC) should also be modernized to require less manual intervention by production operators, for the plant to be more autonomous, to reduce instrument maintenance work, and to make the plant more sustainable.

By Jonas Berge,
ISA Fellow,
Emerson

Many old-style automation components remain in plants today because when they fail there is no time to review newer and better solutions, so they are replaced with identical components. Thus, there are still many mechanical instruments in operation. Those components were the best of their kind when originally selected, but today better solutions are available. Plants that do not keep automation up to date will be at a huge disadvantage in the long term. Instrumentation and controls problems have direct business impact. Modernizing automation help plants attain operational excellence. New plants being built now can use these technologies right from the start.

●●●●● **Instrumentation issues** like failure, underperformance, inaccuracy, and lack of integration force production operators to manually intervene in loops that otherwise would be in automatic.

The core process control zone includes the distributed control system (DCS) and safety instrumented system (SIS), together referred to as the integrated control and safety system (ICSS), as well as the associated sensors and valves. These systems have rigorous management of change (MoC) procedures to preserve the robustness and safety of production. This article is about the automation in this CPC zone. But the CPC zone does play a part in digital transformation. Plants that successfully pursue digital transformation adopt the NAMUR open architecture (NOA) whereby data from the DCS is channeled securely through data diodes out to an independent monitoring and optimization (M+O) zone with automation for digital transformation of other functions. The data diodes make sure the security and robustness of the systems in the CPC zone are not affected. Open standard OPC-UA interfaces are used to make the DCS data available to the automation in the M+O zone. Thanks to this security, sensors and software apps can be added freely in the M+O zone.

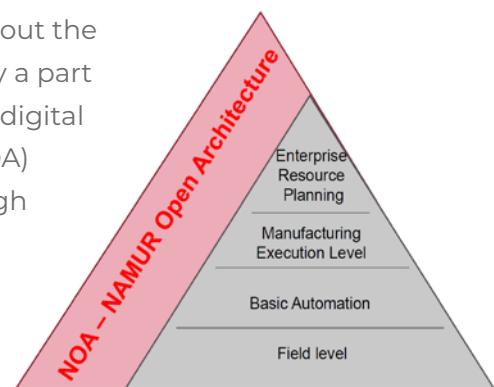


Figure 1. The NAMUR open architecture defines standard interfaces between the core process control zone (gray pyramid) and monitoring and optimization zone (pink sliver). *Courtesy: NAMUR*

Reducing manual intervention: Production

Instrumentation issues like failure, underperformance, inaccuracy, and lack of integration force production operators to manually intervene in loops that otherwise would be in automatic. Additional work causes stress, but various new, intelligent field instrumentation, controllers, and software components are available to help.

Transmitters with moving mechanical parts are susceptible to wear and failure, and when they do fail, production operators are forced to operate loops in manual. This, in turn, causes off-spec product, higher energy consumption, and operator stress, which may lead to mistakes. For example, displacer type interface level transmitters have moving parts. The recommendation is to upgrade these positions with guided wave radar (GWR) level and interface transmitters (Figure 2) that have no moving parts whenever conditions permit.

Another mechanical example is turbine and positive displacement (PD) flowmeters. The recommendation is to upgrade these positions with magnetic, vortex, or Coriolis flowmeters with no moving parts. As a result of more reliable instruments, loops stay in automatic for greater sustainability and reduced off-spec product, plus operator stress is reduced. In addition, many new instruments now support Bluetooth wireless communication that enables configuration, calibration, and diagnostics at the device using a phone, tablet, or laptop.

When the process cycles or deviates from setpoint, it could be due to control valve issues like high friction or high/low air supply pressure. Or the problem could be elsewhere in the loop. When analog control valve positioners or I/P converters are used, production operators cannot tell there is a valve issue because there is no diagnostics or position feedback. So, production operators put the troubled loop in manual. Again, they will experience the same manual challenges described previously.

The recommendation is to upgrade all control valves with smart valve positioners with valve performance analytics. Valve issues can be verified on the positioner display or over Bluetooth from a mobile



Figure 2. A guided wave radar (GWR) level and interface transmitter has no moving mechanical parts that can wear or fail. *Courtesy: Emerson*

device as explained earlier. As a result of diagnosing and fixing valve issues, loops can be returned to automatic with the same benefits described previously.

Actions that cannot be made directly on the operator console are associated with high stress, workload, and poor health. High levels of stress lead to errors. A good example of this is a manually actuated valve. This was acceptable in the past but not anymore. The recommendation is to upgrade manual valves by adding actuators. As a result of operation from the operator console, workload and stress are reduced.

Inaccurate transmitters make production operators set setpoints with conservative “comfort margins” to not cross limits. Comfort margins cause quality giveaway and high energy consumption. For example, ultrasonic or differential pressure (DP) level transmitters, turbine or PD displacer interface levels, remote seals or temperature sensors direct to system input cards each have their accuracy challenges.

The recommendation is to upgrade these positions with new sensing technology such as non-contacting 80 GHz frequency modulated continuous wave (FMCW) radar for level (Figure 3), magnetic, vortex, or Coriolis flowmeters, electronic remote sensors (ERS) in place of remote seals in most applications, GWR for interface level, and temperature transmitters close to the temperature sensors. For DP flowmeters, upgrade the DP transmitter to a high accuracy and stability model. With more accurate measurements, plants see reduced production cost and greater sustainability.

Custody transfer storage tank level gauges or flowmeters with moving mechanical parts can also be inaccurate. This leads to inventory



Figure 3. Inaccurate transmitters make production operators set setpoints with conservative “comfort margins” that decrease quality and increase energy consumption. A radar level transmitter (left) and radar level gauge (right) use new, more accurate sensing technology. *Courtesy: Emerson*

loss or leaves the customer shorted. For example, servo or float-and-tape level gauges and turbine flowmeters are mechanical devices that have accuracy challenges. The recommendation is to upgrade storage tanks with custody transfer certified FMCW radar level gauges with no moving parts. For metering skids, the recommendation is to upgrade from turbine flowmeters to custody transfer certified ultrasonic or Coriolis flowmeters without moving parts. With more accurate measurements, plants avoid inventory losses and avoid shorting customers. Terminals have the confidence to fully use tank capacity.

Package units and skids connected to the main distributed control system (DCS) through hardwiring or RS-485 networking carry limited information, like a single common alarm, to the production operators. Those operators then are forced to send someone out to the module for closer inspection when an alarm occurs. This causes operator stress, potential mistakes, slower problem resolution, and production downtime.

The recommendation is to upgrade the package unit controllers and DCS to use Ethernet, OPC-UA, and Module Type Package (MTP) integration technology (Figure 4). With the complete set of information from the package unit, plants reduce operator stress and production downtime.

DCS that use proprietary software “connectors” require custom-coded application programming interfaces (APIs) for integration of data into apps, which is very costly. Consequently, helpful apps like advanced control, state-based control (procedural automation), and loop tuning do not get adopted in the plant. So, production operators must make various manual interventions that could otherwise be automated with software. This is contributing to operator stress, possibly mistakes, off-spec product, high energy consumption, and low throughput. The recommendation is to upgrade the DCS to use OPC-UA. The added

Figure 4. Replace hardwiring or RS-485 networking with support for Ethernet, OPC-UA, and MTP communications to reduce operator stress and downtime. An Emerson RSTi-EP Ethernet/IP network adapter is one solution. *Courtesy: Emerson*



software enables plants to reduce operator stress and off-spec product, increase sustainability, and achieve greater throughput.

Pressure switches only have an on-off contact output, so there is no telling if pressure is ever close to the limit or how fast it is changing. Production operators get no early warning (no prediction). In addition, there is no self-diagnostics so production operators cannot tell if it has failed. This in turn leads to operator stress. When in doubt, production operators must request a manual check on signal validity. The recommendation is to upgrade these positions to pressure transmitters with self-diagnostics flagged as <4 mA or >20 mA. For example, American Petroleum Institute (API) standard 682 recommends transmitters instead of switches for mechanical seals.

Similarly, proximity switches are sometimes used for position feedback, but they only tell you if the valve is fully opened or closed, and there are no self-diagnostics so production operators cannot tell if a switch has failed. This in turn leads to operator stress. When in doubt, production operators must request a manual check on signal validity. The recommendation is to upgrade these valves to position transmitters. With more information, plants can reduce operator stress and increase safety.

Mechanical controllers, as found on some control valves in some corners of most plants, are isolated because they are not integrated with the operator consoles. Production operators must go to the field to manually check the pressure or change the setpoint. This leads to operator stress. The recommendation is to upgrade these valves to electronic controllers with networking, enabling remote setpoint and process monitoring from a central location. This helps plants reduce operator stress.

Reducing the workload: Maintenance

There are thousands of instruments in a plant, so it is critical they are reliable, requiring minimal attention and that any necessary maintenance is made easy. This is over and above what digital transformation can do for equipment reliability.

The mechanical servo and float-and-tape tank gauges, displacer interface level, turbine and PD flowmeters, turbine flowmeters, and mechanical controllers have moving parts and therefore are susceptible to wear and failure. When they do fail, the maintenance team must replace the failed device, resulting in increased workload and maintenance cost as well as causing production downtime. The recommendation is to upgrade these positions to radar level gauges; GWR level and interface level transmitters; magnetic, vortex, or Coriolis flowmeters; and electronic controllers, respectively.

Float-level switches used to detect high or low level also have mechanical moving parts. The recommendation is to upgrade these positions to vibrating-fork-level switches without moving parts.

Turbine flowmeters may also be used for custody transfer. Also, for these positions, the recommendation is to upgrade to custody-transfer-certified ultrasonic or Coriolis flowmeters without moving parts.

Displacer transmitters may also be used for density measurement. For these positions, the recommendation is also to upgrade, in this case to vibrating fork density transmitters.

Lastly, old-style control valve positioners and position transmitters have mechanical position feedback linkages, which are susceptible to wear and failure. The recommendation is to upgrade these valves to positioners and position transmitters with non-contact position sensing with no moving parts. As a result of more reliable instrumentation, plants enjoy reduced maintenance cost and reduced process downtime.

Replacements like temperature sensors in thermowells or pressure transmitters with manifolds cause little downtime. However, replacing an inline flowmeter, bottom-mounted level transmitter, an instrument on a pressurized tank, or a valve positioner causes significant downtime. For these positions, it is even more important to have a reliable instrument with no moving mechanical parts.

Flowmeter calibration is labor-intensive because the flow sensor is installed inline and must be pulled. Often, the flowmeter must

be shipped to an external lab, possibly overseas. This incurs high maintenance cost and production downtime during the swap. The recommendation is to upgrade to flowmeters with smart meter verification (SMV) to predict calibration drift to assess the need for flowmeter calibration or whether calibration can be scheduled later, all without interrupting the process. By optimizing the calibration schedule, plants reduce maintenance cost and production downtime.

As explained previously, with analog control valve positioners or I/P converters, there is no telling if control loop setpoint deviation or hunting is due to the control valve. There is a risk of unnecessarily overhauling the valve, adding to the workload and maintenance cost as well as causing production downtime. The recommendation is to upgrade all control valves with smart valve positioners with valve performance analytics. Valve issues can be verified on the positioner display or over Bluetooth from a mobile device. By verifying valve issues, plants can avoid unnecessary overhaul or optimize a necessary overhaul. Plants reduce maintenance cost and production downtime.

●●●●● **With analog control valve positioners** or I/P converters, there is no telling if control loop setpoint deviation or hunting is due to the control valve.

Devices connected to the DCS through hardwiring provide very limited information, for example, in the case of drives and motor starters. Maintenance technicians must go to the marshalling cabinet or motor control center (MCC) to check from the local display. Similarly, interaction becomes very slow when RS-485 networking is used in cases such as instrumentation through HART multiplexers. This adds to the workload.

Another challenge is that as servers go obsolete or fail, new servers do not support RS-485/RS-232. Many new replacement

devices no longer support RS-485. The recommendation is to upgrade devices and DCS to use Ethernet networking with the appropriate protocol like PROFINET for motor controls and HART-IP for instrumentation and infrastructure. As a result of the complete set of information from the device, plants reduce maintenance cost and production downtime.

Improving plant sustainability

Automation has a key role to play in the sustainability of industrial plants. Solutions for several challenges such as loops in manual and comfort zones are already mentioned. But even more can be achieved by modernizing automation. And this is over and above what digital transformation can do for sustainability.

Direct spring pressure release valves (PRVs) start lift and reseal well below set pressure. This, in turn, causes emissions, flaring, and product loss. The recommendation is to upgrade to pilot operated PRVs (Figure 5), which have more precise pressure handling thus reducing release and flaring. As a result, plants minimize product loss and enhance sustainability. They are also less sensitive to back pressure.

Manual gas leak inspection with portable testers for greenhouse gas (GHG) emissions like methane is time consuming. This in turn leads to delayed detection and response and therefore excessive emissions. It is also labor intensive, which leads to field operator stress. The recommendation is to deploy ultrasonic, infrared (IR), or non-dispersive infrared (NDIR) sensors to detect gas leaks. As a result, plants improve safety and sustainability.

Simple proportional-integral-derivative (PID) control does not handle multiple interacting loops, multiple constraints, and difficult process dynamics such as long deadtime, long time constants, and inverse response. Production operators are forced to make frequent manual adjustments, which leads to operator stress and mistakes. This in turn causes off-spec product, high energy consumption,



Figure 5. Direct spring pressure release valves (PRVs) can cause emissions, flaring, and product loss. The recommendation is to upgrade to pilot operated PRVs (shown,) which have more precise pressure handling. *Courtesy: Emerson*

and low throughput. Combustion control is one such example. The recommendation is to upgrade to a DCS with advanced process control (APC) software for model predictive control (MPC) based on dynamic matrix control (DMC) supporting multiple inputs, outputs, and constraints. For selected loops, this will reduce process variability and keep the process within constraints. As a result, plants reduce operator stress, reduce off-spec product, and improve sustainability and throughput.

PRV in applications with back pressure such as from flare headers often use internal bellows. When the bellows eventually fail, the PRV will vent process gas straight to the atmosphere contributing to emissions and potentially causing fires and explosions. The recommendation is to upgrade to PRV with backup piston. The backup piston can reduce emissions by more than 90 percent in the event of a bellows rupture, and it ensures balanced operation. As a result of the better back pressure handling, capacity, and reliability, plants reduce emissions and product losses, while improving safety and sustainability. Bellows leak detection can also be added.

Improving plant safety

Both functional safety as well as occupational safety and health will benefit from automation modernization. Many modern instruments recommended in this article like the tank gauging system, radar level, GWR interface level, level switch, ERS, temperature and position sensors, as well as Coriolis, magnetic, and vortex flowmeters are available as safety integrity level (SIL)-rated. This means they have a low failure rate and high diagnostic coverage, making them ideal for safety instrumented functions (SIFs). As a result, plants can improve safety.

High aerodynamic noise is created by turbulence in gas, steam, or vapor flow in high pressure-drop valves. Traditional valve trims and insulation do not help sufficiently. Noise is an occupational health issue, so requirements have become more stringent. The recommendation is to upgrade to control valves with valve trims and

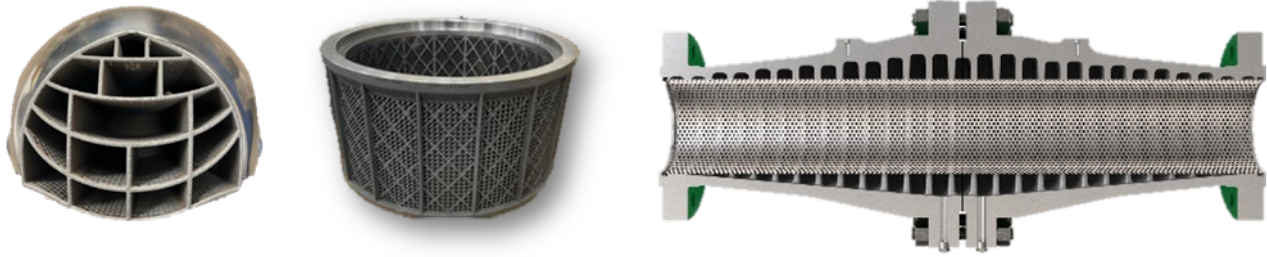


Figure 6. Loud control valves can be upgraded with a valve trim (left), valve cage (middle) or modal attenuator (right) inserted to act as a silencer to decrease noise and improve occupational safety. *Courtesy: Emerson*

cages designed and built using additive manufacturing for low noise with minimal pressure drop. Additionally, a modal attenuator (Figure 6) can be inserted to act as a silencer with no pressure drop. As a result, plants improve occupational safety.

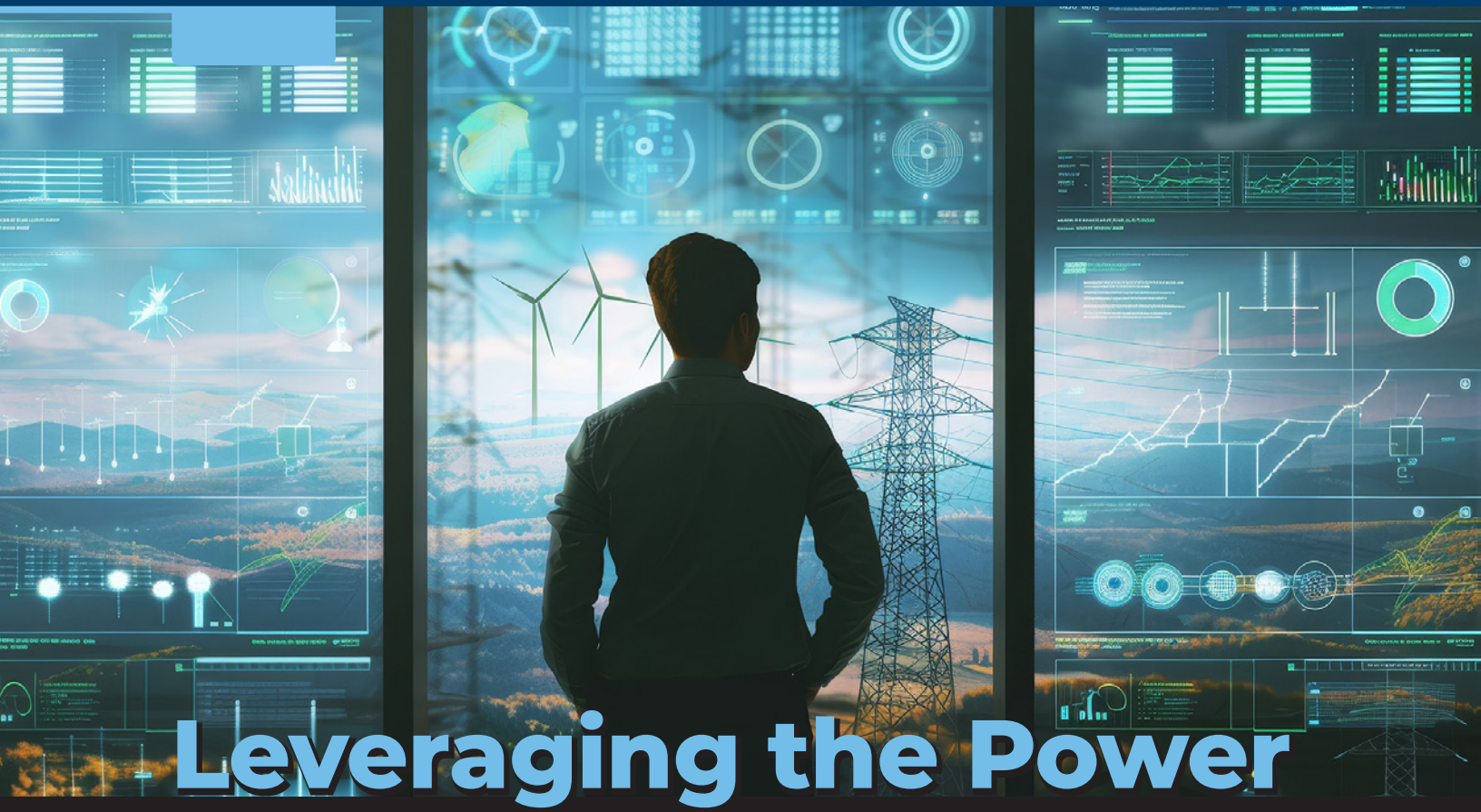
A smart plant modernization workshop

Your plant may have some but not all these problems. And it may have other problems. Conduct a smart plant automation modernization workshop to uncover challenges around manual loop intervention, instrument maintenance, sustainability, and safety. Based on the workshop findings, replace old automation components across the plant before they fail. But remember: Each modernization campaign and application should be validated. Do not replace just because there is something new.

ABOUT THE AUTHOR



Jonas Berge is an ISA Fellow and the senior director of Applied Technology at [Emerson Automation Solutions](#) based in Singapore. He is a trusted advisor for plants and EPCs to adopt new technologies moving the industry forward with digital transformation. He has more than 30 years of experience and is a subject matter expert (SME) in digital transformation (DX)/Industrie 4.0 including data management, analytics, wireless sensors, and the Industrial Internet of Things (IIoT) with particular emphasis on sustainability and decarbonization.



Leveraging the Power of Modern Simulation

By Rick Kephart, Emerson

With the recent focus on electrification of human lifestyles across the globe, it can feel as though the energy industry has changed overnight. Today, the global public is hearing more about photovoltaic solar, wind generation, and battery storage than ever before. Businesses and residences are installing solar panels at an unheard-of pace, while expanding solar and wind farms become visible reminders that the grid is changing rapidly.

However, solar, wind, and battery systems have existed for a long time. Though in the past they did not enjoy the market share they do today, these technologies have been understood and improving for decades. It took a cultural shift—increased pressure and incentives from governments and the public—to bring renewable energy generation technologies into the spotlight.

Digital twin technology is critical to navigating the new, more complex energy generation landscape.

With such a change comes increased complexity. Power generation companies must now run their operations differently than before. As these organizations incorporate renewables, they must navigate continual changes, both in weather and in energy markets, to be profitable and efficient. Simultaneously, many of these companies face severe workforce shortages, making it hard to find people with the expertise necessary to run generation facilities—renewable or traditional dispatchable—at peak operational efficiency.

Fortunately, a critical technology the energy industry has relied on for decades—digital twin simulation—has continued to evolve to support transitions in generation portfolios. Modern digital twins provide a way for users to navigate a changing industry. As a result, as power generation operations increase in complexity, the business case for digital twin simulation continues to improve.

What is a digital twin simulation?

Digital twins come in many different forms, but for the power industry, one of the most valuable is a virtual simulated replica of a control system that duplicates the monitoring and control of plant, process, and system operations in a secure, risk-free environment. Key components of a digital twin include:

- ▶ Simulation models that accurately reflect the operation and interaction of plant equipment and processes.
- ▶ Virtual controllers that replicate plant controllers to execute simulated models.
- ▶ An instructor station that controls the simulation for operator training.
- ▶ Standard control system software for operations and engineering.
- ▶ Replica control system logic and graphics.

There are many different use cases for digital twin simulations, with the most common use case being operator training. With increasing turnover in industry and a shortage of experienced workers available to backfill a retiring workforce, companies need to train operators quickly,

safely, and effectively. Best-in-class digital twins use the same automation platform as the plant control system for this training. An operator training on such a system gains real-world experience, interacting with controls, graphics, and tools that are identical to the ones they use when operating the physical plant. Also, systems using a single set of common tools help organizations realize cost savings through less maintenance, training, and service required to maintain a single platform for both the digital twin and plant controls, versus individualized platforms for each (Figure 1).

In addition, companies using a digital twin for training can take snapshots of certain operational states, allowing them to quickly return to critical training exercises repeatedly. Trainees can test a wide variety of mitigation strategies and control options, and see how the results cascade across the automation system, making it easy to evaluate best practices.

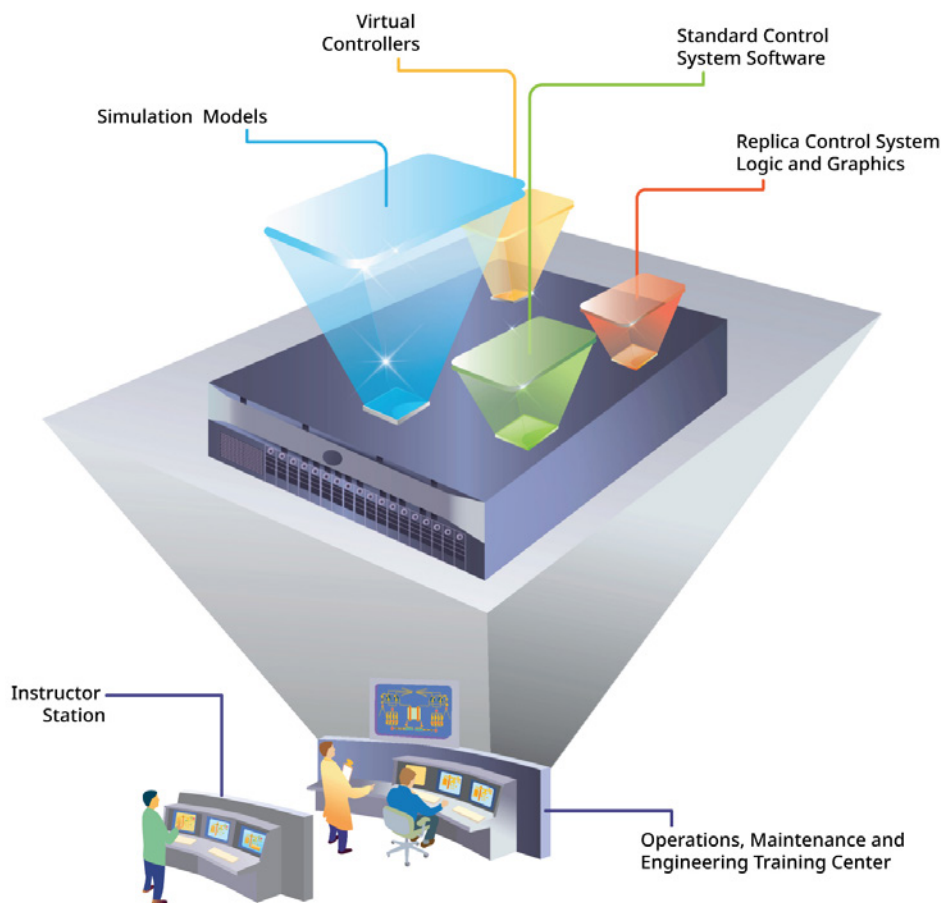


Figure 1. The best digital twin tools are based on the same platform as a control system to eliminate the complexity and cost of maintaining separate modeling software, and to make it easy for in-house staff to update plant models and training scenarios.

Digital twin simulation is also commonly used for engineering. For teams looking to test new control strategies, or to develop new automation algorithms, a digital twin provides a testing environment that is both realistic and safe. The best digital twin systems have the capability to mix and match the fidelity of each module. Such a solution not only saves cost and time during deployment—high fidelity models are more complex and costly to develop—but also provides flexibility for modernization across the lifecycle of the system. A team can start with a low fidelity digital twin simulation, and then upgrade specific elements to higher fidelity as needed.

Benefits for traditional dispatchable power generators

Power generation operations are changing. Plants built decades ago were typically designed to run continuously, supplying as much power to the grid as possible. However, with the rise of renewables, such plants are seeing the need for more dynamic operation, which increases the number of complex activities operators must perform. Improved operational efficiency is highly reliant on the organization's ability to tap into the knowledge of industry veterans to reskill current staff, and to teach a new generation of digital natives how to operate plants safely and efficiently.

However, traditional dispatchable base load power plants typically have a lot more moving parts than most renewable facilities, with more severe consequences for failure. Consequently, it is difficult, if not impossible, to train new personnel on complex activities, such as startup and shutdown, on live equipment. New operators in these plants have likely had few or no opportunities to start up and shut down the plant. In addition, they will have had even fewer opportunities to experience abnormal conditions such as when a boiler feed pump fails.

These new personnel not only need to know what to do in such situations, they also need to know what *not* to do. For example, if the plant has a failure on a critical piece of equipment, the automation might initiate a runback, bringing the power output back to a level it can support. A system running back looks very different from a system

in normal operating mode, and operators need to recognize such a status and understand the normal mitigation strategies common in abnormal operations. The only way to accomplish this is to let operators see such situations themselves, and the best way to let them do that safely is via a digital twin simulation.

In addition, as dispatchable base load generators experience more startups and shutdowns, it becomes more important to ensure that those operations occur in the same, optimal manner regardless of who is on shift at the facility. For example, as soon as a system starts burning fuel, the team needs to close a breaker as soon as possible, without violating equipment constraints, but doing so requires expertise. Digital twin simulation training allows teams to score operators based on ideal responses, training and retraining them until they can optimize operation without creating undue mechanical stress on equipment (Figure 2).

Benefits for renewable power generators

Companies with renewables operations are seeing the most benefit from using digital twin simulations when they use them as test beds for engineering and improving operation. A digital twin can be used to test and validate new control strategies before starting commercial operation. This capability is particularly beneficial to organizations investigating microgrids—a collection of assets that presents

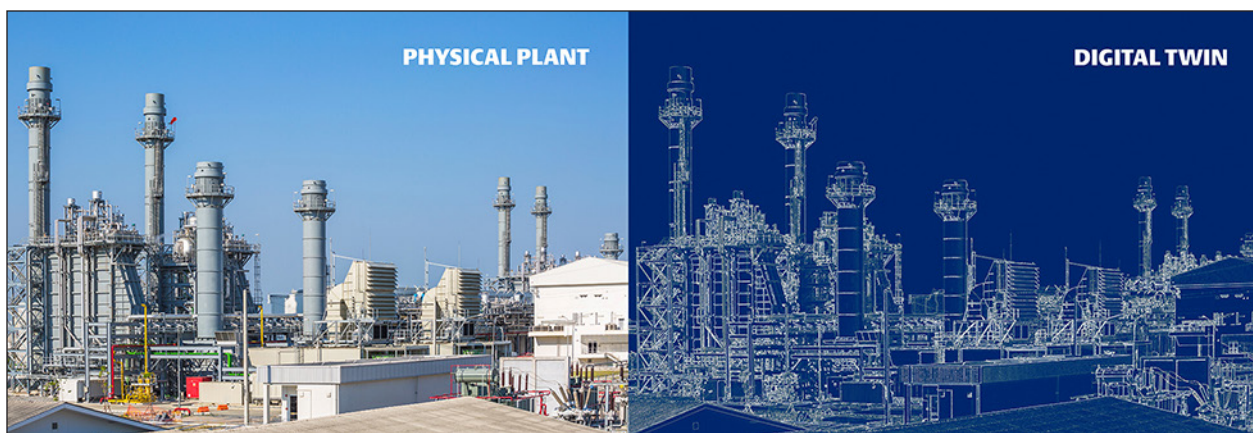


Figure 2. Digital twin simulation provides a safe, risk-free environment for training operators to respond to abnormal conditions, and for engineers to test and validate control logic changes.

itself as a single entity for energy distribution. Using a digital twin simulation, teams can more easily build and manage their portfolio of assets, modeling loads and determining the capability of electrical components.

Teams can also use a digital twin to model the way distributed energy resources (DERs) interact more easily with each other. As Federal Energy Regulatory Commission (FERC) order number 2222 gains more traction, allowing DERs to compete more easily in energy markets, new players in the industry will likely use digital twins to build virtual power plants, aggregating all their disparate DERs into larger, more easily controllable generation assets.

Many companies are also extending their digital twin capabilities outside of the plant with smart grid extensions. These tools are used with grid-level simulation packages to provide simulation of an organization's total power system. Such a solution can help organizations understand the grid's varying conditions, while managing communications and data flows to optimize production across the total power system, from generation to distribution.

Predicting the future

One of the most significant trends in the power industry is the shift toward control room consolidation. The historical footprint for power generation is far less applicable to renewables sites, many of which maintain few or no personnel on premises. Even traditional plants have been forced to cut back on their onsite personnel, as many are facing worker shortages. As these changes occur, the way the fleets are being controlled and monitored is also changing. Consolidation of multiple plant operations into a single, remote operations center is a common strategy power generators are using to improve reliability, reduce costs, and increase operational flexibility.

As power companies centralize operations, digital twin simulations help them cross-train co-located experts to remotely monitor, operate, and maintain a wider variety of assets. Technicians, engineers, and operators in a centralized control facility can also use the digital twin

as they collaborate to improve maintenance strategies and develop improved operations across the enterprise.

Another increasing trend in power generation is the use of artificial intelligence (AI) to improve efficiency and productivity. Under the right circumstances, a digital twin could be used in a predictive capacity, incorporating real-time plant data and running at faster than real time to identify potential flaws, bottlenecks, or other problems that will occur in the future.

Today, accomplishing this predictive capability on a digital twin is a difficult task. First principles models are hard to run faster than real time due to the complexity of their calculations and the computing overhead necessary to accomplish such a task. As tools improve, however, AI components could exercise digital twin models to learn the dynamics of a system, enabling them to build lightweight surrogate AI models that could be run faster than real time. Coupled with a generative AI-driven copilot, these tools could make a predictive digital twin more approachable, empowering personnel to ask the AI to predict the results of any changes to standard operations (Figure 3).



Figure 3. A built-for-purpose digital twin simulation helps teams adjust operations to test future technologies, such as AI.

Building a flexible foundation

The rise of renewable power has brought increased complexity for generation and distribution organizations. Operations teams need to be much more flexible, which requires them to lock in best practices to ensure peak safety and operational efficiency. Digital twin simulation is a critical enabler of that flexibility, helping teams not only teach all their personnel to operate at their best, but also providing a test bed for the increasing number of operational changes necessary to compete in a more complex, hybrid environment.

The best digital twin tools will be based on the same platform as a control system designed specifically for the power industry. Such solutions eliminate the complexity and cost of maintaining separate modeling software, and they make it easy for in-house staff to update plant models and training scenarios using familiar—and often, automated—tools. Moreover, implementing a built-for-purpose system today will provide the foundation necessary for the smart grid extensions, centralized control, and AI technologies that will help organizations navigate the even more complex dynamic operations just over the horizon.

All figures courtesy of Emerson

ABOUT THE AUTHOR

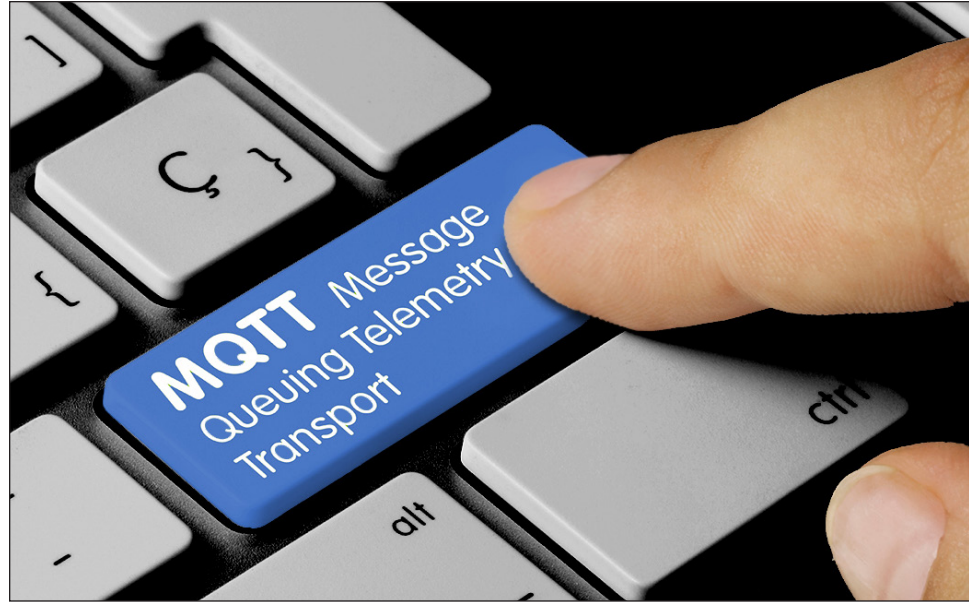


Rick Kephart has more than 30 years of automation experience in the power and water/wastewater industries. Over his career, he has become an expert in control systems and theory, embedded systems, and real-time systems. Kephart currently serves as the vice president of technology for Emerson's power and water solutions business. Previously, he was the vice president of software solutions and responsible for the [Ovation](#) automation platform. He has a BS in electrical engineering from Penn State University and an MS in electrical engineering from the University of Pittsburgh.

MQTT: The Path to Smart Manufacturing Sustainability

By Ravi Subramanian, HiveMQ

MQTT-based strategies consider the manufacturing environment and continually seek opportunities for improvement.



Smart manufacturing benefits such as downtime reduction of 30-50 percent, throughput increase of 10-30 percent, and forecast accuracy increases of up to 85 percent are being realized as a result of adopting Industry 4.0 technologies like the Industrial Internet of Things (IIoT), artificial intelligence (AI), digital twins, digital threads, augmented reality (AR), virtual reality (VR), according to a [2022 McKinsey study](#). Helped by Industry 4.0 technologies and the best practices advocated by smart manufacturing, manufacturing industries are being transformed back into an economic powerhouse.

A key aspect of Smart manufacturing is having an enterprise data augmentation strategy that enables real-time bidirectional communication between the various systems powered by MQTT, paving way toward energy optimization and sustainability.

[MQTT](#) is a lightweight messaging protocol designed for efficient communication in IIoT and smart manufacturing systems. It is an integral part of smart manufacturing. It has become the de facto standard for communicating industrial data from on-premise to enterprise or cloud due to various advantages it provides in optimizing energy usage and promoting sustainability in smart manufacturing. The following sections highlight the advantages (Figure 1).

Efficient communication

MQTT was created as a very efficient event-based publish-subscribe ([pub sub](#)) data communication protocol. The message packet size is only up to 200 KB, which helps minimize the amount of data exchanged between industrial devices, systems, applications, and the broker, reducing energy consumption. Using MQTT, devices, systems, and applications only receive relevant information, minimizing unnecessary data transfer. This also helps optimize the bandwidth and help reduce costs of operation. MQTT also allows the message

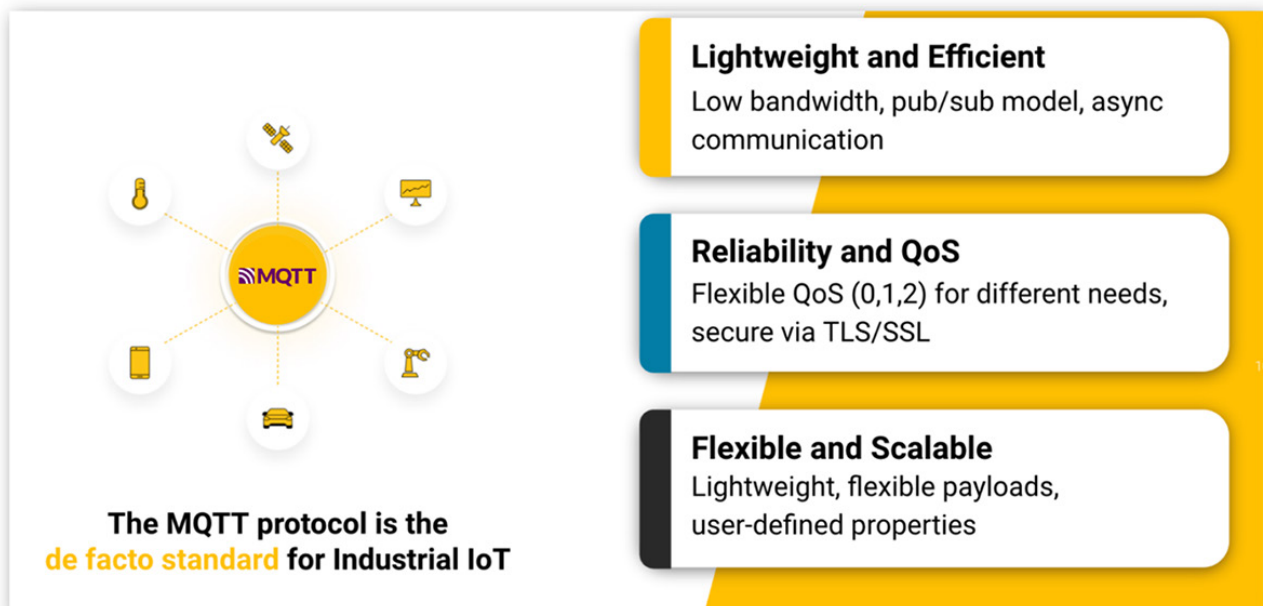


Figure 1. Advantages of MQTT, the de facto standard for IIoT.

payloads to be optimized by using efficient data serialization formats like JSON and protocol buffers to reduce network bandwidth usage and energy consumption.

Quality of service levels

MQTT provides the flexibility to select the appropriate quality of service (QoS) level for message transmission, based on the criticality of the data. This empowers users to optimize their data transmission strategy, ensuring efficiency and reliability. Higher QoS levels ensure message delivery but may result in increased energy consumption. Also given the async nature of MQTT, devices can implement sleep modes during idle periods to conserve energy.

Devices can wake up based on MQTT triggers when there is relevant data to exchange. In addition to MQTT clients, local brokers allow much of the data to be processed at the edge before sending it up to the enterprise broker, reducing the amount of data transferred over the network, thus saving energy.

Device management

Remote device configuration and management can be implemented using MQTT data to optimize device settings, update firmware, and apply energy-efficient parameters. In addition, monitoring systems can be implemented to track energy usage and sustainability metrics. Reports and exception alerts can be created based on predefined thresholds to identify areas for improvement.

Renewable energy integration

With MQTT, energy consumption and production can be monitored in real time to optimize the use of renewable energy sources. The data can be used, for example, to adjust manufacturing processes based on the availability of green energy. Also, MQTT can be used to regularly review and optimize the movement of manufacturing data based on changing requirements, technology advancements, and energy-saving opportunities.

Advanced analytics

With real-time data movement powered by MQTT, predictive maintenance can be implemented to monitor equipment health. The result is reduced downtime, improved efficiency, and the prevention of energy waste associated with faulty machinery. In addition, advanced data analytics and machine learning (ML) models powered by Generative AI can be implemented using MQTT data to provide insights into energy usage patterns, enabling the implementation of proactive energy-saving measures.

Interoperability

By ensuring that devices, systems, and applications in the smart manufacturing environment adhere to MQTT messaging standards for data interoperability, manufacturers can create a more flexible and scalable ecosystem. Also, by regularly reviewing and modifying the MQTT implementation based on changing manufacturing requirements, manufacturers ensure they are optimizing their systems and future-proofing their investments.

Combining people, process, and technology

By creating data movement strategies powered by MQTT, the right smart organizational structure to take advantage of it, and the processes to remove impediments, manufacturers can create a more energy-efficient and sustainable smart manufacturing ecosystem. The key is to integrate the data strategy based on MQTT into an overarching manufacturing strategy that considers the unique requirements of the manufacturing environment and continually seeks opportunities for improvement.

ABOUT THE AUTHOR



Ravi Subramanyan is director of Industry Solutions, Manufacturing at [HiveMQ](#). He has extensive experience delivering high-quality products and services that have generated revenues and cost savings of more than \$10B for companies such as Motorola, GE, Bosch, and Weir. Subramanyan has successfully launched products, established branding, and created product advertisements and marketing campaigns for global and regional business teams.

Controlling Nonindustrial Processes to Mitigate Climate Change Effects

By Renee Bassett

Béla Lipták's new book "Controlling the Future" describes how automation advances can help tackle the effects of climate change.

"Artificial intelligence is creating a new culture, climate change is creating a new physical environment, and both processes are out of control."

That is what inspired ISA Fellow, engineering consultant and author Béla Lipták to write his latest book, "Controlling the Future." Subtitled "Controlling Nonindustrial Processes: Preventing Climate and Other Disasters," the book provides a comprehensive

analysis of how processes developed and perfected by the automation industry can be used to tackle the climate change problem.

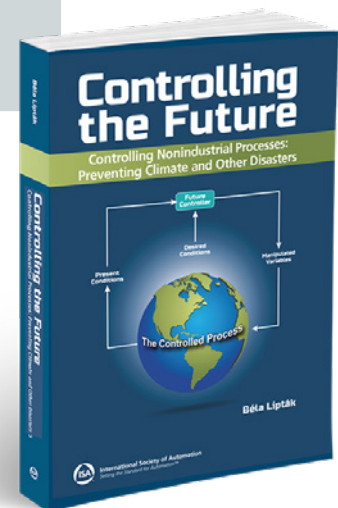
“Humankind has reached a fork in the road of its evolution where it has to select one road that leads from the fossil to the green energy age or the other that is a dead end,” said Lipták. “I was also inspired by knowing that in the past, humankind fixed such global threats as the need to close the ozone hole in the atmosphere. I believe that the coming generation is also ready to fix things. All it needs is a roadmap of how to proceed.”

“**Humankind has reached a fork in the road** of its evolution where it has to select one road that leads from the fossil to the green energy age or the other that is a dead end,” said Lipták.

Other books discuss climate change, artificial intelligence (AI), or process control, but none combines all three. This book analyzes the probable future effects of AI and global warming using the tools of process know-how that have accumulated over the last century. “This book aims to provide the information needed to guide the coming generations into a physically safe, culturally healthy, and peaceful future,” said Lipták.

Reviewers within the International Society of Automation agree.

“In his groundbreaking book, Béla Lipták leverages his world-class expertise in dynamics and process control to ingeniously recalibrate our approach to government policies,” said ISA Fellow George Buckbee, PE, president of Sage Feedback LLC. “With visionary insights, he paves the way toward a sustainable future, offering actionable solutions to combat global warming and confront pressing crises. I am thrilled to order copies of this book for my adult children. With Béla’s unparalleled knowledge and dedication, he is not only providing solutions for the world’s problems but also inspiring the next generation to become informed, think critically, and act responsibly.”



“Readers may find this book beyond their expectations,” said Prakash Jayprakash Bapat, Director of ISA’s Automatic Controls and Robotics Division. “ ‘Controlling the Future’ alerts the conscious reader to the magnitude of global warming (GW); occurrences of disasters due to climate change (CC); the need for timely action toward deployment of technologies such as carbon capture, utilization, and storage (CCUS); prioritizing rapid transition from fossil fuel-based energy to hydrogen-based green energy; and the requirement to focus on R&D and subsequent deployment of currently unavailable technologies like reversible fuel cells (RFCs).”

Jayprakash continued: “The book adds valuable information, a variety of relevant data sets, and even the cost of remedial measures. The reader is warned through striking comparisons of GW to, for example, the heat generation of five Hiroshima atomic bombs per second and the added weight of five Empire State Buildings per hour. [That brings] the harsh reality to the table.”

Lipták said his other goal in writing the book was to bolster recognition for the automation and control profession. “In contrast

About Béla Lipták

Béla Lipták was born in 1936 in Hungary. As a Technical University student, he participated in the revolution against the Soviet occupation. He escaped and entered the United States as a refugee in 1956. In 1959, he received an engineering degree from Stevens Institute of Technology; he received a master’s degree from the City College of New York in 1962; and later, he did graduate work at Pratt Institute.

In 1960, he became the chief instrument engineer at Crawford and Russell, where he led the automation of dozens of industrial plants for more than a decade.

In 1969, he published the multivolume “Instrument and Automation Engineers’ Handbook,” which is currently in its fifth edition. Lipták has published more than 300 technical articles on climate change, global warming, and the automation of the new infrastructure they require, as well as more than 20 books on various aspects of automation, safety, and energy technology.



with all other professions, it can also analyze the largest and most complex nonindustrial processes. This is not well understood,” he said. “When I was teaching process control at Yale University, the course was offered as a chemical engineering course; and when I published my process control books, the publisher listed them among their electrical engineering volumes.” Those organizations had nothing against the automation and control profession; “they did not even realize it existed. I hope this book shows that it does,” he explained.

Lipták said he has spent the last several years “in an effort to fully understand the dynamic ‘personality’ of the multivariable and extremely complex process of climate change and to determine if my conclusions agree with the presently accepted predictions on where it leads.” The result is knowledge that “the main process control rule is that global processes can only be controlled by global action, which requires establishing global institutions that can overcome the resistance of political and corporate interests.”

“Controlling the Future” provides an abundance of facts and data and lists several steps that can be taken to achieve specific goals: “Not only converting to a carbon-free (hydrogen-based) energy economy but also being realistic about the steps needed during the transition, which probably include the temporary use of safe (underwater) nuclear energy,” Lipták said.

“Controlling the Future” is available to [order](#) in print and digital formats through the International Society of Automation, <https://www.isa.org/>.

ABOUT THE AUTHOR



Renee Bassett is chief editor of [Automation.com](#), a subsidiary of [ISA](#), International Society of Automation. She is a technology journalist with 20+ years’ experience producing and managing content creation related to industrial automation, manufacturing, engineering and IT systems.