Five Industrial Automation Trends for 2022

At the Y NOW 2021 virtual live event, attendees learned from leading global industry experts how to accelerate digital transformations to create agile autonomous operations that can navigate the Energy Transition and rapidly adapt to market disruptions. During the Yokogawa-sponsored conference, speakers revealed five predictions for the not-so-far-off future of industrial process automation.

In 2022, the industry will see a significant jump in progress toward autonomous operations and a major transition in the way companies manage cybersecurity. Meanwhile, three technologies will take a big step forward from conceptual stages to points where they prove themselves by producing results. Among them are biological processes, some carbon negative, which demonstrate promise for "Net Zero." Over the past year, several companies initiated testbeds for the Open Process Automation Standard (O-PAS). They will prove themselves in 2022 or 2023. While technologies such as AI/ML and first-principles models formerly competed, suppliers have learned how to make the best of both worlds. In 2022, hybrid models will be mainstream.

Trend #1: Autonomous Operations Turn the Corner

With renewed attention to autonomous operations in the post-pandemic era, 2022 will see a significant ramp-up in progress. Yokogawa's Dr. Yu Dai pointed out that many companies responded to COVID-19 by rapidly accelerating the development of capabilities such as secure remote operations. Not only did they provide the quick wins that turned skeptical managers into believers, but they also gave industries such as offshore upstream a head start in making those remote operations autonomous.

The reigning autonomous operations maturity model consists of six levels or achievement milestones on the path to complete autonomy. Tom Fiske, Principal Technology Strategist at Yokogawa, explained that the first three levels represent "pre-autonomous" stages ranging from manual to automated. In most companies, one of those stages describes the present state.

In the manual stage, humans control all operations at all times. In a semi-automated operation, humans and automation systems share the workload. Typically, standard operating procedures, tracking, and reporting results are paper-based, and humans are responsible for safe operations. In an automated operation, humans are still responsible for safety even though automation systems control practically all processes. Still, connections and interactions among various disciplines such as engineering, design, production, and the supply chain are limited. That, in turn, limits productivity and real-time decision-making.

The next three levels are various stages of autonomous operations. According to Alex Reed, co-founder and CEO of Fluence Analytics, "to compete effectively in our rapidly changing world, 80%+ of the polymer manufacturing industry will need to attain one of these levels in the next decade." In 2022, we expect a significant step-change in the number of companies reporting achievement of at least the first of those.

Continuing Tom Fiske's description, the initial level of industrial autonomy, semi-autonomous operation, is characterized by a mixture of autonomous and automated assets with human orchestration. "Human orchestration" means that humans oversee the entire operation. This level deploys autonomous components, but the autonomy does not apply across an entire system.

	Autonomy Level	Stage	Attribute
Industrial autonomy	5	Autonomous Operations	The facility is completely autonomous including process operations, supply chain, etc. *System of systems*
	4	Autonomous Orchestration	The facility operates autonomously, synchronized to optimize manufacturing and safety under most circumstances. *Autonomous systems*
	3	Semi-Autonomous	A mixture of autonomous and automated assets with human orchestration. *Autonomous components*
Industrial automation	2	Automated	Humans are responsible for safe operations, assisted by traditional automation systems
	1	Semi-Automated	Humans and automation systems share the workload, with humans responsible for safe operations.
	0	Manual	Humans control the facility at all times.

IA2IA

Unattended Ops

Remote Ops

The industrial automation to industrial autonomy (IA2IA) maturity model

At the semi-autonomous stage, an organization can manage remote operations. As many companies focused on remote operations, some achieved unattended operations. As they reach higher levels of autonomy, the performance at unattended operations will improve.

At the next level, autonomous orchestration, most assets can operate autonomously in a synchronized manner to optimize production and safety in specific modes. It brings together autonomous components that can operate as a system, but not all disciplines are integrated.

An autonomous operation is a highly idealized state that is difficult to achieve. Most organizations will not attain that level in the near term. It represents a state in which facilities can operate autonomously and integrate with multiple domains that also operate autonomously. That can be extended to the supply chain. This stage brings together multiple systems that operate as a whole—a "system of systems."

The system of systems concept illustrates that autonomy extends well beyond process operations. Within a company, autonomy applies to multiple domains such as production optimization, asset performance management, asset reliability, value chain optimization, and safety. The vision for a completely autonomous plant is one that monitors customer demand, releases purchase orders for raw materials as necessary, devises production plans, and schedules production—all autonomously. Even maintenance is autonomous. If equipment needs repair, the facility will 3D print a replacement part, and a robot will perform the replacement.

Trend #2: Cybersecurity Transitions from a Technical Problem to Solve to a Risk to Manage

While most customers interested incybersecurity focus on technology, some leading experts predicted a completely different track. Many clients have found that new approaches often transcend budgeting cycles for cybersecurity projects due to their coincidence with industrial asset insurance, HSE, and disaster recovery strategies. The cybersecurity strategy has transitioned from a technical problem to a business risk. When companies look at cybersecurity in this manner, it removes the mystery and becomes an issue upon which management can act.

David Llorens of RSM US observed, “In their corporate governance, most companies comply with industry regulations but, when they look at their OT architecture in detail, they find cybersecurity implementations to be simplistic, for example, limited to firewalls. They want to make a one-time investment and move on. However, threats keep changing; the target keeps moving. Executives need to understand why they must continue to invest in cybersecurity.”

According to Tom Finan of Willis Towers Watson, “Executives want to think in terms of business impact and are quickly lost when confronted with technical terminology. They need to determine what is really mission-critical. With boards and executive management, it is easier to understand risk and allocate resources to manage it.

“Underwriters, today, are looking more into a company’s maturity level, how well they understand their IT and OT vulnerabilities, and whether they are deploying their resources where they could do the best. That’s becoming a dividing line between organizations that can obtain cybersecurity insurance and those that cannot.”

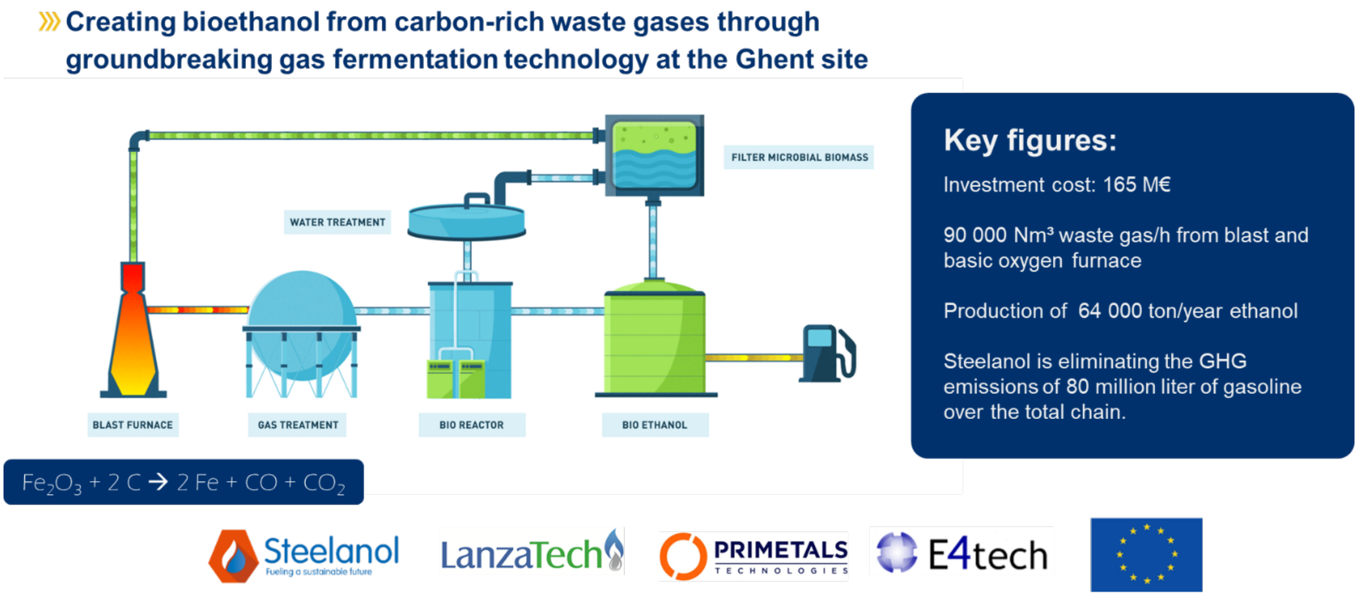
Jerry Caponera of ThreatConnect added, “There are options. Companies can look at Option A, Option B, etc., assess the relative risks, and make an informed decision. Cybersecurity has to make sense to the business. In cybersecurity, we cannot be “Dr. No,” that is, an inhibitor to the business. We must be enablers.”

On the manufacturing side, as Tom stated, “if company managers can explain to an underwriter why they are safe, why they are investing against risks the way they are, and what they have learned from past mistakes, that ability is a differentiator that will allow the company to secure a policy. But cybersecurity insurance is just one part of a comprehensive cyber risk management program.” While much of the rest is technology-dependent, it is now conceptualized in terms that management in a digitally transforming company understands.

Trend #3: Biological Processes Produce Results

Several forward-thinking approaches to addressing CO_2 reduction goals are reaching fruition. Among them are biological processes. LanzaTech has commercialized the first waste gas-to-ethanol process that uses an anaerobic bacterium, Clostridium autoethanogenum, to convert the carbon from steel mill exhaust gas into fuel quality ethanol.

ArcelorMittal, the world’s leading integrated steel and mining company, has begun construction of a groundbreaking bioethanol facility, which will put that process to work. According to Kristof Verbeeck of ArcelorMittal, the company’s Steelanol plant will transform part of the carbon-containing gases from blast furnaces into advanced bioethanol to be used as a sustainable fuel for transportation or as raw material for the production of synthetic materials and chemicals. Steelanol will be the first industrial installation of its kind in Europe and the largest facility built to date utilizing this technology globally.



An overview of the Steelanol plant process

The Steelanol plant aims to demonstrate the possibility of producing bioproducts at an industrial scale through an innovative gas fermentation process using the bacteria to capture the carbon-rich gases emitted by steelmaking activities and convert them to bioethanol. A key challenge was to find suitable online analytical systems for gas and liquid that match the specific process conditions of this first-of-a-kind gas fermentation plant. Production of 80 million liters of bioethanol annually is expected to begin in 2022.

Trend #4: Open Process Automation Proves Itself

According to Jac Opmeer of Shell and Dave Emerson of Yokogawa , significant progress is being made with O-PAS™ testbeds.

Process companies face continuous challenges with obsolescence, interoperability, and the difficulty in taking advantage of new technology in their OT systems. Proprietary control systems have repeatedly been cited as major inhibitors to digital transformation, autonomous operations, and Smart Manufacturing.

The Open Process Automation Forum (OPAF) has released two major versions of the O-PAS™ standard, which addresses these challenges and continues to build out the standard to provide additional foundational interfaces for automation products and systems. The potential for O-PAS to standardize the interfaces between automation system components to enable their interoperability and interchangeability in addition to portability of control strategy configurations between systems and versions is very attractive to the industry.

Although the standards continue to be works-in-process, with a significant update, Version 3.0 expected in the near future, numerous testbeds are already underway. End-users typically set up the testbeds in cooperation with automation suppliers active in OPAF, have access to pre-release hardware and software, and act in the capacity of open process automation (OPA) system integrators.

A large testbed at a Yokogawa facility

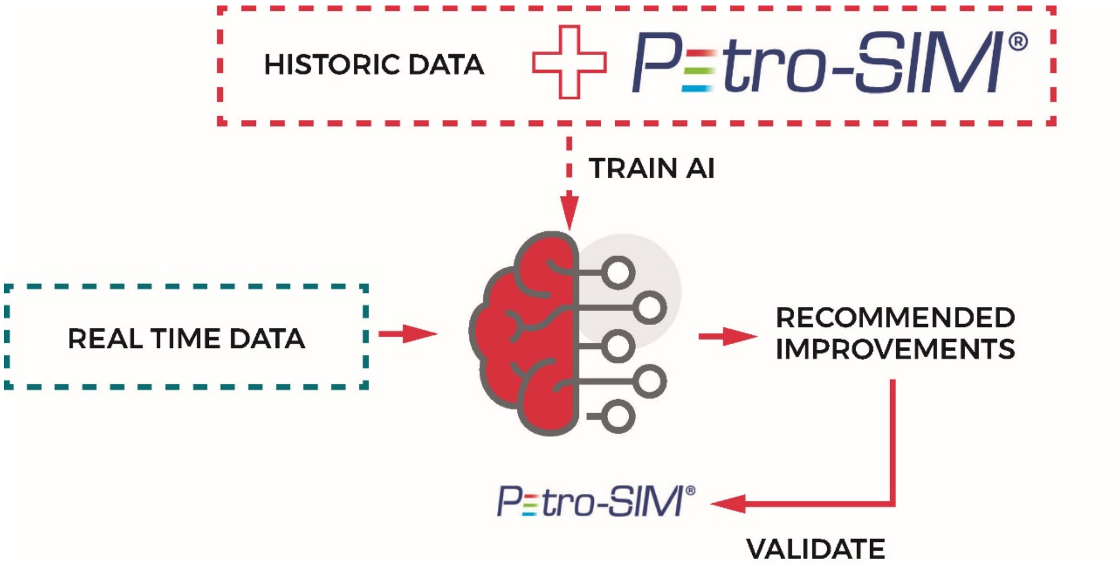
Testbeds range from small tabletop systems to larger systems with hundreds of I/O points controlling simulated processes. The use of testbeds allows end-users to plan the adoption of O-PAS by their companies, train employees, acquire knowledge, and understand the qualification processes and testing needed before deploying O-PAS-certified products in a live process.

A key question is when O-PAS-certified products will be commercially available. A prerequisite is that the OPAF certification process must be fully established. Since the forum is currently working on the certification process, prospective users should watch for the publication of certification documents, the establishment of test labs, and announcements for the first certified products. Despite the significant O-PAS work still in process, the testbeds are making progress, and we can expect reports on results in 2022 or 2023.

Trend #5: Hybrid Models Become Mainstream

Energy management is a key application for process models. Digital twins based on rigorous first-principles models have proven themselves in achieving energy efficiency and emissions reductions. However, their complexity has driven users to consider alternative methods such as artificial intelligence and machine learning (AI/ML). Hybrid solutions, which combine the best of the two worlds, first principles-based digital twins and AI/ML, have recently emerged.

Pedro Jose Lucas Guillen of Repsol described a low emissions operation (LEO) solution for a refinery crude unit. Jointly developed by Repsol and KBC, A Yokogawa Company, it is based on a combination of KBC Petro-SIM models and machine learning algorithms. LEO is designed for operations to maintain the unit at optimal energy use while achieving the production plan, regardless of process disturbances such as feed changes.



The architecture combines a digital twin with AI/ML.

KBC determined that the introduction of digital twin and AI/ML technologies into a digital energy management system provides real-time accuracy, data consistency, information visibility, and the long-term performance sustainability that businesses need to navigate the Energy Transition.

Real-time data combined with a single, asset-wide digital twin and proprietary analytics capabilities enable automatic opportunity identification and performance gap breakdown. That applies to entire utility systems and processing equipment.

In this way, improvement areas can be highlighted in real-time and daily facility energy improvement opportunity lists can be provided to closed-loop systems and operators to make changes. Furthermore, the efficacy of planned capital projects can be tracked with accurate projections so operators can make faster-informed decisions for capital allocation throughout the implementation cycle.

The digital twin can ensure that the yield energy trade-off for the entire operating envelope is appropriately considered. It can accommodate a high data volume consisting of process variables and a wide array of operating modes. To be relevant to the business and allow proper prioritization, the evaluation also considers the dynamic nature of supply pricing and the variability of process demands.

The digital twin accounts for these changes in real-time. It connects real-time energy optimization with process/yield conditions, state-of-the-art thermodynamics, electrochemical corrosion and scaling analytical prediction, and remote asset performance monitoring of pumps and turbines. Combining this analytical output into the engineer's visualization makes the full impact transparent. It also directly provides the need for action with the operator's visualization. In this way, convergence in understanding and action is achieved between stakeholders.

While machine learning (ML) algorithms are not new, enhanced computing power and cloud storage are key enablers that allow such algorithms to be fully leveraged. Artificial Intelligence (AI) using correlation-based analytics will have a strong role to play in driving energy management because it is relatively simple to use and fast to execute. It appeals particularly to the IT organization because it relies on familiar technologies and does not require deep chemical, mechanical, or electrical engineering knowledge. However, it does need some added intelligence to overcome its shortfalls.

The digital twin can be the training ground for a correlation-based AI algorithm. First-principles models can explore operating worlds beyond operating windows the plant has experienced and generate valid linearized models for the AI to use in those previously un-encountered regions. The combination of synthetic data and plant data to continuously train machine learning algorithms allows real-time solutions to be recommended directly to operators and engineers at the moment of greatest impact.

To learn more about accelerating your autonomous operations, click here to watch all 52 on-demand recordings from Y NOW 2021.