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Instrumentation Underpins the Drive to Digitalization



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Maintenance Gets Smarter

More insightful data and better analyses boost uptime

By Seán Ottewell, Editor at Large

■ Plants increasingly are turning to machine learning (ML) and artificial intelligence (AI) to recognize precise patterns in sensor data. The technologies ease differentiating between normal and abnormal equipment behavior and also detecting specific patterns that lead up to failures — and, so, enhance capabilities for predictive maintenance.

Meanwhile, advances in sensor technology are reducing both procurement and implementation costs and, thus, spurring greater adoption. “It’s now economically feasible to roll out shadow sensing technology in both greenfield and brownfield applications to capture high fidelity data in volumes that were unachievable several years ago,” notes Jim Chappell, vice president, information solutions for Aveva, Chicago.

The incentive for adopting predictive maintenance is compelling, stresses Mike Brooks, senior director, APM Consulting, Aspen Technology, Bedford, Mass. “A European customer tells us that 15% gross margin losses are attributable to unplanned

maintenance. Even best-in-class approaches 4–5% losses.”

He also points to a large automation company’s finding that 63% of scheduled maintenance is unnecessary and such work often causes more damage than if the equipment were left untouched. He cites the experience of a large oil company: out of five automatic tank-gauging systems, the only one giving little trouble at all didn’t get regularly scheduled maintenance and inspection; the other four, subjected to regular planned maintenance, constantly broke down.

“So, the spend in maintenance today is in searching for wear-and-tear conditions while the problem is in process-induced failures caused by operating equipment outside safety and design limits: incorrect setpoints, pumps running dry and cavitating, compressors affected by liquid carryover, and so on,” he emphasizes.

“People talk about the IIoT [Industrial Internet of Things] like it is an initiative. The initiative is always to improve operational excellence. The technology is how

you do this. The most important thing you must solve is improving equipment uptime. Mtell, Aspen’s predictive and prescriptive technology, is borne out of operations and maintenance — so stopping the breakdown of machines is right at the heart of what we do,” he adds.

Now in its fifth generation, Mtell uses small pieces of software called anomaly and failure agents. The anomaly agents constantly monitor to detect irregularities while the failure agents recognize a pattern of behavior that leads to the breakdown of a single machine or process.

“They can tell you what will happen, when/why it will happen, and what you can do to avoid or mitigate the outcome. Mtell lets ‘Joe Normal’ solve very complex problems without having to understand how it works,” explains Brooks.

Mtell allows users to scientifically decide on the most appropriate maintenance schedule, he underscores: “This is important because refiners and chemical plant owner/operators tell us they spend 200% more on maintenance than they should but cannot realistically determine which preventive maintenance routines to cut back on.”

Brooks cites the example of refiner and fertilizer manufacturer Borealis, Vienna, which had applied expensive vibration

systems and reliability-centered maintenance techniques on the hyper-compressors at one of its refineries but still was losing millions of dollars' worth of production annually.

Aspen found the root cause of the problem to be issues with packing seals and poppet valves. Such problems now are flagged with 30–50 days' notice. This has enabled the refinery to avoid unplanned shutdowns; the new technology also has completely eliminated false alarms.

Another example is from Saras, Sarroch, Italy, which operates a 300,000-bbl/d refinery and 575-MW integrated gasification combined cycle plant. As part of the company's digitalization initiative, it wanted to employ prescriptive maintenance to reduce unplanned downtime.

Aspen used Saras' existing condition data and maintenance records to build agents for a subset of compressors and pumps. The failure agents accurately predicted two valve events: a high outlet temperature failure with 39 days' lead time and an instrument failure with 25 days' lead time that would have led to a valve replacement. They also identified numerous process equipment failures such as oil leaks on pumps. Here, the agents achieved a 91% detection accuracy with 30 days' lead time, reports Brooks.

The next step for Aspen is culling data from similar process equipment at different sites to find non-variable conditions common to them all. "This way we can solve bigger and more challenging problems. We call this 'transfer learning' and expect to do a lot more things like it in the future," says Brooks.

RETHINKING STRATEGY

To remain competitive, chemical companies must take a more holistic approach to digital technology and look beyond traditional techniques for increasing margin, counsels Chappell.

dynamic periods when processes are starting up or in transition.

To do this, the company's Predictive Asset Analytics technology uses a patented algorithm called OPTiCS that applies advanced pattern recognition and ML technology. For systems with lower levels of historical repeatability, high noise or that use process-driven problem solving, Predictive Asset Analytics uses a predictive algorithm plugin called KANN.

"This algorithm allows users to create models that predict future values for signals. It uses artificial neural network technology and

A single critical asset failure can wipe out years of savings from process optimization.

"Many companies today focus on the gains achievable through process optimization. However, a single critical asset failure in a chemical manufacturing application can wipe out years of savings from process optimization," he cautions.

Aveva's answer to this is to combine its process simulators with ML, an approach that enables modeling a wide range of assets and processes — including the

allows users to create operational profiles with a specific set of inputs and outputs, testing how the outputs will evolve in the future through data playback and 'what-if' analysis," he explains.

Predictive Asset Analytics learns an asset's unique operating profile during all loading, ambient and operational process conditions. Existing machinery sensor data are input into the software's advanced modeling process and compared

to real-time operating data to determine subtle deviations from expected equipment behavior and alert if necessary. Once an issue has been identified, the software can assist in root-cause analysis and provide fault diagnostics to help the user understand the problem reason and significance.

“Within the chemicals industry, rotating equipment such as compressors, turbines and pumps have traditionally benefited the most from predictive analytics technology. Some of Aveva’s larger customers have

(conservatively) estimated over \$34 million savings for individual avoided ‘catches,’ and total avoided costs at over \$100 million each,” notes Chappell.

Companies using Aveva’s technology include Covestro, BASF, Air Liquide and Abu Dhabi National Oil Company (ADNOC). The latter firm has installed Aveva’s enterprise visualization and integration technologies, including predictive and prescriptive analytics, at its Paronama digital command center in Abu Dhabi (Figure

1). ADNOC uses the center to monitor, control and optimize the performance of the entire end-to-end value chain across its 16 operating companies.

A major remaining challenge is the cleansing and curating of existing big data to make them suitable for and useful in predictive and condition-based modeling software, he says.

“Over time, we anticipate a shift in maintenance strategies from the traditional cost-centric approach to a more revenue-centric approach. Combining cloud,



Command Center

Figure 1. Facility in Abu Dhabi controls and optimizes, including via predictive and prescriptive analytics, operating company’s entire end-to-end value chain. *Source: Aveva.*

edge, IIoT and predictive analytics enables companies to develop revenue streams through maintenance-as-a-service programs,” he adds.

Predictive analytics also is advancing rapidly as well, with anomaly detection no longer the state-of-the-art, says Chappell. “To stay cutting-edge, software must predict the future.”

So, Aveva’s ongoing developments focus on leveraging deep learning to forecast the remaining useful life of an asset and, from there, provide prescriptive guidance for maintenance and remediation.

THE VALUE OF EXPERTS

The digital revolution is catalyzing improved outcomes using advanced analytics, stresses Michael Risse, vice president of Seeq, Seattle, citing the company’s rapidly growing list of commodity and specialty chemicals customers as proof. “The drive to gain better insights from existing data is absolutely there, and Seeq is working on spreading awareness.”

Rather than a black box technology that tries on its own to recognize patterns in data, Seeq enables subject matter experts (SMEs) to define what’s important to them or what they’re looking for. To this, they can add context based on experience

and other data sources, such as manufacturing execution and laboratory information management systems, and investigate to identify precursors to asset failure or degraded production.

“When SMEs put these efforts into action, in the form of monitoring and analyzing incoming data, they are able to accurately predict failures and prescribe mitigations,” he says.

They can build predictive models that are adaptable over time as plant conditions change — an interactive approach that actively promotes sustainability in the predictive analytics, rather than a one-time optimization effort, Risse adds. The benefits of such an approach include improved asset uptime and proactive rather than unplanned and costly reactive maintenance.

As an example, Risse cites a global analytics program instigated in late 2017 by Abbott Nutrition, Lake Bluff, Ill. One of the pilot studies that Seeq conducted managed to identify the

root causes of why some clean-in-place (CIP) runs took longer than others — typically leaking valves and instrumentation failures —highlighting those parts of the CIP process that Abbott should

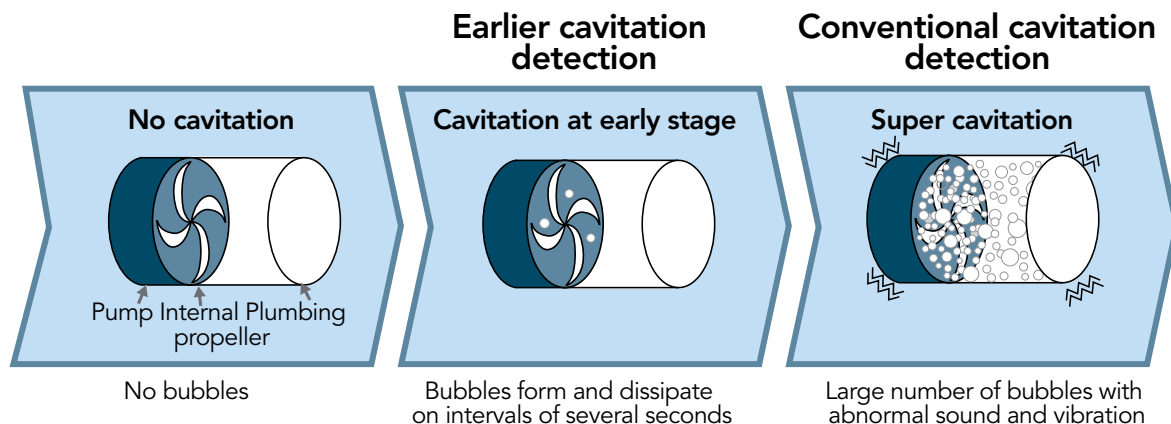
New sensors and more data rarely are the issues these days.

focus on to make further production improvements.

New sensors and more data rarely are the issues these days, Risse is quick to point out. What users want is faster, meaningful insights from the data they already have stored in process historians: “For all the fancy talk about AI and ML, the number one tool for finding insights in process data is the spreadsheet, a 30-year-old innovation. What the spreadsheet lacks in capabilities, it makes up for in terms of accessibility by the SMEs who have experience/expertise in the plant. Whatever the future may hold in terms of AI and ML, it must maintain that level of ad hoc self-service access for SMEs.”

FASTER DETECTION

Meanwhile at Yokogawa, Tokyo, efforts are focused on using its



Pump Cavitation

Figure 2. Different pressure transmitter detects data that enable machine learning to predict the onset of cavitation. Source: Yokogawa.

technologies to drill down and better identify and understand individual equipment issues, for example, cavitation in pumps.

“Rather than relying on sound and vibration, we have devised a method to measure cavitation accurately in a different way by monitoring minute pressure changes. This ability to detect very low levels of cavitation has been further enhanced by ML analysis,” notes system products marketing specialist Masaru Kimura.

The system detects the minute pressure fluctuations caused when cavitation bubbles pop (Figure 2) using the oscillation value parameter on the company’s DPharp differential pressure transmitter.

“By using the data detected by this system for ML, it becomes possible to construct a model for detecting signs of cavitation. Usually, the most important barrier in machine modeling analysis and modeling is the collection of labeled-learning data but the cavitation detection system can be used to automatically create it. The data can then be used to construct a prediction detection model of cavitation,” he explains.

This, in turn, does away with the need for operators who are experts in cavitation, and allows equipment changes to be made while minimizing reductions in operating load.

“The system has only just been released and already we have

received feedback from field trials showing it can help extend asset life and improve efficiency by reducing or eliminating operating losses,” he adds.

Kimura sees the chemical industry as a very important market because its cavitation issues are more pronounced than those of other sectors. As sensors become more accurate and data collection and processing faster, he also believes other phenomena will become measurable, enabling further reductions in customers’ asset maintenance costs. ■

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Pursue The Right Path To Industry 4.0

Avoid wrong turns that can lead the journey astray

By Peter Guilfoyle, Northwest Analytics

■ Manufacturing continues to evolve and has progressed through four stages thus far. It started with the implementation of steam power to mechanization. The second stage comprised mass production and the introduction of the assembly line powered by electricity. The third stage added computers and automation into the mix and, in the fourth stage, cyber-physical systems emerged to enable the computerization of manufacturing. This stage currently is evolving before our eyes and commonly is referred to as Industry 4.0.

“Industrie 4.0,” coined by the German government in a national strategy to promote the computerization of manufacturing, exemplifies the fourth industrial revolution on the way to an internet of things, data and services. Decentralized intelligence helps innovate intelligent object networking and independent process management, with the interaction of the real and virtual worlds representing a crucial new aspect of the production process.

The principle concept embodies connecting machines and systems to create intelligent networks along the value chain that control each other — for example, machines that predict failures and trigger maintenance processes autonomously or self-organized logistics that react to changes in production. Industry 4.0 technologies include many of today’s buzz-words like big data, advanced analytics, virtual reality, the cloud, the internet of things (IoT) and machine-to-machine (M2M) communication. In the past decade, these technologies have swept across the globe, as manufacturers worldwide recognize the value of Industry 4.0.

It certainly sounds great: a vision of the future with efficient, self-automated manufacturing processes that monitor themselves so they never go wrong.

A DEVELOPING PROBLEM

It’s difficult to find fault with this formidable vision but a problem is brewing in implementing the

principles of this industrial revolution. The potential for Industry 4.0 is so vast that a lot of companies rushing to adopt the technology haven’t paused to first figure out what root goals they are trying to achieve and problems they are striving to solve.

If these two issues aren’t addressed before embarking on the path to Industry 4.0, the route to follow is unclear; indeed, many companies are losing their way. The key technologies required for digital transformation cause radical changes in the business processes of any company. Those changes require discussion and understanding before they are undertaken.

For example, key stakeholders in the business must consider the company’s culture and how to help employees (at all levels) deal with change. This involves overcoming a general reluctance to change that’s typical of the human makeup as well as training employees to ensure they are qualified to use the new technologies. In addition, corporate leadership must address staff concerns about continued employment after digitalization is achieved by providing reassurances as appropriate and deciding if people can be redeployed in the new system (as often is the case).

Adopting Industry 4.0 involves a commitment and adequate

resource allocation by the information technology (IT) department to ensure necessary connections are made and maintained, and to avoid any IT snags that could cause expensive production outages. Modern information and communication technologies like cyber-physical systems, big data analytics and cloud computing will foster early detection of defects and production failures, thus enabling their prevention and thereby providing productivity, quality and agility benefits that have significant competitive value. However, as more databases move onto — or connect with — the cloud, security issues commonly are cited as a barrier to fully embracing the

new technology. It's undeniably important to adequately protect all databases.

Some software technologies necessitate the moving or duplicating of historian data or other data sources. This creates its own problems, both in terms of external data security and internal validation of the data. If a validated database is duplicated, does it need to be re-validated? These additional drains on IT and other resources demand consideration and discussion; sometimes an alternative approach is available that avoids these issues but still allows the company to move forward with digitization.

New technology must be reliable and stable for critical processes and

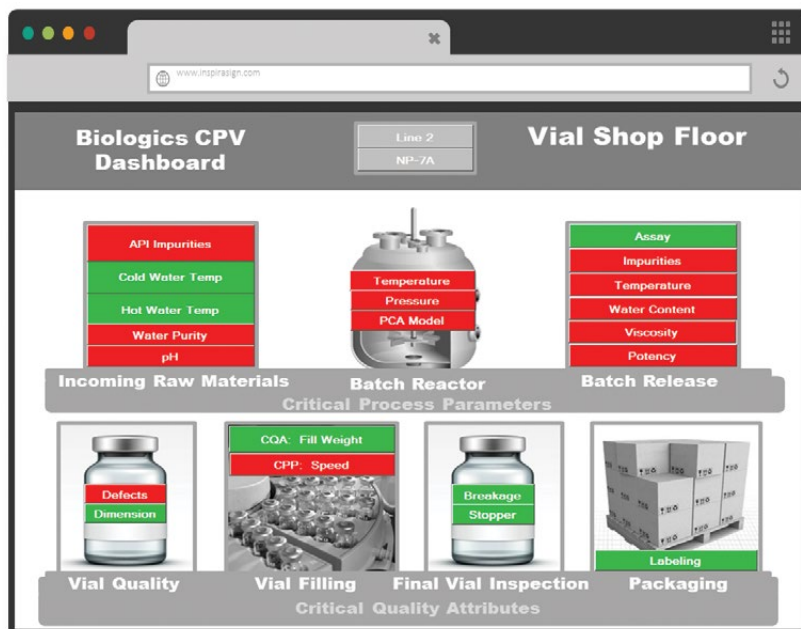
operations and must meet any regulations applicable to the particular industry sector.

Ideally, a company can justify the economic benefits of this considerable investment and estimate an expected return on investment (ROI) for each stage and investments prioritized accordingly. In addition, it should ensure that all changes are based on strategic plans to place the company at an advantage or, at the very least, preserve current favorable market position.

WHERE TO BEGIN

Like any journey, the path to Industry 4.0 should start with a map. From both strategic and technological perspectives, a company adopting these technologies must visualize every step on the route towards a digital enterprise. Success in the digital transformation process largely depends on a firm's ability to prepare that plan in the most accurate way.

Dow is a great example of a major chemical company on its journey to Industry 4.0. Crucially, that journey started with an extensive effort to take better advantage of its data (see: "[Data Initiative Improves Insights](#)") as well as embark on a review of processes and unmet needs. Dow looked at how best to maximize existing strengths, expertise and



Biologics CPV

Figure 1. Dashboard provides a single red/green view of the entire manufacturing process.

technology in moving forward to the next stage of its evolution.

For example, one plant suffered repeated upsets that resulted in unscheduled downtime. The site's management realized that learning how to listen to signals the plant was sending to operators and responding better to those

analytics cut the time for gathering and analyzing the data to zero, freeing the production staff to focus on other things. The ROI was rapid.

In summary, in looking for a solution to issues that were impacting the bottom line through lost manufacturing time

presents another ideal application for Industry 4.0 technology (see: "[Control Systems: Take the Smart Road to CPV](#)"). To meet regulatory guidance from the U. S. Food & Drug Administration and the European Medicines Agency, a pharmaceutical plant must continuously monitor hundreds — sometimes thousands — of variables to verify they remain within the parameters established and validated for its process. Industry 4.0 technology provides four key ways in which digitization can support CPV:

1. Analytics. Statistical process control techniques develop the data collection plan and statistical methods and procedures used in measuring and evaluating process stability and capability.
2. Risk-based real-time approach. This verifies a process produces material that meets all critical quality attributes and control strategy requirements.
3. In-line, on-line or at-line controls. These monitor process performance and product quality.
4. Quality attributes. Checking of feeds, in-process materials and finished products confirms they meet specifications.

Other benefits of digitization that apply especially to the

Many companies are losing their way on the path to Industry 4.0

signals was key to addressing the problem. A team identified parameters of importance. This wasn't an easy task. The amount of data was substantial — staff was spending eight hours per week gathering, analyzing and visualizing the data. However, these data were scattered in different databases, making it difficult to understand what was important. Analytics helped the team realize what the data meant and which parameters were crucial. The software provides operators with a simple green/red dashboard so they can quickly and easily see which parameters require attention and respond before product quality suffers or a shutdown results. Moreover, the

and the need for reprocessing, Dow set a goal to achieve a better data-driven understanding of parameters changing during the manufacturing process and the real-time effects of those changes — realizing such insights would lead to more-consistent more-efficient production. The success of this project reflects careful planning regarding the implementation and applicability of the new technology, setting the company on its path to Industry 4.0 in a useful and productive way.

CONTINUOUS PROCESS VERIFICATION

The adoption of continuous process verification (CPV) by the pharmaceutical industry

pharmaceutical industry are the continual assurance of process control and the ability of data analytics to quickly detect any deviations from expected parameter limits. Such automatic monitoring and control gives a company continuous data for validation against regulatory guidelines, helping it comply with the rigorous associated requirements.

FIVE KEY STEPS

Our world is becoming increasingly digitized. This can be a good thing — improving efficiency, enhancing quality and helping a company meet ever-increasing data-related regulatory requirements. However, before embarking on the journey to Industry 4.0, a manufacturer should pause to consider the objectives of the exercise and set clear goals that will guide it on the way to successfully implementing — and sustaining — novel technologies. There's no shortage of technologies. The crucial decision is choosing the one that's going to

provide the greatest positive impact on your company in the area that you most need it.

With this in mind, the five stepping stones to success on the path to digitization are:

1. Start with the problem. What challenge are you trying to address?
2. Pick an appropriate team. Which employees have the technical expertise to identify parameters of importance and how is your IT group going to help access key data sources?
3. Analyze the “people aspect” of the problem. Do you have the talent you need to achieve success?
4. Determine the best technologies. Besides being fit for purpose, do they maximize

using existing technologies and data sources, provide a platform compatible with current equipment and offer scalability for the future?

5. Deploy effectively. Can you identify a pilot project for refining implementation and building confidence so you then can speed rollout to other sites?

By following these five steps, you can avoid common mistakes in implementing Industry 4.0, and set your company on the right path to a valuable and industrious new era of manufacturing. ■

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Digitalization can support continuous process verification in four ways.

Succeed at Digital Transformation at the Edge

By Nicholas Meyer and Kevin Finnan – Yokogawa Corporation of America

INTRODUCTION

■ As companies in the process industries pursue their digital transformation journeys, the collective role of field instruments such as pressure transmitters and flow meters can vary widely. Thousands of them could be deployed in a manufacturing facility. Although they have not moved physically, they have found themselves in a situation now described as “the Edge.”

Where do they fit into the digital transformation strategy? While digital transformation plans often

overlook measurement instruments or simply look at them as a number, certain types of instruments could actually be digital transformation enablers.

The transformation program team might be quick to list an analog device such as a pressure transmitter that outputs a 4–20 mA signal as a “non-digital” entity that calls for replacement. However, in a plant in which thousands of them operate, that will not happen very quickly. Although the analog instruments support very little in terms of the needs of a digitally

transformed enterprise, they can be enhanced with wireless communications and effective analytics at the Edge or in the Cloud. Those allow the enterprise to realize reasonable value from the limited information that can be derived from the analog instrumentation.

Ultimately, however, the enterprise demands a comprehensive digital infrastructure that extends to the Edge. Otherwise, it cannot fully realize all the benefits digital transformation offers.

An enterprise counts heavily on devices at the Edge. Actuators, analyzers, flowmeters, sensors, transmitters and valves are where the physical world first meets the digital world. Sensing devices form the foundation of an operating technology (OT) platform and, collectively, provide an indication of a plant’s vital signs. Sensor data informs and drives the performance of plant operations. Analytical models, artificial intelligence, digital twins, machine learning and many other technologies count on it. A successful digital journey rests on the quality and fidelity of measured data.

Sensor technology is not only changing the way process data is measured, but also the way it is analyzed. Eradicating process errors and improving asset efficiency has never been as important as it is for connected plants of the future. Process operations generate



large volumes of data. While in the past, those large amounts of valuable data would be largely unused, a digitally transformed enterprise will take complete advantage of it.

Measurement instrumentation began its digital journey nearly 40 years ago. Microprocessor-based smart transmitters not only improved performance vs. analog instruments, they were able to generate valuable data in addition to the measured variable. As smart instrumentation evolved, it added functionality that was useful to asset management and provided insight into the process.

Recently, a new class of intelligent instrumentation has emerged. It consists of flowmeters and transmitters that integrate seamlessly into a digitally transformed enterprise.

TOTAL INSIGHT

Digitally aware devices, such as the Total Insight portfolio from Yokogawa, represent a major step change in technology over today's intelligent instruments. These devices operate seamlessly in a digitally transformed enterprise. The instruments possess deep knowledge of their health status for predictive asset management and of the process for use in conjunction with advanced analytics and digital



twins at the Edge, in the Cloud and on premise.

These devices provide alarming functionality consists of system and process alarms, which are individually classified according to NAMUR Recommendation NE 107, 'Self-Monitoring and Diagnosis of Field Devices,' which has been adopted as a "gold standard" in the process industries. The user can adapt the action of each alarm individually to the process requirements and prevent unnecessary alarms from distracting plant operators. Alarms are classified as "Failure," "Function Check," "Out of Specification" or "Maintenance Required." The alarms work in conjunction with asset management software as well as a variety of digital twins.

These instrumentation and asset management platforms create

sustainable value throughout the product lifecycle. They fully supports the primary digital transformation focus areas including asset availability and reliability; human effectiveness; safety, sustainability and compliance; and operational performance and productivity.

DIGITAL TWIN

Total Insight supports digital transformation strategies through digital twin technology. The instruments, themselves, incorporate asset management digital twin technology internally. For example, meter verification uses an internal reference to compare with real-world flowtube characteristics. They can also work in conjunction with practically any digital twin on the market including Yokogawa's broad portfolio. That portfolio includes digital twins for instrumentation and process equipment productivity, advanced chemistry, predictive maintenance, process optimization, value chain optimization and enterprise-wide insight.

A digital twin is a virtual, digital copy of a device, system, human or process that accurately mimics actual performance in real-time, is executable and configurable, allowing a better future to be developed.

Digital twins work in the present, mirroring the actual human, device, system or process



in simulated mode, but with full knowledge of its historical performance and an accurate understanding of its potential in the future. In this way, the digital twin delivers the full scope of hindsight, insight, foresight and oversight. As an advanced decision support tool, a digital twin enables improved safety, reliability and profitability in design or operations through forecasting (what's next?), prediction (what if?) and optimization (what's best?).

Digital twins replicate real-world events and actions by combining live sensor inputs from their physical counterparts with historical-performance data. Digital twin technology relies on a first-principle model, which simulates the performance of an asset; the physical process feeds input into the algorithm, which then uses that data to generate an accurate digital representation of the real-life event. The first principle model is the same as those used in process simulators.

However, unlike a simulator, the digital twin is an accurate representation of the asset, not just in a particular operating case but over its full range of operation, all the time. Instead of a static provision of a snapshot in time, the digital twin captures the full history and future of an asset. The digital twin operates in an automated manner, making regular model runs that are built-in to business workflows. It provides a centralized, single version of the truth, used by everyone, with outputs delivered directly to the business.

Digital twins operate at multiple levels and perform a variety of functions ranging from asset management, predictive maintenance, production optimization and value chain optimization:

- *Instrumentation and equipment productivity:* Real-time and predictive data that digital twins collect reduces the risk of equipment breakdown by improving predictive maintenance outcomes. For example,

data drift could be an early problem indication. Stakeholders can reduce operational expenditures through online monitoring and prediction of field device health.

- *Advanced chemistry:* Pumps, flowmeters, transmitters, and chemical analyzers are highly intelligent devices that provide asset performance information and live process information to process and maintenance-purpose digital twins. The digital twins recommend ongoing performance optimizations for the process and instrument operations and add adaptability to changing duty requirements throughout the intelligent device life cycle
- *Increased production and predictive maintenance:* Breakdowns in any manufacturing system can result in delays along the supply chain. Digital twins make it possible to run an AI/ML model with a first principle-based process simulator

to identify predictive maintenance and keep downtime to a minimum.

- *Plant process optimization:* Operators can use digital twins to create high-fidelity models that they can then use for performance monitoring, simulation, and optimization to deliver enhanced yield performance, flow assurance, energy-efficiency improvement, enhanced reliability, and operator-capability assurance.
- *Value-chain optimization:* Understanding when and where products are in demand allows companies to adjust production and labor needs while exploiting market opportunities. Data analytics that operators derive from digital twin applications is invaluable when predicting market demand.
- *Asset life cycle:* Operators can use data this digital twin captures to determine real-time performance across the entire life cycle of an asset for optimization.
- *Enterprise insight:* Digital twins can set up a simulation based on existing company key performance indicators. Given a dashboard with information that a simulator-based digital twin provides, operators can use the model in real time and run multiple hypothetical scenarios or predict

the future course of a business based on existing data.

Working in conjunction with Total Insight, the digital twins facilitate information flows across organizational boundaries and enable faster identification and resolution of unit issues. With improved performance gap visibility, second-guessing of decisions is minimized and the organization can more quickly realize benefits and outcomes. Ultimately, Total Insight enables digital transformation benefits including enhanced profitability, improved reliability, improved safety, extended asset performance, reduced asset failure, higher return on investments, and vastly improved productivity.

DIGITAL TRANSFORMATION

For process manufacturing industries, digital transformation has moved to center stage. At the highest levels in practically all organizations, it is no longer viewed as a matter of investigation and experimentation, but a strategic imperative linked to the company's survival.

While digital transformation means different things to different people, its concept can become a mantra for earning relevance and establishing leadership in a digital economy. Rather than reacting to change or allowing themselves to be disrupted by it, forward-looking

industry leaders are investing in digital transformation to adapt, achieve operational excellence and outperform peers.

There is no "one size fits all" approach to operational excellence. A company's approach could vary broadly depending on its industry, company size, and digital maturity. For instance, a smaller plant may view operational excellence to mean consistently producing a product at export quality, expanding plant capacity, or expanding regional and global business. On the other hand, a digitally savvy operation could be pursuing remote, unmanned or autonomous operations.

Benefits in common to all approaches to digital transformation are as follows:

- *Updated company vision* - The company vision is modernized and earns support from customers who have digitally transformed or are in the digital transformation process.
- *Thriving culture of innovation* - This effort creates buzz within the organization and inspires a company culture and ability to innovate in product and service development.
- *Deeper data analysis* - Better understanding of what/where data is across the organization, which translates into the ability to infer insights and

deepen customer analysis to prove ROI.

- *Increased customer value* - A true 360-degree, seamless customer experience contributes to increased conversions and customer loyalty.
- *Improved customer journey* - Customers naturally continue every step of their journey, improving conversions and outcomes.
- *Increased internal collaboration* - Collaboration significantly improves between business functions to unlock greater business value and efficiency.
- *Empowered workforce* - Leadership and employees feel empowered through greater knowledge and information.
- *Improved efficiency* - Decision-making and processes become more efficient across departments.
- *Sustainable continuous improvement* - In a survival-of-the-fittest environment, businesses that can continue to adapt and lead will thrive in a dynamic business climate.

For process manufacturing operations, the primary focus areas are asset availability and reliability; human effectiveness; safety, sustainability and compliance; and operational performance and productivity.

Asset availability and reliability goals call for no unplanned outages, flawless startups, shutdowns and transitions, obsolescence management and predictive maintenance. Human effectiveness goals include a skilled, motivated and informed workforce and rigorous adherence to operating plans.

Safety, sustainability and compliance goals address functional safety, physical and cyber security, environmental stewardship and regulatory compliance. Operational performance and productivity measures target maximizing revenue, capital expense management, and operating cost containment. It will also provide for an agile response to market changes and a culture of profitability.

Operating at the Edge, Total Insight instruments seamlessly mesh with digital transformation implementations in a manner that supports all company goals and objectives.

CONCLUSION

Measurement instrumentation began its digital journey many years ago. As smart instrumentation evolved, it added asset management functionality and provided insight into the process. Today, smart instrumentation

must integrate seamlessly into a digitally transformed enterprise. The Total Insight portfolio from Yokogawa is a major step change in technology over smart instrumentation and enables digital transformation.

Total Insight creates sustainable value throughout the product life-cycle. It fully supports the primary digital transformation focus areas including asset availability and reliability; human effectiveness; safety, sustainability and compliance; and operational performance and productivity.

Total Insight supports digital transformation strategies through digital twin technology. Together, these technologies facilitate information flows across organizational boundaries and enable faster identification and resolution of unit issues. With improved performance gap visibility, second-guessing of decisions is minimized and the organization can more quickly realize benefits and outcomes.

Ultimately, Total Insight enables digital transformation benefits including enhanced profitability, improved reliability, improved safety, extended asset performance, reduced asset failure, higher return on investments, and vastly improved productivity. ■

Fit-for-Purpose Then... Inappropriate Now

Immunize Plant Instrumentation Against Uncertainty

By Nicholas Meyer – Yokogawa Corporation of America

INTRODUCTION

What cannot and is not measured, cannot be improved. Any data-driven approach for continuous improvement in manufacturing requires definition, ongoing tracking, and reporting of key performance indicators (KPIs) against targets. This is as relevant in the boardroom with management as it is on the shop floor with the field instruments and systems that enable highly precise measurement, data acquisition and analysis. What is the point in providing the tools and applications to steward manufacturing operations conformance against targets and constraints if the basic means are not first in place to measure the operation for situational awareness?

CHANGING TIMES

What was fit-for-purpose then is no longer. An added challenge is that many facilities were built at a time – some as far back as the 70s and 80s – for a particular process, a certain level of control, and a

certain suite of optimization applications. Today the world grapples with the impacts of the uncertainty. These facilities are now operated and maintained at skeleton staffing levels, retooled for a different service level than originally intended and designed.

Operating envelopes are changing and the impact of these changes on field instrumentation must not be underestimated. Instrumentation with a design rating of a particular flow rate or capacity is stressed heavily when the service or load is increased substantially. In some cases, the instrumentation for the original service is unsuitable for the new service and must be swapped out. This is typically the case for low grade instrumentation that does not have the resilience of higher quality devices that can be re-purposed for the new service/operating envelope.

Some fine and specialty chemicals manufacturers may be dosing new chemicals into flowlines for

enhanced process efficiency or to eliminate emulsions and hydrates. For legacy instrumentation this can be a real issue as it affects the effectiveness of the instrumentation resulting in periods of time when the plant is subject to sub-par control. This can impact plant safety and reliability, as well as profitability; profitability can be impacted significantly because the product on the backend of the process is either burned (e.g. erroneous temperature measurement) or the material produced is off-spec.

Newer field instruments that have been designed to retrofit well into existing infrastructure can handle these situations much better.

PANDEMIC IMPACTS

Refining and chemicals plants have changed their manufacturing recipes to manufacture products that their trains/lines have not produced in a long time, if at all. Refineries are trying to minimize production of jet fuel and gasoline while everyone is physical distancing, to produce more chemical feedstock.

Chemical plants have changed their recipes and configurations to ramp up production of hand sanitizers and face masks. Some units have been turned up, others turned down and some shut down altogether.

These unforeseen operational changes highlight the need to

periodically audit all fit-for-purpose instrumentation.

KEY PLANT MEASUREMENT DEVICE/DATA CONSIDERATIONS

Situational awareness forms the basis of effective decision-making in process facilities. The foundation for situational awareness is the plant data itself, gathered from the various devices on the front line. With context and relationship, plant process data measurements constitute information. Increasing context, connectedness and patterns/relationships, and the understanding thereof, can then lead to knowledge and insight. This knowledge and insight are fundamental to effective decision-making in plant operations, which is made easier through data analytics, which itself is underpinned by the quality of the fundamental plant data. Only with robust plant data can the true potential of analytics be realized.

For facilities to be safe, responsive, and adaptive, plant data management can no longer be viewed as an after-thought or down the pecking order in terms of the plant management hierarchy. Key plant measurement device/data considerations include:

1. Measurement device/

data governance:

- Is there an ownership record for each device/data point?

- Is there an audit trail of changes?
- Where devices/data are replaced or over-written, what happens to applications that used old values? How are discrepancies handled between old and new values handled? Are applications properly tested to ensure validity of source data?
- Are security arrangements in place to allow appropriate exposure of data within the organization, yet limit risk of exposure externally?

2. Measurement device/ data propagation

- When a change is made in the field, how does the system of record know about it?
- Which devices and applications are affected by these changes?
- Are the affected devices designed and tested to cope said changes?

3. Measurement device/ data sufficiency

- Are all necessary values being collected?
- Is there sufficient coverage of the process/asset?
- Is there sufficient measurement intensity/frequency?
- Does the level of redundancy meet the level of criticality of the application?

4. Measurement device/ data trust

- Are instruments of adequate accuracy and reliability for their intended application(s)?
- How does turndown affect instrument performance when operating outside of standard conditions?
- What is the impact of saturation or process spikes?
- How resilient are instruments to changing ambient conditions such as temperature, vibration, EMI, etc...?
- Do you need to consider a new frequency for measurement validation?
- Are there new/difference compliance requirements?

THREE DECISIONS TO MAKE TODAY

1. Undertake a Value Of Information (VOA) audit: Knowledge and information is useless unless you are going to do something with it. While an excess of process data presents many opportunities, it can also paralyze an organization and hinder speed of decision-making. It can also cost a lot to gather and maintain. Since the value of information varies depending on particular circumstances and strategic priorities, which information sources matter the most in your plant? Evaluate the key value drivers of the plant. Assess what plant

data and information is required by relevant applications and personnel to create value. Inventory the key devices/instrumentation needed to ensure value creation can be sustained.

2. Instrumentation-related Management of Change (MoC) processes and procedures: Quality measurements must be maintained when switching between plant production levels, product line batches, or with other plant configuration changes as these stress instrumentation devices in different ways. Assign responsibility to an individual within the instrumentation discipline to work with operations for creating or updating formal Management of Change processes and procedures for key plant measurement/data considerations. Based on this, establish a fleet-wide measurement device monitoring and assurance program. All devices should have a purpose, goals and target performance to achieve,

constraints and limits to respect. Some are explicit and some are implicit; some are simple to measure and some are derived from complex chemistry, physics and math; some are static and some are dynamic; some are constant and some are conditional. A well-managed operation will know what these are, will document why they are needed and the consequences of non-conformance, and will have personnel accountable for compliance. A fleet-wide system for tracking and reporting performance, as well as assuring compliance is a necessary first step to operational improvement.

3. Operations staff re-deployment: Where unit operations have been turned down, or temporarily shut, can those operators be re-deployed to support re-instrumentation elsewhere in the plant or additional measurements where measurement sufficiency (coverage or frequency) or integrity/trust

issues exist? For example, regular and accurate pressure measurements and flowrates at either end (top and bottom) of impulse lines on distillation columns are vital for a reasonably accurate mass balance to be achieved in order to match models to plant data. After all, many analytics and rigorous dynamic models use on-line measurements from the plant to provide information about the status of the plant which cannot be directly measured, can predict the future trajectory of the plant and advise the operators on action required to keep the plant within its operating window and at its optimum operating point. However, accessing these measurement locations isn't always straightforward. Downtime of operations staff could be utilized to find sustainable solutions for these challenges for when operations ramp up again; finding ways to retrofit, upgrade or maintain measurements across the plant. ■

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