November/December 2019

InTech

A PUBLICATION OF THE INTERNATIONAL SOCIETY OF AUTOMATION

Optimization algorithms

Cobots and workers

Integration production planning

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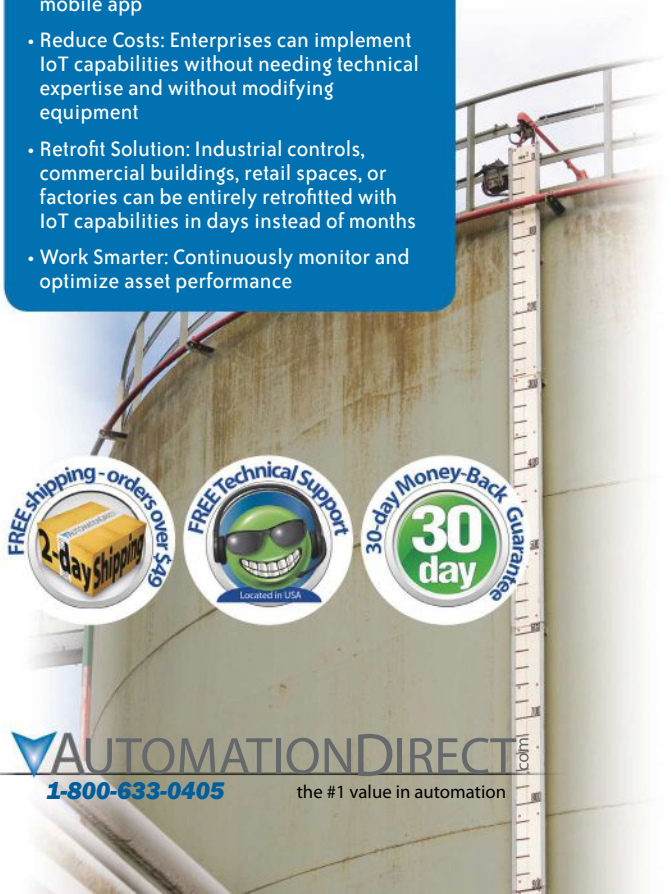

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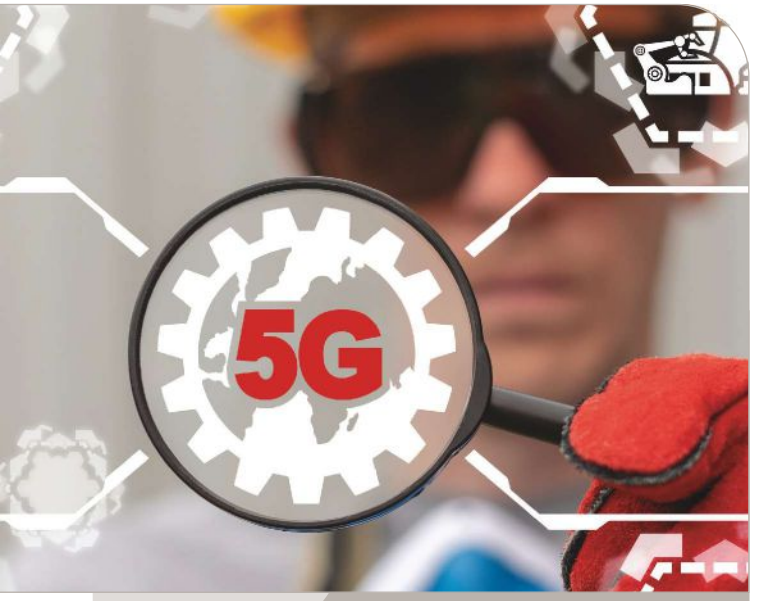

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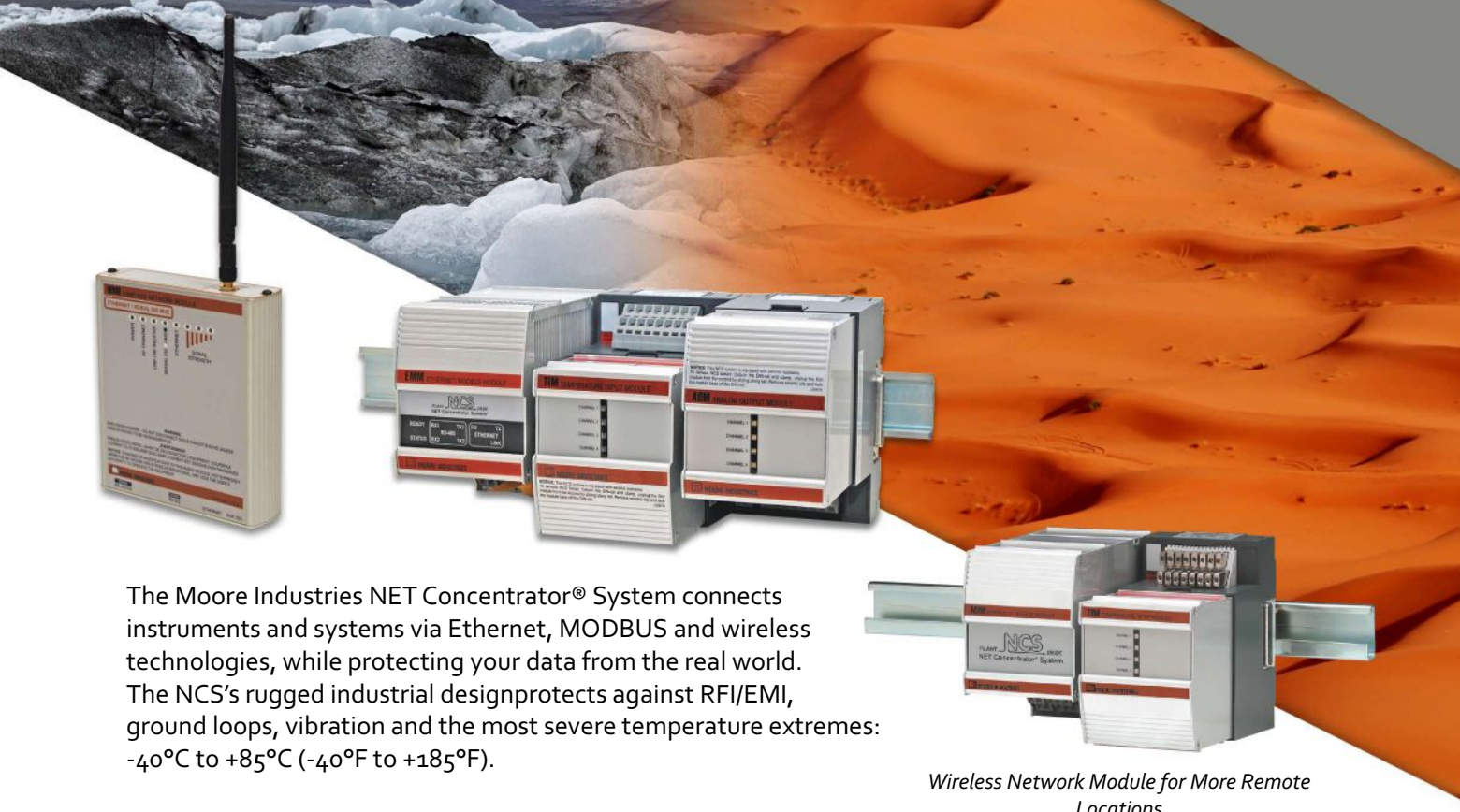

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Is 4G enough for 2020 and beyond?

By Renee Bassett, *InTech* Chief Editor

Technology advances are exciting. Things that literally could not be done a generation ago are now common. But rapid technological change also can make people feel like they're being chased by a snowball rolling down a hill. The snowball starts out small, and the run is exhilarating, but as its size and speed increase, it can feel like there's no outracing the avalanche.

5G wireless communications can be one such avalanche, threatening to overwhelm industrial automation and operations professionals with pressure to respond to the hype. To help slow the roll of this particular snowball, this month's cover story delivers stories of pilot projects and sources of technological expertise from folks who are planning to make the most of what 5G promises to deliver: high-bandwidth, low-latency, and highly reliable wireless communications.

The ones planning for 5G have in mind specific industrial applications, such as high-speed video inspection systems. But a whole lot of others, like those who have invested in third- and fourth-generation mobile computing devices, "are a little sensitive at this point to a transition," says Bruce Willins, Zebra Technologies' technology evangelist for mobile computing.

Willins says many Zebra customers in logistics, warehousing, and field service are holding on to 3G devices, but current events are forcing them to revamp their portfolios. Various Microsoft Windows operating systems commonly found in industrial devices will see the end of technical support soon, which means companies will no longer have access to security patches and bug fixes. Support for Windows Embedded Handheld 6.5 ends in 2020 and support for Windows CE7 ends in 2021.

"Most rugged devices using Legacy Windows are older and include outdated technical capabilities, i.e., old crypto, slower Wi-Fi," according to a white paper on the future of mobile computing operating systems from SOTI Inc. "However, these devices often deliver features perfectly suited to their use case, i.e., barcode scanners and removable batteries. . . . These purpose-built devices deliver a capable, customizable platform for device and data security." SOTI says many hardware OEMs have committed to support Microsoft operating systems beyond their end-of-service dates, which means "you can continue to use Windows CE 6.0 for some time, or you can side-grade to Windows Embedded Compact 7.0 or Windows Embedded Compact 2013."

All this is happening while 5G and Wi-Fi 6 technology are advancing but not yet proven. This leaves users wondering if 4G devices with modern operating systems are a good investment. Will 5G make them obsolete as soon as they're bought? Not likely, Willins says. Improvements coming with Wi-Fi 6 will give that protocol many of the same attributes as 5G cellular technology. Also, "3G got introduced roughly around 1998. So, we're talking, 20 to 21 years before it really started getting decommissioned. If we extrapolate that onto 4G, which started roughly in 2010, a 20-year lifespan means decommissioning in the 2030 time frame," he says. "So, with respect to those customers who are concerned about future proofing, we're quite confident 4G is not going away anytime soon," he says.

What do you think? Is 4G enough for 2020 and beyond? Mobile computing and Industrial Internet of Things communications are two things that 5G wireless technology is supposed to make exponentially better. How soon are you planning for that to happen? Let me know: rbassett@isa.org. ■

Veterans and automation

Thank you sincerely for the veteran recognition, very much appreciated. I really enjoyed reading your "Perspectives from the Editor" section in the September/October *InTech* [www.isa.org/intech/201910talk]. I am an Air Force veteran myself, and I started on my career path in the early '90s as a production maintenance technician with an aluminum diecasting company. Over the years I've taken advancing opportunities in different industries, and I've had the opportunity to work with veterans of all branches. Your article covered everything I've seen with my veteran peers starting from a great work ethic to the pride they have in their workmanship and overall attention to detail. I've been very blessed in my career path with opportunities given to me by people like you who believe in our veterans.

Joe Heibel, automation engineer, Continental Cement

Thank you for your article in ISA *InTech* about military veterans in industrial automation. I am a member of ISA Calgary and thought I would share my experience with you. I started in the Canadian Navy in the engine room on the ships doing oil changes and maintenance. After a year there, the Navy offered me the opportunity to study electronics at Memorial University and move into the Combat Systems Engineering department, where I subsequently specialized in repairing electronic warfare equipment (missile jamming and surveillance equipment). After I left the military, I attained civilian journeyman qualifications in electrical, instrumentation, and gas. I found the military (and my time at Memorial University) laid an extremely solid base of knowledge and skills that were transferable to the "real world."

There are many success stories from other veterans who followed a similar path as I. Among the individuals that I know who were the most successful lies a common denominator: they transitioned from the military to a civilian postsecondary school, and then from there to a civilian career. The individuals I know who went straight from the military to the civilian world without attending a civilian school did not have nearly as good outcomes (but in most cases still OK).

Civilian postsecondary school "fills in the holes" as military systems are similar (but still enough different) that it may be a struggle to move directly. Thank you again for your thoughtful article.

Justin Trupp, E/I + Gas(A), Kezen Thermal Inc.

Are you a veteran who now works in industrial automation? What was it like making the transition from military to civilian work? Who or what helped you find your new career and be successful in it? Let me know. –Renee Bassett, InTech *editor in chief, rbassett@isa.org*

University of Rhode Island, Hexagon partner on advanced manufacturing

Hexagon, a global maker of sensors, software, and autonomous solutions based in Stockholm, Sweden, announced that its Manufacturing Intelligence division has formed a collaborative partnership with the University of Rhode Island (URI) College of Engineering. Hexagon will provide manufacturing technologies to enable a rich research environment for undergraduate and graduate programs focused on advanced manufacturing.

With the North American headquarters of its Manufacturing Intelligence division in Rhode Island, Hexagon has long supported URI engineering students with an internship program and study abroad assistance. Many of the company's employees are URI graduates.

In October, URI opened its new 190,000-square-foot, six-story Fascitelli Center for Advanced Engineering. The work conducted there will build on research in clean energy, nanotechnology, robotics, cybersecurity, water for the world, biomedical technology, smart cities, and sensors and instrumentation. Hexagon will provide the facility with state-of-the-industry metrology systems, applications software for both measurement and computer-aided manufacturing, and sophisticated simulation software tools for design engineering.

Shown (left to right) Angus Taylor, president and CEO, Hexagon's Manufacturing Intelligence division, North America; (standing) Ray Wright, Dean of the College of Engineering at URI; URI President David M. Dooley.

"The University is grateful for Hexagon's continuing investment in our engineering programs. Its support is recognition of the strength of our faculty, their areas of research, and the importance of educating and training the next generation of scientists and engineers," said URI president David M. Dooley.

"Early on, Hexagon recognized that URI's International Engineering Program was an important local asset for building our workforce with graduates with technical knowledge and the skills needed to delve into the international business arena," said Angus Taylor, president and CEO, Manufacturing Intelligence, North America. "Hexagon's diverse portfolio of hardware and software makes factories smarter and helps manufacturers drive smart factory initiatives forward. We are proud that our technology portfolio and Hexagon experts across the global spectrum will support the university's research and development efforts." ■

Industrial Transformation MEXICO 2019 surpasses expectations

A new showcase of smart manufacturing and digital transformation held in Mexico drew more than 30,000 attendees from all over Latin America and abroad this fall. Put on by Chicago-based Hannover Messe USA, the inaugural Industrial Transformation MEXICO (ITM 2019) is the first Hannover Messe industrial technology event organized in Mexico and Latin America.

"The premier of ITM 2019 is hardly comparable with any other in the history of Deutsche Messe Group and is a real benchmark," said Deutsche Messe CEO Jochen Köckler, the organizer of Hannover Messe. Held 9–11 October at the Poliforum León in Guanajuato, Mexico, ITM 2019 had 265 exhibitors from 10 countries that showcased the latest in Industry 4.0 technology.

"The ITM 2019 results surpassed all expectations," said Hannover Fairs Mexico CEO Bernd Rohde. Of the 30,000 attendees, approximately half were professional buyers, 12,000 students, and 790 accredited international journalists. "The more than 70 conferences, workshops, and seminars exposed thousands of students, young people, and small and midsize companies to the Industry 4.0 mindset, while the ITMujeres program became the first educational platform designed to encourage more women to participate in Industry 4.0 initiatives," added Rohde.

During the post show press conference, Guanajuato Governor Diego Sinhue Rodríguez Vallejo said, "ITM 2019 generated $52 million in onsite business and another $850 million in the form of an investment project." According to Vallejo, the ITM trade show will initiate a new phase in Mexican industry, paving the way to a better future for the state of Guanajuato in particular and Mexico in general. "ITM 2019 establishes Guanajuato as an Industry 4.0 hub for the design of the technology of the future," he said.

ITM 2020, the second edition of Hannover Messe in Mexico and Latin America, is scheduled to take place 7–9 October 2020 in Guanajuato, Mexico. ■

Industrial Transformation MEXICO reportedly "exposed thousands of students, young people, and small and midsize companies to the Industry 4.0 mindset."

ISA 2019 Process Industry Conference: 5G, deep-water robots, more

Dennis Ong, PhD, head of 5G Mobility for Verizon, said some industrial users are already deploying applications that take advantage of the low latency and high bandwidth of 5G communications.

From cybersecurity and safety to deep-water robotics and more, ISA's 2019 Process Industry Conference (PIC) delivered three days of essential insight and information to hundreds of industrial automation professionals in Houston this November.

More than 50 sessions presented by process industry experts from around the world "has made PIC the "go-to" event for process automation and manufacturing professionals," said Edward Naranjo, director of fire and gas systems for Emerson Automation Solutions – Rosemount Flamed Gas Detection and 2019 PIC conference chair. This year's event also involved the technical knowledge and experience of several leading industry groups and associations, resulting in a more robust and diverse technical program, he said.

Presentations were given by experts from ARC Advisory Group, the Society for Underwater Technology (SUT), The Center for Operator Performance, The Open Group, and others.

When not attending or presenting, ARC analysts were hosting panel discussions, including one on the formation of the new ISA Global Cybersecurity Alliance and the convergence of cybersecurity and safety. "The convergence of safety and cybersecurity has evolved beyond concern around cyberattacks on process safety systems to include a wide range of issues where cybersecurity affects plant safety," said Larry O'Brien.

Covestro Baytown's expert engineer Qing Cai spoke about functional safety in operations and maintenance, giving practical examples of why chemical process owners should retain functional safety expertise and resources after new or modified systems are validated.

Dennis Ong, PhD, head of 5G Mobility for Verizon Smart Communities, spoke on the future of 5G communications technology in the industrial space and public sector. A former TEDx speaker who has spoken on "Transforming IoT with Machine Learning," and "Securing the World with Blockchain," Ong gave a compelling talk on how 5G is enabling industrial mobile robots, Industrial Internet of Things (IoT), and autonomous vehicles.

"5G is applicable for both consumer and industry. It's not like 5G is specialized for a particular industry. It supports [transmission of] massive amounts of data, so it can support industrial applications, plus consumers," said Ong. "Customers can start to take advantage of the billions and billions of dollars that Verizon and other service providers are spending on 5G and start deploying applications that take advantage of the low latency and high bandwidth today." (Read more from him in this month's cover story about industrial 5G: "The 5G future is now.") ISA's 2020 Process Industry Conference will again be in Houston in November. ■

Honeywell to enhance Kuwait's domestic petrochem, gasoline operations

Honeywell Process Solutions (HPS) will be the main automation contractor for the Kuwait Integrated Petroleum Industries Company (KIPIC) new Petrochemicals and Refinery Integration Al Zour Project (PRIZe). Under the agreement, HPS will provide front-end engineering design and advanced process control technology for the complex, which will help KIPIC expedite production startup and reach production targets faster and more efficiently.

The new facility will become the first integrated refining and petrochemicals complex in Kuwait and will significantly enhance Kuwait's domestic petrochemicals, aromatics, and gasoline manufacturing capabilities.

Honeywell UOP also was awarded a contract with KIPIC earlier this year for modernization of the Al Zour complex. Honeywell UOP will revise the configuration and capacity of the refinery's gasoline production facilities and supply technology licenses, design services, equipment, and catalysts and adsorbents to produce clean-burning fuels, paraxylene, propylene, and other petrochemicals.

Honeywell has been in Kuwait for more than 50 years, said Rachad Abdallah, president of Honeywell in Kuwait. "At the integrated refining and petrochemicals complex at Al-Zour, we are leveraging our experience and technologies to help develop one of the most ambitious initiatives in the region. This project will help transform Kuwait into a pioneering manufacturer in the downstream oil and gas industry," she said.

Hatem Al-Awadi, acting CEO, KIPIC, agrees, "The PRIZe project will revolutionize Kuwait's domestic production capabilities, helping KIPIC meet the increasing demand for fuels and petrochemical products within the country. With Honeywell's support, we are building a strategic project that will transform Kuwait's domestic oil and gas market and provide a significant accelerator for the country's long-term economic development." ■

The Absolut Company taps Siemens software to increase manufacturing efficiency

Siemens Digital Industries Software will conduct a pilot of the company's Opcenter Execution Process (formerly known as SIMATIC IT Unified Architecture Process Industries) in one of three bottling facilities owned by The Absolut Company. Said Anna Schreil, vice president of operations, "The Absolut Company always strives to have best-in-class manufacturing where Industry 4.0 will be a key enabler to deliver on future consumer demands. We are happy to have Siemens Digital Industries Software as a key partner on this journey."

The collaboration will involve Opcenter Execution software, which is part of the Siemens Digital Enterprise Suite manufacturing execution system solution. Installation of the software in one plant in Åhus is the first step of an enterprise-wide roll out across three factories that produce spirits for global distribution, said Schreil.

Opcenter can help The Absolut Company to better meet some of the challenges in the beverage market, including the increasing demand for high quality and variety in products and production, as well as cost pressures. The Opcenter Execution Process can help to increase traceability, to manage orders more efficiently, and to monitor production in real time.

"Companies across the consumer products industry are facing increased regulations, the need for global manufacturing to meet local demands, and competitive pressures that can result in reduced margins," said Mats Friberg, vice president and managing director for Nordic Operations at Siemens Digital Industries Software. "The Absolut Company recognizes the key to staying ahead in this changing industry is through digitalization. We will be a responsive partner to The Absolut Company as it continues to move toward a digital enterprise." ■

Joint venture to help U.S. power companies be cybersecure

Fortress Information Security launched a joint venture called Asset to Vendor Network for Power Utilities, or A2V, to address concerns about protecting the U.S. power grid from cyberthreats and promote collaboration among electric companies. Fortress Information Security and American Electric Power designed A2V to reduce the costs associated with cybersecurity regulatory compliance.

Power utilities share many of the same supply chain vendors for equipment, software, and services for their bulk electric systems, an industry trait that has been identified by malicious actors and is resulting in an increasing number of attacks on the power grid. In response, the Federal Energy Regulatory Commission (FERC) has issued new rules that require utilities to develop a plan for managing cyberrisk related to the supply chain.

The plan includes procedures for prioritizing vendors based on risk, requirements for completing standardized risk assessments on each vendor, and verification of the authenticity of software manufacturers and the integrity of their software updates. The deadline for completion of the plan is currently June 2020. Utilities that fail to meet this deadline can face various levels of penalties, ranging as high as $1,000,000 per day.

A Fortress spokesman said the number of supply chain vendors providing equipment, software, and services to power utilities makes the completion of this goal both challenging and costly for individual companies—not to mention potentially burdensome for the vendors. So, Fortress and AEP developed AV2 to facilitate the sharing of technology and information.

Fortress, an experienced cybersecurity partner, will operate the A2V platform. The tool's databases include a library of completed vendor risk assessments that comply with the new regulations. Power companies who join A2V can purchase vendor assessments for much less than it would cost for them to conduct the assessments themselves. Participating utilities also will be able to contribute their own completed assessments for purchase by the network and receive a portion of the proceeds. ■

Design a smart city on your lunch break

Are you interested in the digital transformation of cities as well as industrial plants? An online desktop tool "that breaks down the collective technical elements of smart buildings, e-mobility, energy management, and data centers," is available from ABB Electrification.

The tool shows many of the components that can contribute to the design of a comprehensive smart city, said Amina Hamidi, ABB Electrification's CTO.

"The interactive landscape shows some of the safe, smart, and sustainable solutions that can contribute to the design of a smart city, and the tool will develop further as more innovations and solutions are introduced," Hamidi said. The tool can be accessed at https://www.abbsmartcities.com. ■

Industrial 5G: The future is now

By Renee Bassett

Popular U.S. media sources from *The Wall Street Journal* to television evening news are talking about the coming availability of 5G wireless communications—from a consumer point of view. They are breathlessly describing the download of feature-length films in seconds, the thrill of streets filled with driverless cars, and smart cities that keep you connected no matter where you roam. But there is a whole other world of opportunity for industrial applications, a world where 5G's high speed, low latency, and ability to handle massive amounts of data is already being tested.

Around the globe, providers like Sprint, Nokia, Verizon, Ericsson, and others have spent millions building the infrastructure for 5G wireless. "Cities will be at the heart of the 5G story," says Dimitris Mavrakis of ABI Research. "The rollout of 5G services in urban centers, where user densities are highest, will boost the smart city ecosystem and establish a new connectivity platform for consumer services and industrial actors in urban environments." Suburban and rural areas are expected to take a lot longer to be the focus of 5G service.

Some analysts say manufacturing plants are better suited than cities for 5G, because they can more easily install the equipment needed to

FAST FORWARD

- 5G wireless network infrastructure is being deployed around the globe.
- 5G industrial application pilot projects have arrived and are being tested.
- Some believe 5G is likely to become the standard wireless technology of choice, enabling direct wireless communication from the field level to the cloud.

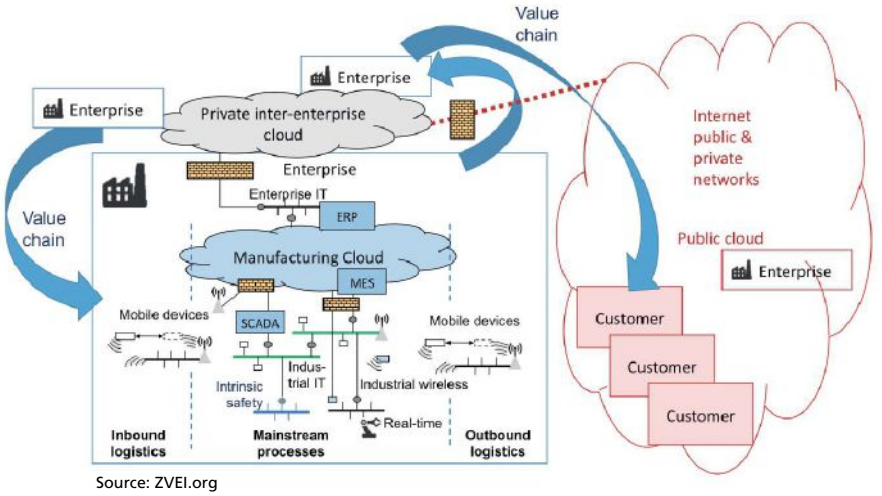
The network infrastructure is being built and pilot projects have launched. Where does 5G fit in your plan?

create a 5G network on their campus or inside the four walls of a plant. In fact, even though the 5G communications standard will not be set until mid-2020 (which means industrial providers of network hardware will not start producing in bulk until then), 2019 was a big year for industrial 5G announcements. First deployments of industrial pilot projects popped up everywhere from Helsinki, Finland, to Hickory, N.C., and discussions about appropriate applications, emerging standards, and multiprotocol layering (5G working in tandem with Wi-Fi 6, Bluetooth, LTE, and other 4G networks) took place around the world.

The Hannover Messe 2019 in Germany and the Smart Automation Fair in Linz, Austria, saw an explosion of interest in and presentations on 5G communications. Launched at Hannover Messe 2018 and with a big presence again this year was 5G-ACIA, the 5G Alliance for Connected Industries and Automation. It is a working group of ZVEI, the German Electrical and Electronic Manufacturers' Association (see the resources box for more from them).

The network service providers and telecoms have been busy as well. As of November, Verizon had already deployed 5G in 15 U.S. cities and has plans for deployments in up to 30 more in the

Aspects of communication in industrial value creation processes



Source: ZVEI.org

The traditional separation of communication solutions into process-oriented real-time communication and enterprise communication is disappearing as web technologies and Industrial IoT create additional communication paths. That means data-driven functions, such as condition monitoring and predictive maintenance, are easier to implement.

coming months, according to Dennis Ong, PhD, industrial 5G development manager for Verizon and a speaker at ISA's Process Industry Conference in Houston. "We're spending upwards of $15–16 billion this year to deploy 5G and fiber-optic cable," Ong said. "And we're not limited to just one sector. 5G is applicable for both consumer and industry."

Verizon is "co-innovating" with Corning, says Ong, "using 5G and fiber to create the factory of the future" in tiny Hickory, N.C. It helps, perhaps, that this is the location of Corning's fiber-optic cable manufacturing facility—one of the largest in the world. Verizon has installed 5G ultrawideband service in the plant, which Corning will use to test how 5G can enhance functions such as factory automation and quality assurance.

The companies are also working together to come up with new 5G-enabled applications like machine learning and augmented reality/virtual reality (AR/VR). 5G's fast speeds, high bandwidth, and low latency promises to dramatically speed data collection so machines can communicate with each other in near real time, and 5G-connected cameras can wirelessly track and inspect inventory. They will also test how 5G can improve the function of autonomous guided vehicles.

"Together, Verizon and Corning engineers expect to break new ground by identifying which 5G-enabled capabilities offer the most promise in a manufacturing environment," said Claudio Mazzali, PhD, senior vice president of technology for Corning's Optical Communications business segment. "This builds on our collaboration with Verizon in a powerful way: Verizon turned to Corning for the fiber, cable, and optical connectivity innovations that are bringing their 5G network to life. Now Verizon is bringing 5G capabilities to a plant where those cable innovations are produced—completing the circle."

Uses for industrial 5G

On the other side of the world, the Swedish multinational networking and telecommunications company, Ericsson, announced the establishment of 5G-based smart factories in Finland, Sweden, China, and the U.S. Ericsson's *2019 5G for Business: A 2030 Market Compass Report* is being used to "better guide our customers in navigating in the 5G landscape beyond mobile broadband," said Jan Karlsson, senior vice president and head of business area digital services for Ericsson.

"The findings quantify the value of potential services based on more than 200 use cases and a set of 5G-enabled business-to-business use case clusters. Covered use case clusters include enhanced video services, real-time automation, connected vehicles, and AR/VR remote operations. Use case examples that build up these clusters include real-time operations and monitoring of distributed energy resources, advanced-performance autonomous cars, and auto-pilot driving, Karlsson said.

Announced in June, Ericsson's own $100 million 5G smart manufacturing plant in Lewisville, Texas, will begin operation in early 2020 using 5G to produce 5G and advanced antenna system radios for sale in North America. Niklas Heuveldop, president and head of Ericsson North America, says, "Fast and secure 5G connectivity will enable agile operations and flexible production." Ericsson's 5G industrial operations will include automated warehouses, connected logistics, automated assembly, packing and product handling, and the use of autonomous carts.

At Volvo Construction Equipment's research and development facility in Eskilstuna, just west of Stockholm, Ericsson teamed up with Swedish telecom company Telia to run Sweden's first 5G network for industrial use. Remote-controlled machines and automation are among the first applications being tested. The partners aim to further develop the remote control of construction machinery and heavy machinery in real time. They also aim to increase industry efficiency and sustainability through 5G testing.

Operating with a test license, Volvo CE employed a 5G network based on Ericsson commercial hardware and software, including 5G new radio and core products from Ericsson's 5G platform. According to a spokesman, Volvo CE hopes to apply the lessons learned from the tests at Eskilstuna to its global activities. By minimizing the potential safety risks and downtime associated with sectors such as mining, Volvo CE expects to get closer to its goal of zero emissions, zero accidents, and zero unplanned stops, he said.

AI + 5G to empower employees

Telia, in partnership with software engineering firm Atostek Oy, is also

In May, ABB announced what it called the world's first industrial artificial intelligence application using 5G technology. The pilot, implemented in partnership with Telia and software engineering firm Atostek Oy, assists the assembly of drives at ABB's Helsinki plant.

supporting what is being called "the world's first industrial artificial intelligence [AI] application using 5G technology to assist the assembly of drives." ABB's drives plant in Helsinki has about 1,300 employees and is the company's main facility for the development of low-voltage drives.

The AI application is being applied to the power module assembly line, which is critical to production quality and is particularly demanding for employees because dozens of different versions of the same product are assembled on the same line. According to Simo Säynevirta, country digital lead at ABB Finland, fast 5G connections will provide workers with real-time feedback, helping to improve quality by making assembly significantly easier compared to following work instructions from a paper document.

Atostek, which specializes in industrial applications, is responsible for the computer vision and the AI application. Telia is providing the system's high-speed 5G mobile connections and the computing capacity needed by the application in its data center. Announced this past spring, the project was expected to be in full-scale production by June 2019.

"The potential of AI is strongest when combined with human expertise, and the goal of supporting employees in a new way is at the heart of this project," says Säynevirta. "At its best, this real-time quality assurance system not only improves production line quality and productivity, but also reduces the stress associated with human errors, which helps improve well-being at work."

Autonomous mobile robots

Network services provider Nokia is teaming up with industrial equipment maker Omron and NTT Docomo for what is said to be one of the first 5G trials involving the Industrial Internet of Things (IIoT). IIoT is considered one of the top use cases for 5G, enabling things like the remote monitoring of production assets and the use of autonomous drones for delivery of emergency services.

The three companies are testing the feasibility of operating a layout-free production line staffed by 5G-enabled autonomous mobile robots (AMRs) working alongside humans. 5G is expected to be a boon for industrial robotics, because the AMRs will get the high-speed, low-latency connectivity needed to communicate with production line equipment and bring components to an exact spot.

During the trial, the AMRs will be trained in real-time using AI. The performance of the human technicians also will be monitored with an AI system that will offer feedback on their movements using machine vision. The goal is to help improve the training of technicians by analyzing the differences of movement between skilled and less-skilled workers.

John Harrington, president and CEO of Nokia Japan, said, "Production lines will be more flexible and adaptable, and productivity on the factory floor can be more easily improved. We are dedicated to helping manufacturers enable this Industry 4.0 vision."

Takehiro Nakamura, senior vice president and general manager of NTT Docomo's 5G Laboratories, said "having conducted multiple trials creating 5G use cases with a variety of partners, [I know] factory automation is one of the most interesting and yet challenging fields to explore. We are confident we will be able to prove the feasibility of layout-free factory production lines with autonomous mobile robots and person-machine collaboration." If successful, the trial will enable factories to rearrange production lines at short notice in response to shorter production cycles driven by fast-changing consumer demands, he added.

Chip-level 5G support

U.S. chipmaker Intel helped Nokia and Telia run a series of 5G smart factory tests using a trial 5G radio access network operating in the 28-GHz frequency band. A video application monitors and analyzes a process on an assembly line at the Nokia factory in Oulu, Finland. It uses machine learning to alert the assembly line operator to inconsistencies in the process so they can be corrected. A second trial showed data from the site could be rendered and accessed in real-time at Telia's data center in Helsinki, 600 kilometers away.

Data was collected and processed close to the assembly line by using multi-access edge computing (MEC) from Nokia and a video analytics application from Finnish startup Finwe. Data was then transmitted across Nokia's 5G AirScale base stations, operating in the 28-GHz band, and collected

in Helsinki using Nokia's AirFrame data center equipped with Intel Xeon Scalable processors. The data was rendered using Intel's 5G Mobile Trial Platform.

Nokia said it will continue to use the setup, combining its MEC platform with Finwe's video analytics across a 4G LTE network at its Oulu factory, and upgrade its software to the 5G Airscale platform in due course. The 28-GHz frequency band and massive MIMO antennas have the low latency and bandwidth needed.

Use of wireless in industry

5G applications are being built with the lessons learned from industrial wireless trials that have come before. "While companies are striving to make their production processes smart, they must consider which communication technology has the qualities to achieve that," says Marcela Alzin, author of a report from HMS Industrial Network. "The well-known wired solutions cannot cover the requirements of Industry 4.0, and thus wireless systems have entered the next stage. Wi-Fi, Bluetooth, and the like have been around for some time, but now they are contended by 5G, which promises to overcome the shortcomings of the other wireless systems."

HMS Networks surveyed 50 international manufacturing professionals in spring 2019 at Hannover Messe to find out "5G: Is the Industry Ready?" It asked professionals about the use of wireless communication in their companies, how they are getting ready for the launch of 5G, and how they felt about industrial wireless technology so far.

As expected, the most widely used wireless technology in industrial production is Wi-Fi. Most respondents (74 percent) indicated that they are using it either on the factory floor or in their products. "Some noted Wi-Fi's poor quality in factory environments. Some mentioned they hoped for improvement with the introduction of the new Wi-Fi 6 standard," said Alzin.

Cellular technologies were the second most popular communication technology mentioned. Forty-two percent said they use cellular technologies (GSM, 4G LTE, MulteFire) in some way (in most cases for IIoT/HMI or routers). In addition to that, 39 percent of respondents said they use Bluetooth in their companies, in some cases specifically Bluetooth Low Energy.

A smaller portion (13 percent) mentioned their companies also were using other wireless communication systems, mostly proprietary: ZigBee, SigFox, LoRA, WiMax, etc. "Two respondents mentioned using RFID [radio frequency identification] tags, and 10 percent of the interviewees were not aware of the communication technologies used by their companies and could not answer the question. One interviewee expressed high hopes regarding low-power solutions, such as NB-IoT, while another company referred to solutions based on ultrawide band," said Alzin.

Important requirements

The HMS Networks survey results showed that wireless systems, especially 5G as a new technology, must fulfill certain requirements to gain trust

Industrial 5G resources and working groups

IEEE.org

According to the organization, the mission of the IEEE International Network Generations Roadmap (INGR) working group is to identify short (~ three years), midterm (~ five years), and long-term (~10 years) research, innovation, and technology trends in the communications ecosystem. The outcome shall be a live document with a clear set of (accountable) recommendations. The document shall be updated annually and be developed in conjunction with the other working groups.

IEEE also sponsors the annual IEEE International Symposium on a World of Wireless, Mobile and Multimedia Networks (WoWMoM). This year, the 20th anniversary event was held in Washington D.C. and included four preconference workshops on data distribution in industrial and pervasive Internet (DIPI), Internet of Things (IoT-SoS), UAV swarms (SwarmNet), and cyber-physical systems (CCNCPS).

IEEE technical papers in 2019 included:

- *Optimal-Capacity, Shortest Path Routing in Self-Organizing 5G Networks using Machine Learning*
- *Towards a Converged Optical Wireless Fronthaul/Backhaul Solution for 5G Networks and Beyond*
- *5G Enabling Technologies: Network Virtualization and Wireless Energy Harvesting*
- *Energy Efficiency Enhancement in 5G Mobile Wireless Networks*

5G-ACIA.org

Launched at Hannover Messe 2018, 5G-ACIA is the 5G Alliance for Connected Industries and Automation, a "working party" of ZVEI, the German Electrical and Electronic Manufacturers' Association. At Hannover Messe 2019, the group's mission was to raise awareness of the challenges and opportunities of technology through a full-week program of podium discussions and presentations

Andreas Müller, PhD, (Bosch), chairman of 5G-ACIA, explains, "With the release of first standards and the availability of the first chipsets and infrastructure components, 5G is fast gaining momentum. In fact, many companies are beginning to realize the critical role this technology will play in the digital transformation of their businesses."

Since its formation in April 2018, the 5G-ACIA has registered significant membership growth, Müller emphasizes. In the year 2019, the 5G-ACIA will continue to expand its activities worldwide. Recent activities included a workshop in Seoul in March and another in Chicago in June. The goal of the organization is establishing 5G in industrial production and making it industry ready from the outset. Among other things, 5G-ACIA is actively involved in the standardization and regulation of 5G. The group also identifies and articulates the specific spectrum needs for industrial 5G networks, and explores new operator models, such as operating private or neutral host 5G networks within a plant or factory. ■

and acceptance in the automation community, said Alzin. "Some of the requirements go in line with the expectations of the industry toward each communication system (reliability, interoperability, affordability); some of them are new because 5G is a cellular technology (availability of spectrum, end-to-end security, quality of service)," she added.

For the majority of respondents (58 percent), the reliability and robustness of wireless systems play a decisive role, whether they were skeptical or had a positive or neutral response to 5G. Low latency was mentioned as important by more than a quarter (26 percent) of the interviewees. "Interestingly, this feature was indicated more by IT [information technology] people (43 percent) than by OT [operational technology] people (17 percent)," said Alzin. About the same importance was attributed to end-to-end security (22 percent), quality of service (20 percent), and affordability (18 percent).

Sixteen percent pointed out the importance of interoperability with legacy systems, and 18 percent felt that affordability of a wireless 5G solution was important. Some importance (14 percent) was given to the issue of spectrum availability.

The new era of 5G

According to 5G-ACIA, one of the main differences between 5G and previous generations of cellular networks lies in 5G's strong focus on machine-type communication and the Internet of Things. The capabilities of 5G thus extend far beyond mobile broadband with ever-increasing data rates.

Because 5G supports communication with "unprecedented reliability and very low latencies, as well as massive IoT connectivity," it paves the way for the next era in industrial production known as Industry 4.0, "providing powerful and pervasive connectivity between machines, people, and objects."

5G-ACIA contends that, in the long-term, 5G "may actually lead to convergence of the many different communication technologies that are in use today, thus significantly reducing the number of relevant industrial connectivity solutions. Just as there is an ongoing trend toward Time-Sensitive Networking for established (wired) Industrial Ethernet solutions, 5G is likely to become the standard wireless technology of choice. It may, for the first time, enable direct and seamless wireless communication from the field level to the cloud."

Are you ready? ■

ABOUT THE AUTHOR

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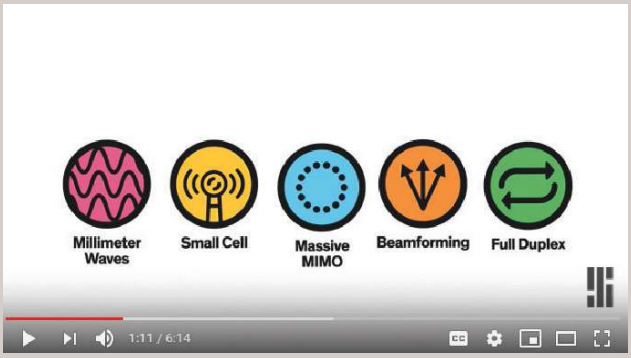
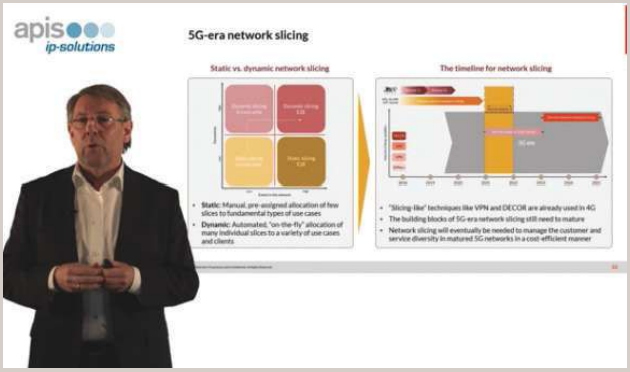
View the online version at www.isa.org/intech/20191201.

Video resources

Corning describes creating the factory of the future with Verizon at its Hickory, N.C., plant. (https://www.youtube.com/watch?v=QOuD7aLLv7g)



IEEE explains everything you need to know about the technologies enabling 5G communications. (https://www.youtube.com/watch?v=GEx_d0SjvS0)



Bengt Nordström, CEO of Stockholm-based Northstream, explains "5G in the next five years" in in a webinar from APIS. (https://www.youtube.com/watch?v=o8PYAGaSe9M)

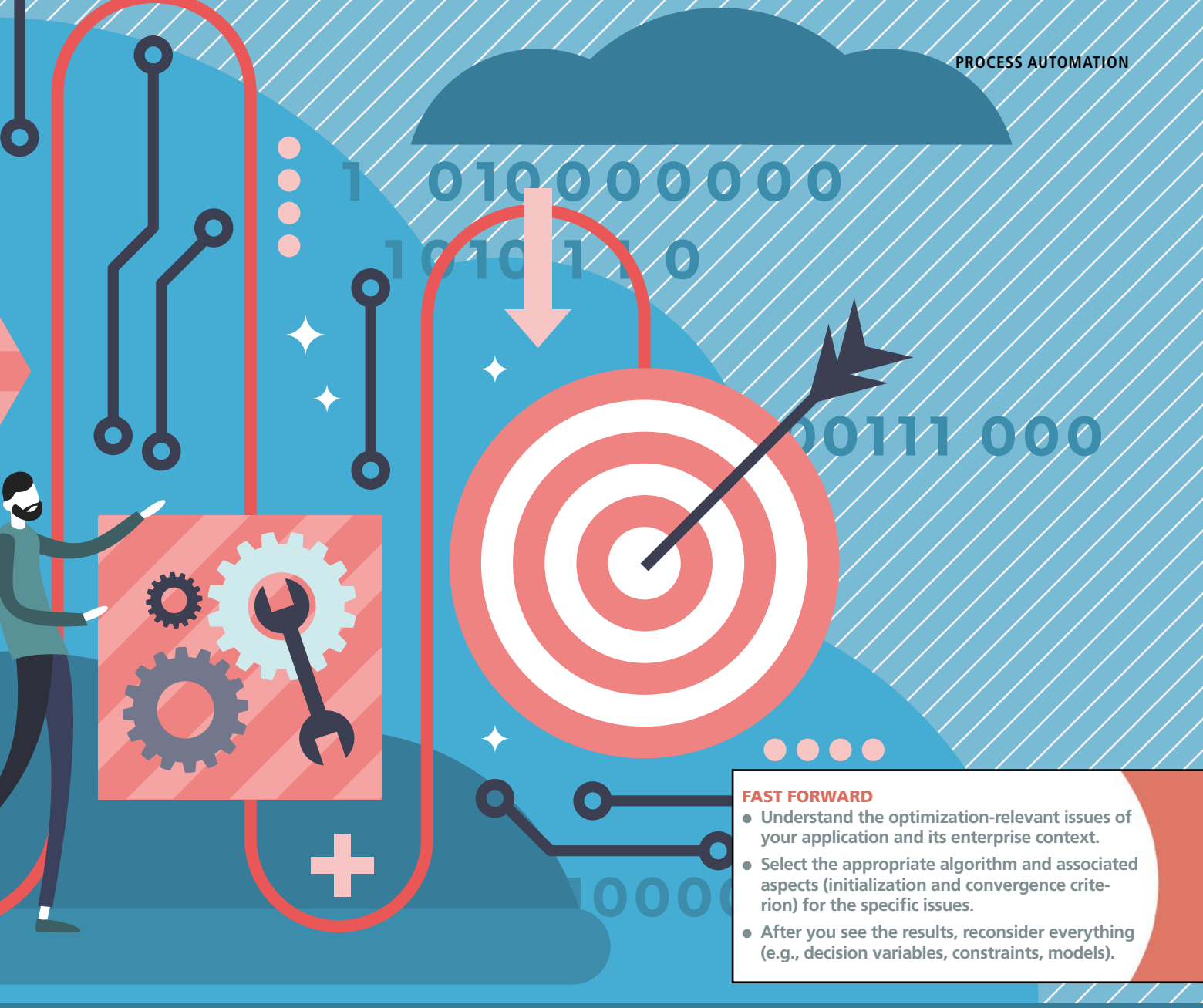
Optimization algorithm selection for process applications

How to match the optimizer to application attributes

By R. Russell Rhinehart

Optimization seeks to find the best. It could be to design a process that minimizes capital or maximizes material conversion, to choose operating conditions that maximize throughput or minimize waste, to tune a controller that minimizes rise time, or to determine a future control sequence that minimizes deviation from the set point while avoiding a constraint.

In any application, there are usually several desirables to be maximized and several undesirables to be minimized. The objective function (OF) is the expression used to calculate a value for the overall desirability. Elements of



FAST FORWARD

- Understand the optimization-relevant issues of your application and its enterprise context.
- Select the appropriate algorithm and associated aspects (initialization and convergence criterion) for the specific issues.
- After you see the results, reconsider everything (e.g., decision variables, constraints, models).

the OF could include the sum of squared deviations in model regression, a controlled variable variance in steady periods, the profitability index in a plant design, or the probability of a worst-case scenario when there is uncertainty.

The optimizer seeks to adjust decision variable (DV) values to result in the best OF value. Usually the DVs are iteratively moved toward the optimum, and each DV choice is termed a trial solution (TS). The search is initialized with a TS, often user defined. The optimum values are represented by DV* and OF*.

Because the optimization procedure incrementally approaches the DV* values, and is stopped when close enough, the DV* and OF* values are not the ideal best. They are in close proximity to the ideal. There is no sense in trying to find the perfect solution. If, for example, the molecular weight of water of 18 is used, the DV* values will change if the more perfect value of 18.0153 is used. Models are imperfect. Users need to understand model imperfection, then they can determine what is justified to claim convergence.

As a simple example of this terminology, the objective is to minimize this function $z = (x–2.345)^2 + (y–3.210)^2$ by changing the x and y values. In optimization terminology, the independent variables, x and y, are the DVs; the calculation defined by $(x–2.345)^2 + (y–3.210)^2$ is the OF; and the value of the response variable, z, is the OF value. There might be a constraint, for instance x must be greater than y. Putting all this together in standard notation, the statement is:

$$\min_{\{x,y\}} J = (x–2.345)^2 + (y–3.210)^2 \qquad (1)$$

$$\text{S.T: } x > y$$

Here, *J* is the OF. The term *min* means to seek the minimum. The DVs are listed in brackets under the *min* term, and S.T: means "subject to," which states the constraints. Any relevant application will be much more complicated, but it has the same elements.

Equation (1) is not the solution. Nor does it reveal how to obtain the DV* values. It is simply a standard presentation of the elements.

Is the coefficient 2.345 exactly right? Model coefficients associated with viscosity, density, heat transfer, feed composition, etc., all have uncertainty. Uncertainty in the "givens" will propagate to uncertainty of the optimized results. Mathematical perfection in optimization is only as justified as the OF calculation is complete and true.

The user needs to choose the optimizer, and the application characteristics should drive the optimization algorithm selection, not the mathematical appeal, academic fashion, or traditional company choice. Further, the user needs to define the OF, choose the DVs, choose a method of initializing the TS, decide how to handle constraints, decide on convergence criteria, etc. Again, the choices need to be right for the application.

Common optimization applications

Regression with phenomenological models: Models derived from a first principles, mechanistic view of the cause-and-effect relationships of a process or product could be termed engineering models. Some model coefficient values have uncertain values, and regression (adjusting model coefficient values to match the data) is a nonlinear optimization with a quadratic-ish OF.

Empirical modeling: These models do not have a first-principles grounding. They could be power series relations, neural networks, first-order-plus-delay, finite impulse response models, or such. Again, nonlinear optimization is used with a quadratic-ish OF.

Trends and associations: The new era of big data and machine learning seeks to identify trends or relations within data using empirical models. The OF response is usually quadratic.

Design: In process design, optimize profitability, flexibility, reliability, safety, etc. In product design, minimize product cost, while meeting functional specifications. These models are usually nonlinear, and the DVs often include class or discretized variables (tray or packed tower distillation, or number of alternating layers, integration time steps). Additionally, coefficient values (future prices) are often uncertain.

Process control: In advanced process control applications, an optimizer defines future control action to best keep the controlled variables at set points while avoiding constraints. Here models are generally linear, but, supporting nonlinear applications include data reconciliation and identification of events/faults.

Scheduling, blending, and managing growth: These relate to allocation or timing, and generally have OF models and constraints that are both linear responses to the DVs.

Process operation optimization: Real-time optimization seeks to determine set points for the controllers to maximize efficiency, conservation, and throughput, while minimizing expenses, waste, variability, risk, and constraints. The models may either be linear or nonlinear.

OF model classification

Linear models: If the mathematical form of the DVs in the OF and in the constraints is linear, then the optimal solution will be on an intersection of constraints.

Quadratic models: If the mathematical form of the DVs in the models is independent and linear, and the OF is a quadratic (squared) function of the model, then the solution is easy with classic methods.

Nonlinear: There are many ways the OF might not be a linear response to the DVs. Most process models are nonlinear and nonquadratic. This creates a DV-to-OF relation that confounds linear or second-order optimization techniques.

Deterministic or stochastic: Most OF responses are deterministic, meaning the model returns the same OF value for a particular TS value. The answer to a deterministic question such as "What is 3 × 4?" is always 12. By contrast, experimental noise and other process vagaries lead to continually varying results. When replicate tests give different values, the response is termed stochastic. The issue is that when the TS is moving in the right direction, the improvement may be masked by the fluctuation, and make it seem like the wrong direction. Stochastic responses also arise when optimizing deterministic models in the presence of coefficient uncertainty.

Integer or discretized: Whether the DV or the OF is discretized, the OF response to the DV has flat spots surrounded by vertical cliffs.

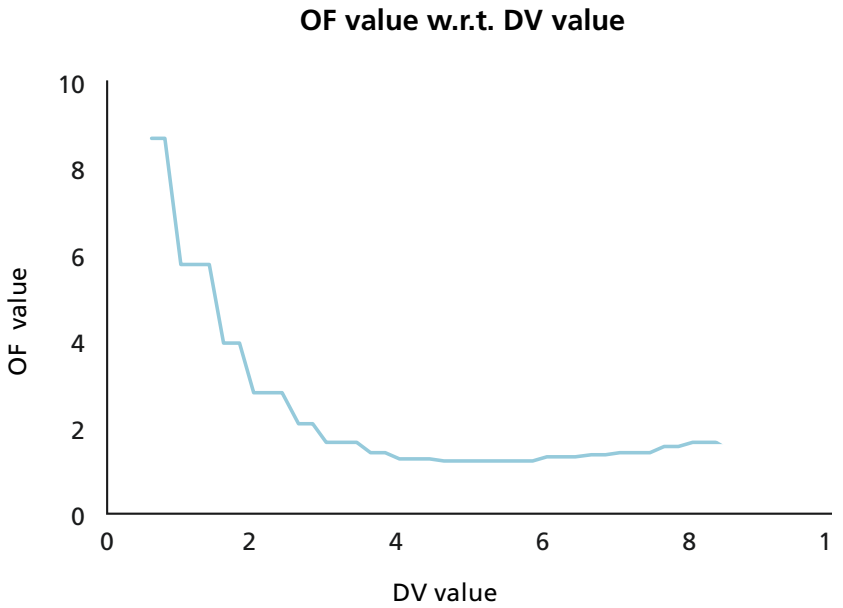


Figure 1. Illustration of flat spots.

Difficulties for optimizers

Flat spots, or nearly so: If the OF response to the DV has flat spots, these are places where any small change in the DV has no impact on the OF. Here most optimizers will think that they have found the optimum, will converge on any of the flat spot locations, and misrepresent the situation. Figure 1 indicates that the minimum is at about DV=5, but since the OF has flat spots, the optimizer might claim convergence at DV values of 1.5, 2, 9, or many others.

Ridges, and gently sloping floor within steep walls: Imagine a deep river gorge with steep walls surrounding the river. Many applications have such a relation between DV values and the OF. Optimizers that use the steepest descent (gradient-based) will tend to zigzag across the river, not follow it downstream.

Discontinuities: Conditionals (IF-THEN-ELSE relations) in a function cause discontinuity. A common one is the transition in pressure drop models from laminar to turbulent flow. The conditionals may be related to any number of choices, for instance selecting the larger size when determined by several criteria.

Striations: Imagine a smooth surface, a pasture with gentle hills, which has a downward slope to the stream. Then be a farmer and plant rows of corn in a contour manner. Rainwater will not go across the striations toward the stream, but will stay in local valleys as defined by the rows. In optimization, there may be a concept of a continuum surface, but numerical discretization in either integrating or solving differential equations will create such striations on the surface, and many optimizers will follow the rows to local minima on the hill, not cross over them to find the true optimum.

Figure 2a represents a contour map of a 2-DV case. The minimum is about DV1=5, DV4=4. But the calculation is of a time-discretized simulation and has striations. These are somewhat recognizable from the kinks in the contour lines. The close-up 3-D view in figure 2b shows the ridges on the surface. The connect-the-dots vertical line in figure 2a is the path a Levenberg-Marquardt optimizer took when starting at DV1=4.2. It could not cross up over the local striation to get to the minimum at about (5.5, 3.5).

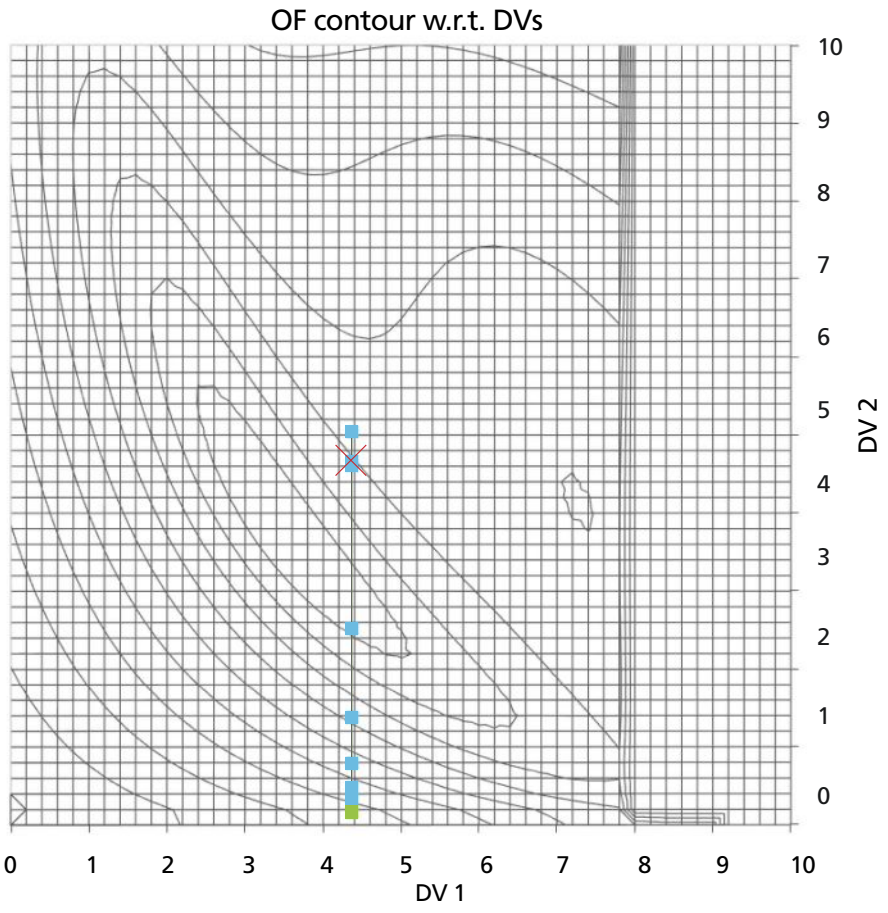


Figure 2a. Contour and optimizer path.

Planar, or nearly so: Many of the "best" optimizers presume that the entire surface is nearly quadratic (proportional to the DV squared). These include Newton's and successive quadratic methods. But if the OF response to the DVs is linear in some region, or nearly so, then these methods will tend to jump to extreme values.

Multi-optima: Imagine hail pings on what should be a smooth hood of a car. Normally, rainwater will run off the hood, but the dings will trap water in local minima. Many nonlinear functions have local optima, that trap an optimizer. In the local optima, any direction is worse, and an optimizer will claim convergence, misrepresenting the big picture. Run an optimizer many times from randomized initializations to detect local traps.

Underspecified: In a new application, it is not uncommon for a user to have redundant DVs. As a very simple illustration, consider determining x and y values to minimize $(x+y-10)^2$. Solutions for (x,y) include (1,9), (5,5), and (50,–40). All give the identical best OF value of zero. This means that the user can make a choice between solutions, and if one is better than another, then that additional concept of better should be included in the OF statement. Run an optimizer many times from randomized DV initialization values, and if there are different DV* solutions with the same OF* value, then you have underspecified the statement.

Stochastic: Contrasting a deterministic function that always returns the same value for the same input, a stochastic function returns a random value. When we are seeking to optimize within business or future uncertainty, or if the objective function is determined by an experiment, the surface can be stochastic. The probability distribution may be analyzed statistically, but the outcome may not be predicted precisely. Averag-

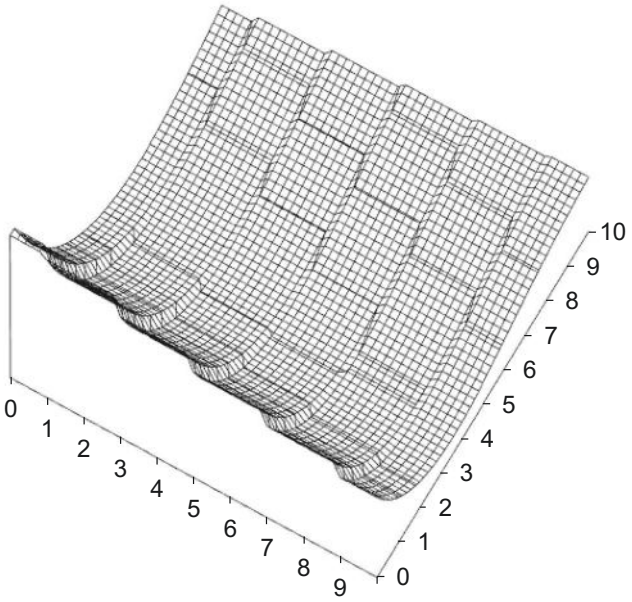


Figure 2b. 3-D detail of the central part of figure 2a.

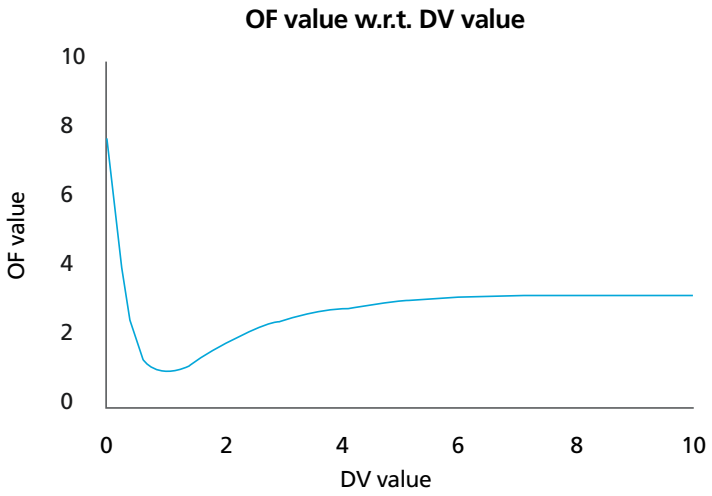


Figure 3. Asymptotic leveling.

ing replicate response values will temper, but not eliminate, the misdirection.

Inflections, saddles, asymptotic leveling: At the minimum, the derivatives of OF w.r.t. DVs are zero. Second-order optimizers seek this point. But they can also be misdirected to points of maximum, saddle points, or to a faraway asymptotic leveling. When using Newton-based or successive quadratic methods, check to see if the solution is a max, min, saddle, or asymptotic extreme. Figure 3 illustrates such a case. The minimum is at a DV value of about 1, but the function asymptotically approaches a constant at DV values of 10 or more. Optimizers that are seeking a point where the derivative is zero often find the high DV values, misrepresenting the solution, or encountering constraints.

Constraints: These may be inequality or equality conditions on DVs, OF, or auxiliary variables. If they are "hard" constraints, they must not be violated. For instance, do not exceed the lower explosive level, or do not ask the computer to take the square root of a negative number. But if they are "soft," a bit of violation is permitted. For instance, keep the level under 80 percent full. Here, a penalty for constraint violation is usually added to the OF. Hard constraints are a confounding barrier to a steepest descent algorithm. It would want to cross over the constraint.

Algorithm classification

Gradient: Gradient-based means that the search logic is based on a model of the slope of the surface. Steepest descent, successive quadratic, and Newton-type methods are of these types.

Direct search: By contrast, heuristic, or direct search methods, use improvement in trial solutions to guide the next trial solution without a mathematical model of the surface. Hooke-Jeeves, Nelder-Mead, particle swarm, and leapfrogging are of these types.

Steepest descent: Steepest descent algorithms take incremental steps downhill. These include many of the direct search algorithms as well as some gradient-based (Cauchy's sequential line search and incremental steepest descent).

Second-order: By contrast, second-order algorithms model the surface with a quadratic surrogate model then jump to the model minimum. These include Newton-like or successive quadratic algorithms. If the application matches the surrogate model, this leap can be very accurate, but second-order methods can jump to absurd locations. Levenberg-Marquardt is one of many approaches that blend the reliable (but slower) steepest descent with the impetuous second-order jump.

Conjugate gradient: To temper zig-zag movement across a ridge or steep valley, this approach uses an average of recent slopes.

Constrained: Constraints might be on the DV, the OF, an auxiliary variable (AV), the rate of change, or a future value. Constraints block the optimizer TS path, and one solution is to convert a constraint violation to a penalty in the OF. This soft constraint can permit a bit of constraint violation, the magnitude of which is dependent on the weighting and functionality assigned to the penalty. Some algorithms search along the constraint. Generalized reduced gradient is one. It linearizes the constraint about the current TS, to permit an analytical solution for the next TS, then relinearize. This too, can permit some constraint violation.

Unconstrained: Classic algorithms (Newton-types) are designed for unconstrained applications.

Single TS: A single TS optimizer evolves that single value with each iteration, and may move to a local optimum, not the global. To solve this issue, the optimization can be redone from many randomized initial TS values to see the distribution of local optima and to increase the chance of finding the global.

Multiplayer: A multiplayer algorithm uses many simultaneous TS points to direct the next player move. Multiplayer

algorithms (particle swarm, leapfrogging, differential evolution) broadly explore the surface, increasing the probability that the global will be discovered.

Interior/exterior point: Linear programming (LP) is a very efficient search. It presumes that the optimal solution is on a confluence of constraints, on the exterior boundary. However, if the optimum is in the interior of the DV range, LP will not find it.

Initialization

If there are multiple optima, one run of the optimizer might find a local, not global optima. If you know the proximity of the global solution, initialize the TS there. Otherwise use multiple runs from random TS initializations and take the best of N trials as the solution. To be c confident that one of the best fraction, f, of all possible solutions will be found, calculate $N=Ln(1-c)/Ln(1-f)$. For example, to be 99 percent confident (c = 0.99) that after N randomized trials at least one result will be in the best 5 percent of all possible results (f = 0.05), $N = Ln(1-.99)/Ln(1-.05) \cong 90$ trials.

Perspective on what is important

Critically important to optimization are aspects of the problem statement: the fidelity of the model and the constraints to the application, handling constraints (method and weighting), and appropriately combining the desirables and undesirables to structure the OF, including uncertainty.

Additionally, as important as the choice of optimizer are choosing a criterion for convergence that makes the answer close enough without excessive iterations, initializing the search perhaps in the proximity of the prior solution to minimize iterations, and ensuring that the procedure is not trapped in a local optimum.

The solution validity depends on those choices. A user should not think that a true perfect solution is found. When you see the DV* and OF* results, reconsider the problem statement. Often, reflection will guide you to alter your choice of "givens," DVs, constraints, models, desirables and undesirables, and convergence criterion. Do not look at optimization as a mathematical challenge-game. Return to the business focus, and see how to remove/diminish constraints, alter the OF, change the givens, restructure the approach, etc. Optimize your optimization exercise!

Matching algorithms to application characteristics

Within any application category or set of characteristics there are many optimization algorithms that are equivalently effective. Criteria for algorithm preference include robustness to surface features, probability of finding the global optimum, simplicity for user setup, number of function evaluations (speed) of finding the optimum, and answer precision. My experience indicates that multiplayer direct search algorithms are generally best, but I understand that convenience of use and familiarity may lead to alternate preferences. Here is a table that matches optimization algorithms best suited to particular application classes. ■

Acknowledgment

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ABOUT THE AUTHOR

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View the online version at www.isa.org/intech/20191202.

RESOURCES

For nonlinear optimization methods:
Engineering Optimization: Applications, Methods, and Analysis
www.wiley.com/en-us/Engineering+Optimization%3A+Applications%2C+Methods+and+Analysis-p-9781118936337

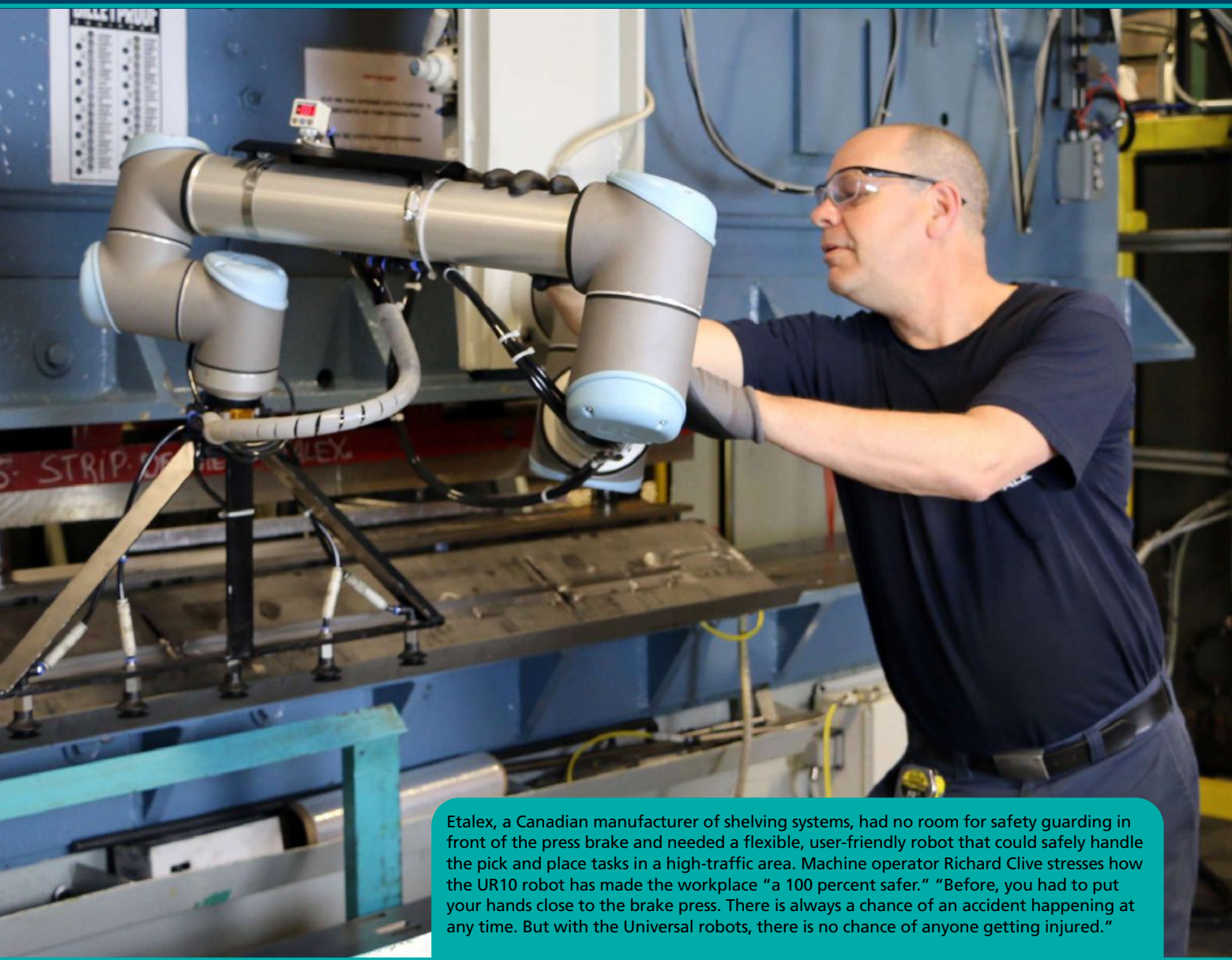
For linear programming techniques:
Introduction to Operations Research
https://www.academia.edu/36556707/Introduction_to_Operations_Research_by_Hillier_10th_Edition

Table 1. Matching optimizer with application

Application attribute	Recommended optimizer
Linear OF response to DV, linear constraints on DV	Linear programming
Quadratic-like OF response to DVs, unconstrained, single optima	Newton-type algorithms, successive quadratic
Nonlinear but smooth OF response to DVs, unconstrained, single optima	Levenberg-Marquardt, conjugate gradient, Hooke-Jeeves, and other single TS direct search techniques
Nonlinear but smooth, with hard constraints, single optima	Generalized reduced gradient, leapfrogging
Discontinuities related to conditionals or discretization, striations, multi-optima, sharp valleys	Leapfrogging (multiplayer) or single TS direct search techniques with multiple starts

Cobots and workers: Better together

By Joe Campbell



Etalex, a Canadian manufacturer of shelving systems, had no room for safety guarding in front of the press brake and needed a flexible, user-friendly robot that could safely handle the pick and place tasks in a high-traffic area. Machine operator Richard Clive stresses how the UR10 robot has made the workplace "a 100 percent safer." "Before, you had to put your hands close to the brake press. There is always a chance of an accident happening at any time. But with the Universal robots, there is no chance of anyone getting injured."

Cobots improve productivity, shifting workers away from dirty, dangerous, and dull jobs

Despite concerns about recessionary headwinds in 2019, the U.S. manufacturing sector continues to outpace much of the rest of the economy. For example, during the first month of 2019, the purchasing manager's index rose to 54.9—well above a reading of 50, indicating continued expansion. Also, in January, U.S. manufacturing added 32,000 jobs, bringing the total number of U.S. workers in manufacturing to 12.84 million, or roughly the same number employed prior to the 2007 recession. This resurgence in U.S. manufacturing employment has helped the U.S. economy to be one of the strongest in the past 12 years. However, this growth comes with challenges.

FAST FORWARD

- Manufacturing automation improves productivity, reduces workplace injuries, and improves employee morale.
- According to the National Safety Council, the total cost of work injuries in 2017 was $161.5 billion.
- One well-documented way to improve safety is automation, including cobots that work hand-in-hand with humans.

Manufacturing by the numbers

The primary challenge facing manufacturers today continues to be their inability to fill open positions, placing a drag on productivity and growth. In late 2018, the National Association of Manufacturers (NAM) issued its latest *Manufacturers' Outlook Survey*, which confirmed that finding skilled workers remains a top challenge for manufacturing executives today.

The Society of Manufacturing Engineers reports 89 percent of manufacturers are having difficulty finding skilled workers. And the situation does not appear ready to improve any time soon. The most recent skills gap study from Deloitte and the Manufacturing Institute—NAM's social impact arm—projects more than half of the 4.6 million manufacturing jobs created over the next decade will go unfilled.

While filling open manufacturing positions is the first challenge employers face, keeping them in those positions is a close second. Quitting and changing jobs is the primary cause (32.6 percent) of manufacturing workers changing positions in 2018, and more than 115,500 manufacturing workers and 17,000 warehouse workers missed workdays due to injuries, with direct and indirect costs that can match or exceed losses in production capacity. In fact, the American Society of Safety Engineers estimates that indirect costs of a worker injury are up to 20 times greater than direct costs.

Direct costs are more obvious, such as medical expenses and lost production, but indirect costs can affect the bottom line even more. These include hiring temporary workers, opportunity loss, the blow to morale resulting in wide productivity losses, and additional administrative burdens to manage an employee's return to work.

The cost of workplace injury

According to the National Safety Council (NSC), the total cost of work injuries in 2017 was $161.5 billion. This figure includes both direct and indirect losses, including wage and productivity losses of $50.7 billion, medical expenses of $34.3 billion, and administrative expenses of $52.0 billion. This total also comprises employers' uninsured costs of $12.4 billion, including the value of time lost by workers other than those with disabling injuries who are directly or indirectly involved in injuries. Further contributing to that $12.4 billion is the cost of time required to investigate injuries, write up injury reports, and so forth.

The $161 billion in work injury costs during 2017 is the equivalent of $1,100 for every employed worker in the U.S. More than 104 million workdays were lost due to workplace injuries ($70 million) and fatalities ($34 million). This is in addition to the $95 billion that U.S. companies pay annually in workers' compensation insurance. Bringing these national numbers down to the individual incident, the NSC estimates that the average direct and indirect cost of a workplace injury was $39,000 in 2017, and the average work-related fatality costs were an average of $1.15 million.

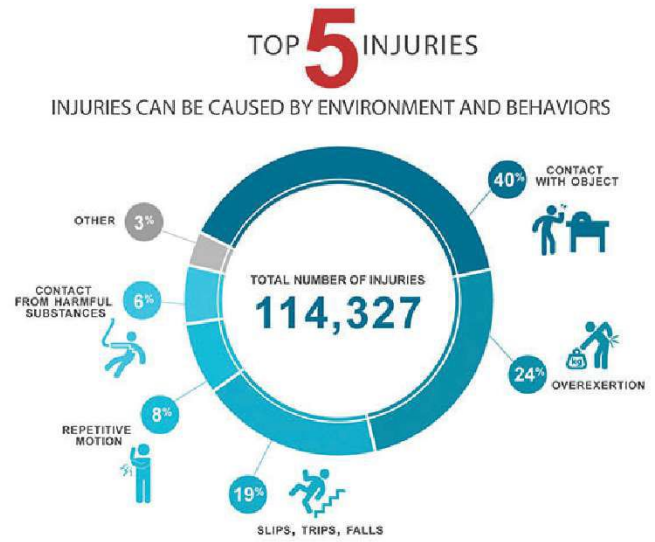
While the numbers above represent U.S. employment as a whole, a deeper look into manufacturing reveals the sector is outperforming the general economy in job growth as well as workplace injuries and associated costs, thanks to the nature of the work and the aging manufacturing workforce.

Make or break? A manufacturing tale

The U.S. Bureau of Labor Statistics (BLS) places the majority of manufacturing and warehouse workers into a single occupational group: installation, maintenance, and repair. This group includes industrial machinery and millwrights; electrical and electronics installers and repairers; and general maintenance workers. In 2016, the manufacturing industry accounted for 394,600 work-related injuries—second only to health care and social assistance, including police and fire, according to the BLS.

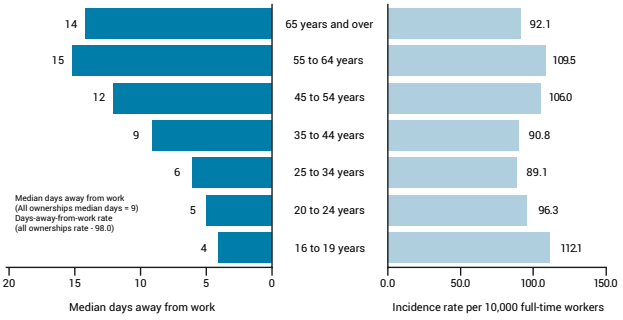
At an average cost of $39,000 per injury, the manufacturing industry lost more than $15 billion in 2017 in direct and indirect costs due to workplace injuries. Although fatalities thankfully were far fewer in incidence, the tragedy of losing 335 first-line supervisors of production

Workplace Safety for Manufacturers



Sources: 50% & Key Concern = Travelers IndustryEdge® Survey 2012; 38% = Bureau of Labor Safety Statistics 2011; Injuries = National Safety Council Injury Facts® 2013 Edition.

Median days away from work due to injuries and illnesses and incidence rate by age of worker, all ownerships, 2017



Median days away from work is a key measure of the severity of injuries and illnesses resulting in days away from work. Half of the cases involved more days and half involved fewer days than the specified median. Workers 55 to 64 years old required more time to return to work than workers in other age groups and their incidence rate was among the highest in 2017.

At Aircraft Tooling, a Texas-based repair center for the aviation industry, a UR10 has taken over the metal powder and plasma spray processes, dirty and potentially hazardous tasks for human operators. The company was surprised to find that their Universal robots could withstand the high temperatures and harsh environment.

equipment and 330 laborers, warehouse, and material handlers between 2003 and 2016 cannot be overestimated.

An aging manufacturing workforce further complicates the problem. According to NAM, workers between the ages of 55 and 64 account for up to 27 percent of the manufacturing workforce today. When older workers are injured, they average three times as many days away from work as their younger counterparts, missing an average of 15 days per injury versus five days for workers in their 20s, or six days for those in their 30s.

All of these numbers add up to one conclusion, amidst a labor shortage that is constricting the availability of skilled workers: on-the-job injuries place a heavy toll on manufacturers, both financially and operationally.

Automation: The safe solution

One well-documented way to fill the manufacturing labor gap and shift workers away from dirty, dangerous, and dull jobs is the use of automation, including robots and "cobots." A cobot is a "collaborative robot" that—unlike traditional industrial robots—can work hand-in-hand with humans without posing unacceptable risks of injury.

Cobots tend to operate more like humans, working at human pace and capable of lifting payloads similar to a human worker. Traditional industrial robots, in comparison, move faster and have more power, which can pose a significant threat to unprotected human workers, often necessitating fencing and additional costly safety precautions.

The top five types of workplace injuries include contact with harmful objects (40 percent), overexertion (24 percent), slips and falls (19 percent), repetitive motion (8 percent), and contact with harmful substances/chemicals (6 percent). According to studies by Travelers Insurance, manufacturing automation—and cobots in particular—can help reduce or eliminate three out of the five leading causes for workplace injuries: contact with harmful objects, heavy lifting, and repetitive stress injuries, essentially reducing the incidence of workplace injuries by up to 72 percent.

Although most automation projects today look to productivity improvements to justify their cost, it is easy to forget that robots were originally developed as tools to take over the less desirable tasks on the line. Unlike "dumb" automation that cannot sense and react to its surroundings, advanced automation, such as cobots, can protect more workers in applications that were beyond the ability of traditional robots or production equipment.

Unlike traditional robots that require engineer-level programming, however, cobots are designed to make programming simple through human-machine interfaces (HMIs) familiar to anyone who has used a smartphone. With advances in artificial intelligence algorithms, cobots are also capable of learning on the job. Often, a worker can reprogram a cobot simply by putting its arm through the desired motions; the cobot remembers the instruction and repeats it independently, without the need for new code.

By eliminating the need for a formal education in programming or robotics, such interfaces and capabilities make the skills gap and learning curve for using cobots diminishingly small. This also greatly reduces the time, effort, and cost associated

with retasking a cobot for temporary tasks or burst production during busy seasons.

Taking over the factory's most repetitive and strenuous tasks means cobots not only help reduce injury, they also help human workers upskill to more complex roles, such as programming and maintaining the cobots, which can significantly improve employee morale.

Industrial robot work cells often require costly and time-consuming factory customization, but a cobot's flexibility translates to a significantly faster return on investment (ROI). By speeding deployment with minimal disruption to a factory layout, and by enabling minimally trained workers to safely program and use the technology to multiply productivity and improve quality, cobots' payback is often measured in weeks or months. (See www.universal-robots.com/case-stories for more details.)

This fast ROI is not just a function of cobot technology's lower capital cost versus industrial robots. It is enabled by cobots' ability to multiply the value of an enterprise's human assets, freeing workers to tackle higher productivity processes and acquire new skills for a modern manufacturing age.

These productivity gains, along with the inherently safe design of cobot solutions, mean this new automation technology can realistically reduce up to 72 percent of the common causes of injury in manufacturing environments. Cobots do not come to work tired or sick; they always do as they are told without complaint—including performing every safety check; and they are not affected by repetitive and potentially dangerous tasks like machine tending, welding, and assembly. By combining productivity and quality gains with safer workplaces, cobots will be an important component in the solution to the manufacturing labor gap today and tomorrow. ■

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RESOURCES

American Society of Safety Professionals
www.assp.org/advocacy/roi-of-safety

Get Started with Cobots
www.universal-robots.com/ebooks

U.S. Bureau of Labor Statistics
www.bls.gov

At EVCO Plastics in Wisconsin, the cobots work right alongside the employees on the packaging line, taking over the most arduous lifting and placing of parts into boxes. "Eliminating the labor cost allows us to run basically two jobs for the cost of one cobot, so the payback comes quite quickly that way," says Bernie Degenhardt, automation manager. "Adding to the quick payback are also savings on workers' compensation insurance, which is a big deal. The cobots help reduce any kind of repetitive strain injuries, so we actually get a lower rate, which is a huge cost savings to us."

At Taiwanese injection molder BTC Mold, the UR cobots have lowered the occupational hazard risks, creating a workplace that is friendlier and safer. Before, workers had to repeatedly bend over to pack boxes with shoehorns, one of the many ergonomically unfriendly tasks now taken over by the cobots.

At T&W Stamping in Ohio, employees have a new type of colleague working side-by-side with them, as the UR5 arrived to tend the resistive welders. Operator Frank Fowler once welded the brackets by hand, a tedious and ergonomically unfriendly task. Now he is programming the robot and is in charge of product inspection.

Integrating production planning using APC and other technologies

By Simon Rogers

Advanced process control can deliver value chain optimization by integrating various types of production planning in the hydrocarbon process industry

The hydrocarbon industry, like many other process industries, has typically optimized its value chain using a siloed approach for supply chain planning, production planning, production scheduling, process control, production accounting, and other business processes.

With a siloed approach, each of the individual business processes has a limited view of the complete value chain, and each optimizes decisions according to its view. This typically results in nonoptimal performance due to the lack of a holistic view and integration.

For example, those involved with operational planning often have poor knowledge of actual plant conditions, use linear models with a limited range of validity, and employ a time-consuming updating and correction process. In addition, the logistics are not generally considered.

Production scheduling also usually happens with a limited knowledge of actual plant conditions, and optimal plans are not implemented due to logistics constraints and limited optimi-

zation capability in the scheduling system. This leads to limited economic consideration in the creation of the production schedule.

Operators often do not update advanced control strategies based on schedule changes, and they have little or no knowledge of intermediate feedstock pricing.

Production accounting must often rely upon poor quality source data, and a largely heuristic and manual reconciliation process, with the resulting information not being used effectively in the other business processes.

The solution to these and other value chain optimization issues is to change the focus from siloed optimization to an integrated approach. This article describes how to implement such an approach in general, and then examines a number of opportunities to use the latest digital technologies to support this integration.

FAST FORWARD

- Data exchange among business units often requires extensive, even manual, efforts by plant personnel.
- Digitalization and automation address these issues, enabling integrated production planning using APC and other technologies.
- Value chain optimization in the oil and gas industry can be significantly improved using a combination of knowledge graphs, rigorous models, and artificial intelligence.

Leaders use an integrated approach

An integrated approach to planning should be used to automate and increase the speed of decisions. Figure 1 depicts some of the main components of such an approach, with data and analysis results continuously and rapidly transferred among different business processes and organizations.

Unfortunately, most organizations do not operate in this manner, and instead use manual optimization processes. They also rely too heavily on limited resources, particularly their skilled subject matter experts (SMEs), who are always in short supply.

The linear models used in production planning have a limited range of validity, restricting their accuracy. Updating and synchronizing each of the tools used in production planning, scheduling, accounting, and process control and optimization is time consuming and relies on SMEs.

There is a largely heuristic data reconciliation process, which is also time consuming and introduces many opportunities for errors. Data is siloed and difficult to manage, with manual processes slowing data exchange efforts. There is often delayed or no recognition by operations of opportunities to expand constraints.

Data-driven optimization addresses these and other issues in a predictive rather than a retrospective fashion. This creates opportunities to expand the optimization envelope by challenging perceived constraints. These opportunities can be addressed by:

- Improving data quantity and quality using first principle models to reconcile data and calculate unmeasured variables.
- Using machine learning (ML) to perform multivariate analysis of planning, simulation, and measured data.
- Automating and simplifying the use of first principle models.
- Diagnosing performance on the basis of past experience.
- Using knowledge graphs to manage and visualize information.

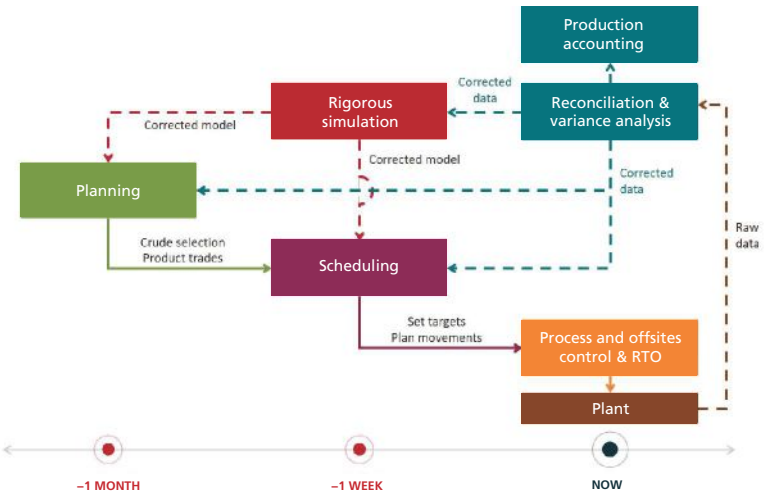

Figure 1. An integrated approach uses simulation and other tools to closely coordinate actions among the business units responsible for process industry operations.

By combining first principle simulation and machine learning, it is possible to:

- Automate data reconciliation and production accounting.
- Automate the comparison of measured, simulated, planned, and optimal key performance indicators (KPIs).
- Analyze changes in the KPIs over time to reveal improvement opportunities and determine when to update models.
- Combine synthetic and measured data in the generation of ML models.
- Automate the calibration of simulation models.
- Automate the generation of planning and scheduling models.
- Use refinery-wide simulation models to evaluate improvement ideas.
- Investigate and implement worthwhile ideas via management of change.

The following examples show opportunities to use artificial intelligence (AI) to improve value chain optimization.

Use case 1: Value chain knowledge graph

Knowledge graphs are the underlying technology used to support web search and digital assistants. Enterprise knowledge graphs are increasingly being used to structure and integrate information to support natural language programming. In many organizations, value chain optimization is split among different business units, each with a limited view of the overall activities. Value chain data is in different databases, spreadsheets, and other unstructured documents—creating data silos with poor integration.

Nonlinear programming can be used to extract valuable knowledge and metadata from the various sources of value chain data. Knowledge graphs can then be employed to manage, integrate, and visualize value chain information.

The knowledge graph in figure 2 shows the connections between information, and it provides a comprehensive and holistic view of the value chain. It can be used to improve the optimization and management of the value chain in real time and improve risk management. The knowledge graph can also be used to structure historical improvement opportunities, and to assist in identifying opportunities for improving value chain optimization using cognitive analytics.

Use case 2: Demand forecasting

Feedstock, product prices, and product demand are increasingly volatile. Optimization of the value chain often relies upon poor price and demand forecasts and is therefore suboptimal.

ML can use more historical data and a wider set of data to improve the forecast of prices and demand. High-performance computing and AI allow the optimization of multiple scenarios to reduce risk and increase the robustness of the plans.

Historical data can be used to determine the inputs that have the most impact on the demand, such as the season, and overall economic conditions as indicated by GDP, prices, and competition. A predictive model can be created with minimal error, and these predictions can be used for multi-period optimization of multiple scenarios.

Use case 3: Retrospective analysis

Planners within the organization want to look at expected market conditions and propose production plans to maximize profit. An event-based schedule meets the day-to-day plan targets as closely as possible given the logistical constraints.

Due to changes in market conditions, model mismatches, or unexpected events, the final operation often differs significantly from the expected plan. Better models and more robust plans can reduce the impact of unexpected events and reduce the gap between the plan and schedule.

Machine learning can be used to perform multivariate analysis of historical plans, schedules, and actual operations to identify and reduce repeating patterns of discrepancies. Recurring active constraints can be tracked, and rigorous refinery-wide models can be used to identify which ones would lead to a significant economic impact.

The ML analysis of plan versus actual can also identify when it is necessary to improve the planning and scheduling models, which are a simplified and often linear approximation of a more rigorous model. These linear models result in artificial constraints and do not reveal all optimization opportunities.

The models require periodic regeneration to account for changes in plant performance. Maintenance and recalibration of these models is time consuming and requires a high level of involvement from process specialists.

Artificial intelligence can be used to automatically detect when the models need to be regenerated and to automate the calibration of the first-principle, physics-based models, along with the generation of simplified planning models.

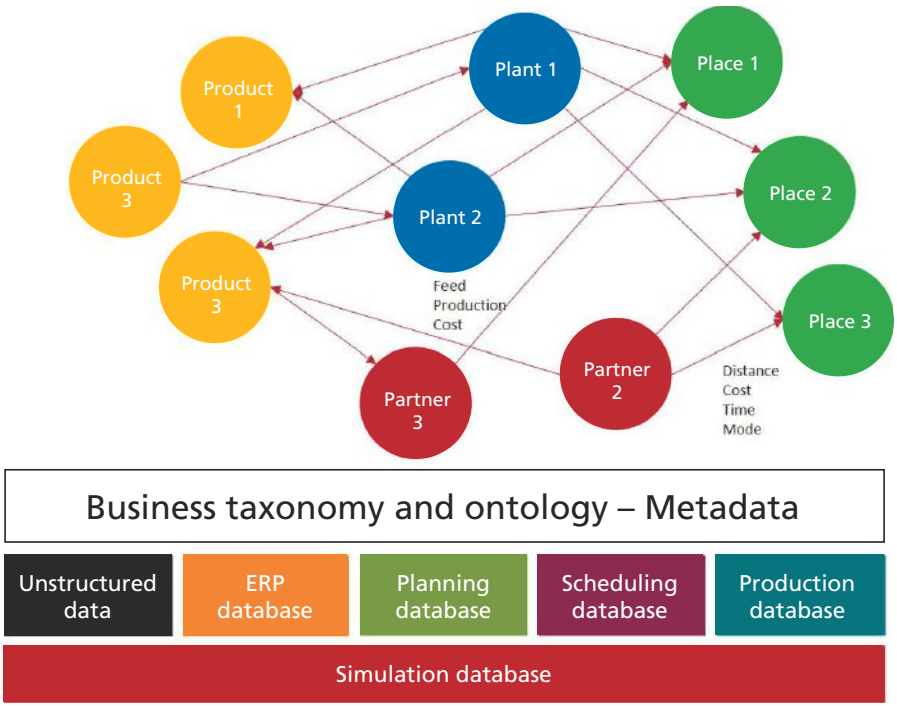

Figure 2. Knowledge graphs can be created to show the required relationships among various business units, along with expected results from improving interactions.

RESOURCES

"Why bother with a digital twin?"
www.isa.org/intech/20190803

"Digitalization delivers value"
www.isa.org/intech/20190603

"Optimizing related process variables to improve profitability"
www.isa.org/intech/20180602

Use case 4: Automated scheduling using AI

Generating a production schedule from a plan is an intractable mixed-integer nonlinear optimization problem. Current production scheduling practices use multiblend optimization for crude and product recipes, along with event-based simulation.

As a result, scheduling is an iterative trial and error, manual process. Schedulers have limited time to analyze discrepancies between actual and expected opening inventories, and to then optimize the schedule or investigate alternative schedules and scenarios, resulting in a suboptimal schedule significantly different from the plan.

Historical operation and scheduling data can be used with ML to identify the likely cause of inventory discrepancies, improve the daily production accounting process, and adjust the schedule baseline. AI can also be used to automate the scheduling process itself by analyzing the constraint violations (e.g., tank levels or product qualities) in the simulated schedule, and to then update the schedule tasks to alleviate the constraints while minimizing the deviation from the plan. Figure 3 illustrates this methodology in more detail, showing the progression from baseline updates and initial discrepancies to the assignment of shipments.

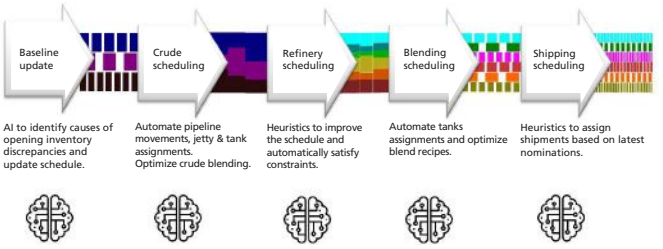

Figure 3. Production scheduling can be automated by linking the business units responsible for baseline updates, and for the scheduling of crude, refinery, blending, and shipping operations.

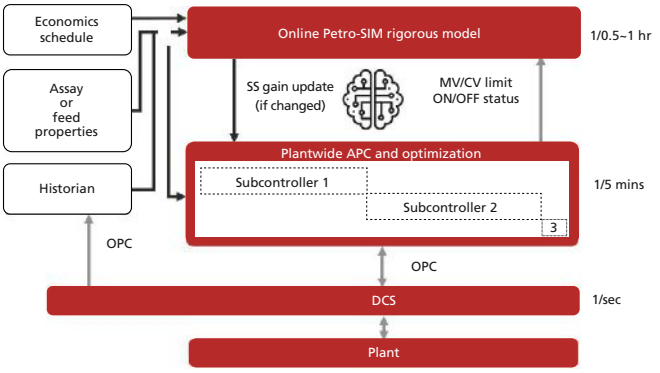

Figure 4. Plantwide optimization requires coordination among various APC and other automated controllers.

Use case 5: Plantwide optimization

In many cases, advanced process control (APC) objective functions and constraints are not routinely updated, and individual unit APC applications typically operate independently with no coordination between units. APC models are only optimized within the operating envelope used during the initial step testing.

It is possible to use dynamic real-time optimization to combine multiple APC applications, allowing the operation of upstream units to adjust to constraints in downstream units. Online rigorous models can provide additional inferential inputs to the APC and update the gains used in the APC models in real time (figure 4). In addition, it is possible to automate the download of the objective functions and targets from the scheduling system to the dynamic real-time optimizer.

As demonstrated by these use cases, value chain optimization can be significantly improved using a combination of a knowledge graph, rigorous models, and AI. The goal is integrated optimization of the entire value chain, leading to significant increases in profitability. ■

ABOUT THE AUTHOR

Simon Rogers is the head of the Advanced Solutions Division at Yokogawa Electric Corporation. He has more than thirty years of global experience in the use of information and control technology to improve the safety, sustainability, and efficiency of the process industries. Rogers holds a BEng degree in chemical engineering from Imperial College, London.

View the online version at www.isa.org/intech/20191204.

OPC UA:

The United Nations of Automation

A global standard for industrial interoperability with common data models

By Stefan Hoppe

OPC UA is a framework for industrial interoperability based on data models that provide a syntactical definition of information that can be communicated with virtually any communication methods, including modern industrial protocols, Ethernet, cellular, and wireless. Device and machine manufacturers describe the object-oriented information of their system and also define the access rights with integrated information technology (IT) security. International security experts have proven this end-to-end, built-in-by-design security with very positive and transparent results. Data producers, like machine builders, thus remain in control of their data and can distribute it in a targeted and controlled manner. They thus also participate in big data and the analysis of their data to achieve increased efficiency and performance, yielding greater manufacturing and production profits.

Information modeling

There are many protocols, but OPC UA's goal is common information modeling that can be used throughout automation systems to achieve seamless interoperability. The actual key for digitalization lies in the meaning and description of the data, and OPC UA provides a framework and standards for information modeling. Unconsciously, every equipment and machine manufacturer today provides an information model. Data and interfaces are already available (via various protocols). We humans have adapted to the way computers "think" and have created documentation about the meaning behind the bits and bytes and hex codes. The new world of devices enabled by service-oriented architecture (SOA) now helps humans understand "things" faster and easier, because these "services," above all, offer their meaning.

The subject of SOA is not new in the IT world—but now SOA is moving into the "things" themselves. In the next step, it would be pleasant if different manufacturers who supply the same devices also agreed on the same data and services. The integration of these devices would be much easier and would provide a plug-and-play solution. This is exactly what the OPC Foundation, with many partners, provides in the joint creation of standardized information models (Companion Specifications).

Before a device and machine builder starts, it should check whether a standardized information model already exists. This interoperability is demanded by more and more operators from different areas of the factory and process industry, but also from the energy or logistics industry—OPC UA has even found its way into industrial kitchen equipment (Association HKI).

Membership growth unabated

A few years ago, the OPC Foundation was still a meeting place for technology experts, but today, the global association is welcoming an increasing number of new members from the OPC-UA user community. The number of affiliated companies is rapidly growing. Currently, the list of OPC-UA members amounts to more than 700 globally. It is very gratifying to see that more and more end users are turning to the Foundation. Companies such as Volkswagen, Foxconn, Samsung, Miele, and British American Tobacco from factory automation, but also Equinor, Exor, Exxon Mobil, and Bayer from process automation are demanding the functionalities of OPC UA in their automation environments. They are thus pushing the development of topics with a strong background and sometimes at breakneck speed. For example, the first, more intensive contact with Volkswagen took place in 2017. After becoming an OPC member in 2018, the company hosted an OPC Day Automotive in spring 2019 with over 300 participants in their headquarters in Wolfsburg, Germany.

Their goal is to influence the direction of specifications to make sure technology brings real value for their needs in factories. The OPC Foundation is where all automation manufacturers and also chip vendors like Intel and NXP or IT companies like Microsoft, SAP, and Cisco meet to cooperate on common standardizations. Connecting a machine or a device within minutes to their systems with standardized data and interfaces and integrated security proven by international experts are unique selling points. This helps to achieve plug and play and simplifies industrial automation installation, commissioning, and production startups.

In summary, the OPC Foundation is the United Nations of automation. Companies meet on neutral ground with rules, transparency, and openness. The board of directors is democratically elected by members (not influenced by money); sample code and specifications (once released) are publicly available; and certification is a (paid) service for nonmembers.

Security at all levels

OPC UA offers integrated security from the ground up. An analysis by the German Federal Office for Information Security (BSI) underlines that this is much more than just a marketing slogan. The BSI experts have intensively studied the specifications and stack implementations of OPC UA and concluded that OPC UA offers a high degree of security. All security methods are available!

FAST FORWARD

- OPC Foundation is an open, transparent, and neutral platform—acting as the United Nations of automation.
- OPC UA is much more than just a protocol—it is a framework for industrial interoperability with common data models.
- OPC Foundation is protocol agnostic, creating standardized data models and interfaces in joint working groups with collaboration partners across the world.

Service-oriented architecture (SOA) is a style of software design where application components provide services to the other components, through a communication protocol over a network. The basic principles of service-oriented architecture are independent of vendors, products, and technologies.

However, these methods must be implemented comprehensively and above all correctly by the users. Even the best lock in the world is useless if it is not locked or the key is not easily accessible.

Evolution: Combine technologies to cover more applications

The OPC UA framework is similar to a modular system of Lego bricks that can be extended. It is not a revolution, but is normal technology development to combine existing technologies and use their strength for new applications:

- In 2007, OPC UA started with the client/server communication architecture based on Transmission Control Protocol/Hypertext Transfer Protocol Secure (TCP/HTTPS) without any break in compatibility.
- In 2014, an additional communication scheme, "Publisher/Subscribe," was launched to enable and optimize OPC UA for one-to-many, many-to-one, or many-to-many system configurations. Specifications and validation with prototyping led in February 2018 to the release of v1.04 with User Datagram Protocol (UDP) for faster real-time communication on premise and Message Queuing Telemetry Transport/Advanced Message Queuing Protocol (MQTT/AMQP) as transport for cloud applications. OPC UA data models can be used with any transport and protocol, for example MQTT.
- In 2015, the Time Sensitive Network (TSN) working group with more than 85 members was founded as a subgroup of the OPC UA core team. This project will add a transport mapping from OPC UA Pub-Sub to Time Sensitive Networking. Based on this mapping, deterministic data exchange between UA applications will be possible once TSN is finally specified and operational by IEEE/IEC. Also on the radar is 5G wireless. Fifth generation wireless systems will offer better performance and determinism—mapping Pub-Sub to 5G protocols is considered similar to TSN mapping, ideally with the same or similar configuration interfaces.
- In February 2018, a new group, "Safety over OPC UA based on PROFISafe," was formed to enable functional safety over OPC UA via client/server and Pub-Sub communication. Today, the group "Safety of OPC UA" is combined in the Field Level Communications (FLC) activities.
- In November 2018, the FLC initiative was formally launched and is now supported by 25 companies providing additional financial and human resources. The aim of this initiative is to extend OPC UA to all relevant industrial automation applications for process and factory automation, including deterministic, safety, and motion.
- In the future, the Advanced Physical Layer (APL) will be combined with OPC UA to provide small devices in process automation, such as flowmeters, with a single cable for power, and to transfer secured data in standardized format directly from data source.

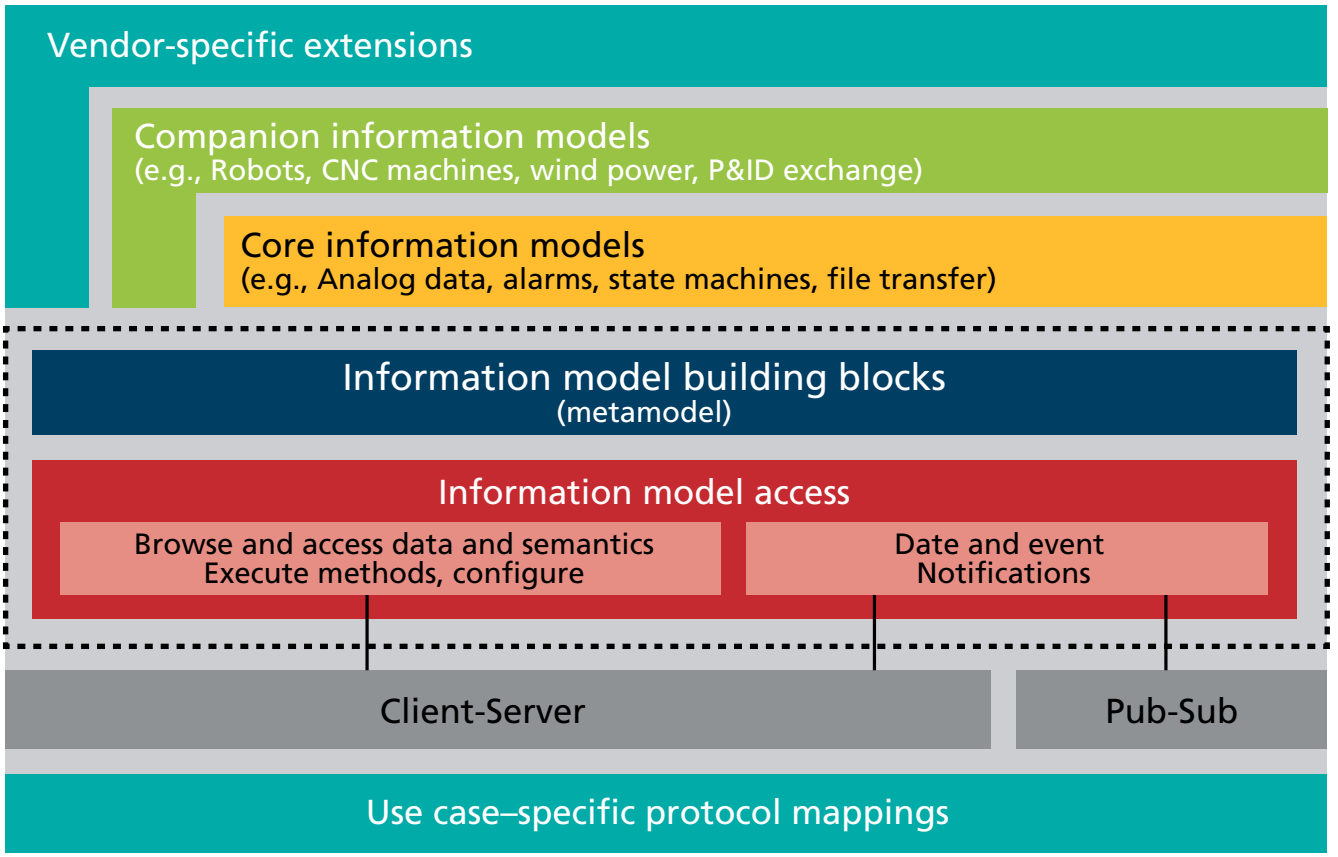

Figure 1. Architecture of OPC UA

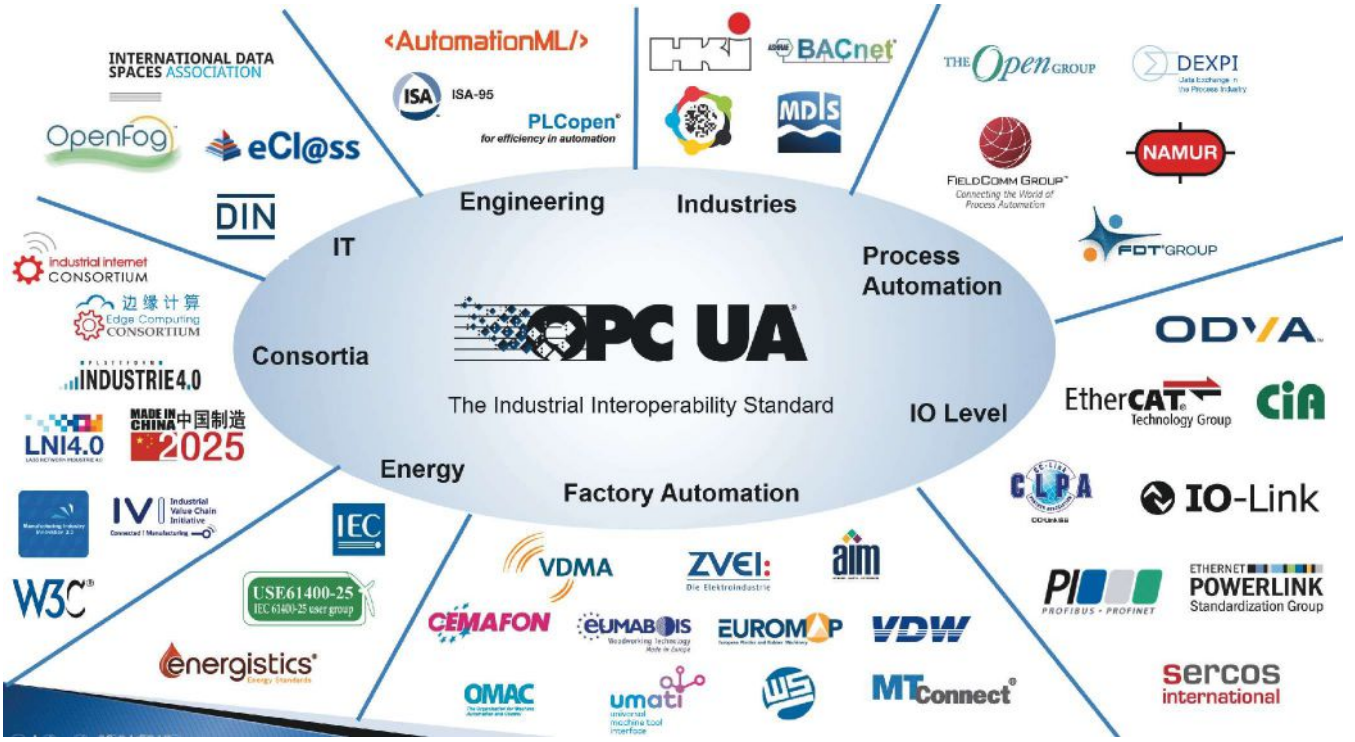

Figure 2. OPC Foundation has a wide range of collaborations with more than 50 today that include process automation, factory automation, energy, engineering, industrial kitchen equipment, and IT standards groups.

Information is key: Companion specifications

One perfect example is the first global OPC UA Machine Vision Companion Specification, as this has been the first OPC UA Companion Specification developed via close international collaboration between multinational machine vision–related standards bodies, including the American AIA, Chinese CMVU, European VDMA and EMVA, and Japanese JIIA. This "big thinking" aligns well with a key OPC Foundation focus on encouraging organizations to work together to reduce the vast number of overlapping "custom" information models into a harmonized set of OPC UA Companion Specifications that will benefit end users and vendors around the world by lowering the barriers to true interoperability.

For equipment suppliers, meeting this type of industry standard does not automatically mean they become exchangeable, as each manufacturer can offer its own special services on top of the standard. Intelligent devices should definitely be able to support multiple information models simultaneously—for example, the dedicated functionalities of an injection molding machine, in addition to the models for energy data or manufacturing execution system (MES) interfaces.

Leading programmable logic controllers (PLCs) can load the machine with understandable information models and expose standardized data and interfaces to the outside world quickly. To reduce the engineering effort, the importance and availability of such industry-specific and multi-industry information models will increase rapidly in the future. It is the key for Industrie 4.0 (also known as Industry 4.0).

Harmonizing cross-domain information models

With the increasing success of the implementation of OPC UA, new challenges arise. In addition to the Companion Specification (e.g., the AutoID industry), each industry sector has its own information model—from oil and gas to the process industry and robotics. The application of OPC UA reduces engineering costs in every sector. The fact that the VDMA (the Mechanical Engineering Industry Association, Europe's largest industry association with 38 trade associations in the mechanical engineering industry) has the topic OPC UA on its agenda in 17 working groups today (and more are on the road) alone shows the current significance of this universal communication model.

This dynamic development creates new challenges for the OPC Foundation. The multitude of defined specifications leads to duplication in some places. The subject of asset management, power management, or firmware updates can be found not only in the machines used in the process industry, but also in robotics or on an oil drilling platform. To meet this requirement, the OPC Foundation established as an important next step a cross-domain harmonization group for the comprehensive modeling of information models within the OPC Foundation. What is now necessary, for example, has been demonstrated in the AutoID industry by merging

"With OPC UA at the heart of Industrie 4.0, adopting the OPC UA technology and using it to its full potential in our factories is a natural progression. Being a member of the OPC Foundation guarantees early information to upcoming key technologies like the OPC UA Companion specifications, which provide secured and standardized information and interfaces for assets," commented Michael Schweiger, account and demand manager, on Volkswagen joining the OPC Foundation.

within a sector and developing a sector-wide Companion Specification.

The next step in interoperability is to examine where similarities exist between the specifications in other areas in order to minimize these overlaps. The aim of this cross-group work within the Foundation is to transfer global data, for example from an MES or energy interface, to a generally available repository one level higher. This will prevent each working group from independently defining data types for identical applications. The outlook for this cross-domain harmonization is a glimpse into the future of the Foundation and at the same time, the greatest challenge (started in July 2019)—one that will definitely not be completed within a year but will be an ongoing process.

As a first fantastic result, all data types and interfaces of all OPC UA specifications and all Companion Specifications are available online in a reference (https://reference.opcfoundation.org/v104).

End-to-end eliminates vulnerabilities

The OPC Foundation and its members are deeply and firmly committed to end-to-end encryption and have not detected any weaknesses in OPC UA that could pose a security risk. The end-to-end functionality is precisely the feature that OPC UA has been using to stay ahead of other systems, such as some broker-based communication. The OPC Foundation has integrated three different security levels into the UA technology, one of which is end-to-end encryption from the sender of the message to the recipient of the message. This approach has proven to be very robust.

According to the BSI, the disclosure of the OPC UA source code is a further factor in this security robustness. The open source approach enables security experts to gain detailed insight and detect vulnerabilities. For example, the security company Kaspersky has made a valuable contribution to a sample code to demonstrate the high security level of OPC UA. This transparency gives the industry that uses it confidence. The OPC Foundation is aware, however, that with all the security features of UA technology, communication is just one piece of the puzzle in an overall solution. If the underlying hardware is backlogged at the chip level, as was often the case with the media in 2018, then even the best and most secure software is powerless. The Foundation must therefore trust in the security of the hardware.

Neutrality leads to UN comparison: Committed to independence and neutrality

The Foundation is 100 percent independent and cannot be dominated by a single company. There is no risk, for example, that the world's two largest automation companies will take the helm and steer the Foundation according to their will. The voice of a small company is just as important as that of a global corporation. This independence, along with the transparency of the open source solution of UA technology, is the Foundation's greatest strength—and, at the same time, the only way to achieve worldwide acceptance among companies from a wide variety of industrial sectors.

Nevertheless, the Foundation's work is not unaffected by global politics and politically initiated economic developments. Like any other association or alliance, the OPC Foundation registers global developments and moods. The Foundation needs to be vigilant and very careful in observing and analyzing the significance this can have on the Foundation's work and objectives. From the Foundation's point of view, it is tremendously important to involve as many companies from as many countries as possible, in order to stick to the idea of a universal, globally usable standard. ■

ABOUT THE AUTHOR

Stefan Hoppe (stefan.hoppe@opcfoundation.org) has been the OPC Foundation president since the end of 2018, coordinating the OPC expansion into the Internet of Things and Industrie 4.0. Hoppe was previously the global vice president and the president of the OPC Europe organization and was the catalyst for initiating liaisons with other industrial consortiums that have resulted in OPC working groups developing companion specifications for the organizations respective information models. Hoppe studied electrical engineering at the Technical University of Dortmund, Germany. Since 1995, he has worked for BECKHOFF Automation. In 2007, he offered the world first OPC UA enabled product: an OPC UA Server integrated into the company's embedded PLC controllers.

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RESOURCES

"Roadmap of OPC UA"
https://opcfoundation.org/opcua-roadmap

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Connected applications: When IIoT meets software

The benefits possible when OT and IT organizations cooperate can be found where domains cross

By Alan Griffiths

As the drumbeat for digitalization continues to get louder, industrial operational technology (OT) and enterprise-level information technology (IT) departments are learning to speak each other's language. The necessity of transitioning from analog signals and manual processes to "connected plants" and "smart manufacturing paradigms" is becoming apparent. So is the need for help.

The benefits possible when OT and IT organizations cooperate can best be found in specific applications related to the Industrial Internet of Things (IIoT) and digitalization. The basic components of the IIoT have been effectively deployed for many years in industries such as process manufacturing and power generation and distribution. The Internet, cloud computing, analytics, and new software tools are now making IoT feasible for many other industries and new areas of application.

Connected applications have become the new place where IIoT and digital transformation service providers can differentiate themselves and grow. Users who understand who these providers are and where they are coming from can find the best partners for their organizations.

Most IIoT solution providers currently offer either IoT technology (e.g., platforms, cloud hosting, analytics) or digital transformation services, and many implementations are just pilot projects. But many leading enterprise software providers are focusing on connected applications: packaged software that is more attractive to users, as it is easy to install and delivers clear business value. These industry-focused, connected applications generally fall into nine market areas (shown below).

Connected application areas: Cambashi research reveals that leading OT software providers are focusing on "connected applications" that fall predominately into nine key categories:

- Connected Production
- Connected Transportation
- Connected Asset
- Connected Product
- Connected Infrastructure
- Connected Supply Chain
- Connected Worker
- Connected City
- Connected Building

Sorting software providers

Let's look at some of the main, global, software providers leading the charge into this new area of connected applications. They fall into two broad groups:

- IT companies provide enterprise-level systems. We have included within this group engineering technology (ET) firms that offer computer-aided design/computer-aided manufacturing (CAD/CAM), product life-cycle management (PLM), and similar solutions.
- OT companies provide software to control operations at the factory, field, and distribution levels.

Both groups use IoT technology to develop software applications, and so the boundaries are blurring. Increasingly, the terms "IT," "ET," and "OT" relate to the background of the companies rather than the type of software they provide.

The IT, ET, and other enterprise software companies that offer cloud computing, data storage, and enterprise-level solutions fall into four categories.

1. Cloud computing, data analytics, and storage providers. Connected applications require sophisticated IT infrastructure to support them, ranging from cloud storage to distributed or edge computing. This is provided by some of the world's best-known IT companies, such as Hewlett-Packard Enterprise, IBM, and Microsoft, as well as by global cloud-computing platforms such as Amazon (with AWS). Google (with Google Cloud Platform) provides IoT capability, but it is not prominent in IIoT.

IBM has a global cloud network and a range of applications with IoT, such as Maximo Enterprise Asset Management, TRIRIGA Facilities Management, and The Weather Company. PTC's ThingWorx can be integrated with Maximo to provide advanced condition monitoring and anomaly management to identify and schedule necessary service or maintenance work orders.

In addition to offering proprietary products like Amazon AWS, IBM has made strategic moves to embrace open source solutions. Its Cloud Functions are based on Apache OpenWhisk, an IoT-ready platform that executes functions in response to incoming events and IoT sensor data. In a move that signals its commitment to open source, IBM announced late in 2018 its intention to acquire Red Hat software for about U.S. $34 billion, which will enhance its hybrid cloud offering.

Microsoft has successfully embedded Azure Cloud and other tools within offerings from industrial connected application providers. For example, Schneider Electric uses Azure in its EcoStruxure architecture. Rockwell Automation uses it to give manufacturing customers real-time insight into their operations. IFS uses Azure as the backbone for its IoT Connector and analytics. The Microsoft Azure IoT Hub provides cloud capability, development tools, and analytics for the Siemens MindSphere IoT operating system. Microsoft is also working with PTC to integrate ThingWorx with Azure IoT and IoT Hub to improve connectivity and support application development. Amazon's AWS cloud platform and IoT capability underpins many IoT projects and has been adopted by many global corporations.

FAST FORWARD

- Connected applications are the place where Industrial IoT and digitalization can reveal benefits.
- IT/enterprise software and service providers are growing in their ability to help with industrial digitalization and IoT implementations.
- Connected (IoT) applications let users keep their familiar OT user interface and use existing databases and infrastructure from their enterprise system provider.

2. Enterprise resource planning and supply chain management (SCM) providers. Oracle has several connected applications targeted at specific market areas, such as IoT Fleet Monitoring, IoT Connected Worker, digital twin, and AI/ML-based IoT analytics capabilities. Oracle offers the "full stack" for an enterprise solution, from the low-level Oracle Java-embedded technologies at the thing level to its suite of cloud-based connected applications.

This approach leverages the strategic commitment to the cloud that Oracle has already made. It has spent about U.S. $35 billion in the past five years on its own cloud data center network, and more than 1,800 customers are live on its SCM Cloud.

Earlier this year, SAP announced that SAP Leonardo IoT will work with Microsoft Azure IoT Hub for connectivity and device management systems that allow its customers to embed IoT into line-of-business solutions. SAP Leonardo IoT Edge also extends support for business processes that use Microsoft Azure IoT Edge and improves latency, bandwidth, and connectivity.

3. Product life-cycle management providers, including virtual and augmented reality. PTC promotes the concept of "smart, connected products and operations." As explained by CEO Jim Heppelmann, "It is the expanded capabilities of the smart, connected products and the

data they generate that are ushering in a new era of competition, innovation, and novel business models." Rockwell Automation recently invested U.S. $1 billion in PTC in a strategic partnership to leverage resources, technologies, industry expertise, and market presence.

Dassault Systèmes, known as a major CAD/CAM and PLM player at the forefront of digital technology, has IoT within its core offering, bringing together design, industrial automation, and operations management under the 3DEXPERIENCE platform. Siemens and Autodesk—also major CAD/CAM and PLM providers—are discussed below.

4. Building information modeling or management (BIM) providers. Autodesk, one of the largest BIM software suppliers, has a collection of software packages that includes Revit, Civil 3D, Infraworks, and AutoCAD. Autodesk Forge and Microsoft Azure IoT Hub are used to integrate digital models with BIM 360 software to connect and monitor equipment and then use predictive analysis to cut building maintenance costs.

Nemetschek, a global software provider of workflow offerings for buildings, recently acquired MCS Solutions, whose smart building platform COBUNDU uses IoT sensors and big data analytics to optimize productivity and efficiency in occupant experience and service delivery. This will be available under the brand name Spacewell, which becomes Nemetschek's offering in the building operations and management segment.

OT software companies

OT software companies have been providing industrial automation systems, such as manufacturing execution systems (MESs) and supervisory control and data acquisition (SCADA) for many years. OT providers like Bosch and Honeywell have invested heavily in IoT and connected applications, to the extent of restructuring their businesses to gather IoT offerings into dedicated business units. Leading OT software providers include the following companies.

AVEVA and Schneider. In March 2018, the AVEVA group merged with the industrial software business of Schneider Electric. AVEVA's software and presence in capital-intensive industries, such as power, utilities, oil and gas, and mining, combines with Schneider's EcoStruxure IoT strategy to strengthen its range of connected products, edge applications, and analytics.

GE has a long heritage in industrial automation from machine controllers to plant automation. In 2016, GE committed to digital technology. Predix, its IoT platform, uses both Amazon AWS Cloud and Microsoft Azure for cloud capability and cybersecurity. In December 2018, GE announced plans to establish an independent company to include GE's Predix IoT platform, asset performance management, operations performance management, SCADA, MES, power digital, and grid software solutions in a $1.2 billion annual software revenue business.

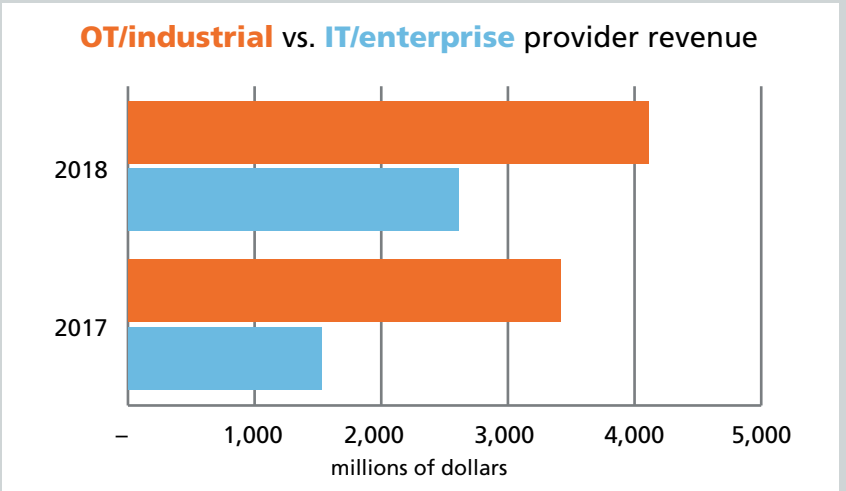
Siemens has a history of blurring the boundaries between the engineering and operational domains. Its new Xcelerator product combines software from electronic design automation to product life-cycle management using the Mendix platform, for low-code software development, and the MindSphere operating system for application support. This allows it to connect a range of devices and enterprise systems and integrate with its portfolio of industrial software for digitalization, including Teamcenter, Tecnomatix, Polarion, Mentor, PLM Components, and Solid Edge.

Siemens MindSphere runs on Microsoft Azure, Amazon's AWS cloud services, and Alibaba Cloud with an ecosys-

Insight from IIoT services provider growth

From the supplier perspective, 2018 was quite a significant year for IIoT. There was a lot of reorganization within supplier companies, and a lot of change taking place. Cambashi analyzed the IIoT and connected applications revenues of OT/industrial and IT/enterprise providers since 2017—our base research year. There is a clear distinction between IT/enterprise and OT/industrial providers. IT/enterprise providers grew by 65 percent in 2018, compared to 30 percent growth for the OT/industrials.

This shows that IT/enterprise providers are making significant advances in their connected application offerings, even though OT/industrial providers started from a higher base value. This is consistent across geographies, where IT/enterprise providers are outperforming their OT counterparts in terms of year-on-year growth. OT and IT providers are both turning their attention to focus more heavily on the Asia-Pacific region.



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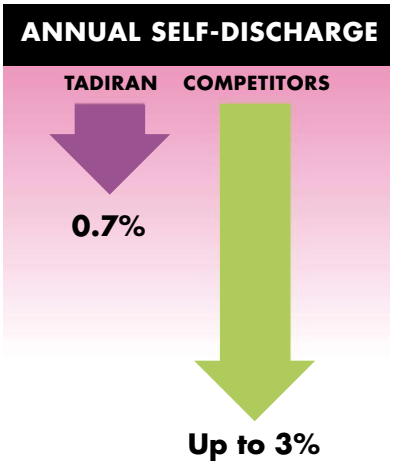

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tem of partners, such as Atos, Bentley, and Flutura, that develop connected applications. In September 2019, Siemens formally announced that it was changing the name of Siemens PLM Software to Siemens Digital Industries Software (within the Siemens Digital Industries operating company).

Cooperation wins

Cooperation is essential in Industrial Internet of Things due to the complexity and breadth of technology involved. There is plenty of opportunity for niche players to partner with software providers and system integrators to provide specialist capability. This gives the user the best of both worlds: a familiar, overarching IT platform (probably from their existing enterprise provider) coupled with specialist capability (such as autonomous control or machine learning) from a niche provider.

There is plenty of opportunity for niche IoT players to partner with software providers and system integrators to provide specialist capability. This gives the user the best of both worlds.

IoT technology providers

The following IT and OT solution providers use IoT technology to build and deploy their connected applications for industry. Most of the major semiconductor manufacturers, such as ARM, Intel, Nvidia, Qualcomm and TI, develop microprocessors or microcontrollers that are used in IoT systems. For example, ARM develops the technology for Cortex-M microprocessors that support most connectivity standards. Nvidia was a pioneer of graphic processor units (GPUs) that turned out to be very effective in neural network simulation and analysis, which is used in machine learning and AI in IIoT applications.

A number of specialized IoT technology providers also exist. They continually develop innovative solutions and, although often deployed via enterprise solution providers, they have the potential to be disruptive agents. For example, AT&T recently announced strategic alliances with both Microsoft and IBM to provide edge computing technology using the 5G network and connect to devices and sensors. Cisco, well-known for providing routers and other connectivity devices, is another innovator in IIoT in the "edge" and "fog" areas.

Some of the pure technology providers will thrive, others may be acquired, and some may find it necessary to move into niche areas to survive. RTI, for example, has decided to specialize in autonomous systems. These are used in a variety of industries from automotive to power generation, where they provide the secure infrastructure for connectivity in the edge area between IoT devices and cloud-based platforms.

The opportunity for users is to keep the same user interface that they are used to and use the existing core databases and infrastructure from their enterprise system provider by adding connected (IoT) applications.

As IIoT technology matures from simple monitoring to control and then to full autonomy, new applications like autonomous vehicles and lights-out manufacturing will become commonplace. This will require plants to look beyond IIoT and connectivity to the data analytics, deep learning, and artificial intelligence capabilities of Industry 4.0. ■

ABOUT THE AUTHOR

Alan Griffiths is the principal analyst, industrial IoT and digital transformation, at Cambashi (www.cambashi.com).

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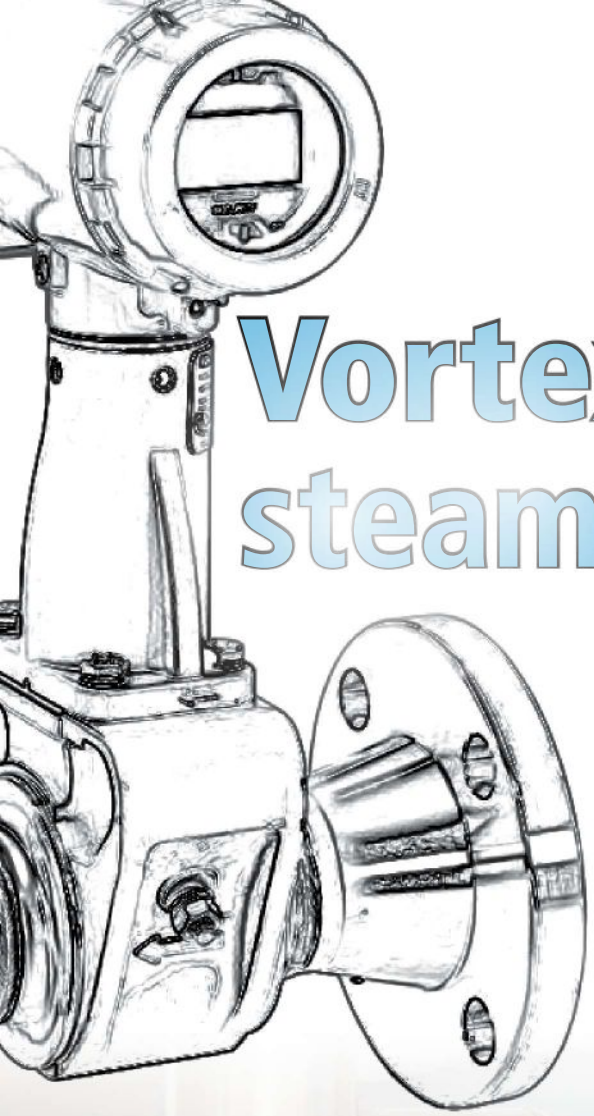


Vortex meters for steam measurement

By Cheng Vue

Vortex flowmeters have been available on the market since the late 1960s, and the number of applications they are used for has steadily increased. Over that same time, reliability has also increased, as the technology continues to be refined. Where excess process noise was a problem in the past, for example, manufacturers are finding solutions to compensate for or mask process signal noise.

Vortex meters help plants use and reuse water efficiently, potentially reducing expenses

Over the years of vortex meter use, it has become clear that the vortex meter is ideally suited for many applications. In steam measurements in particular, vortex provides a high accuracy and steady meter performance even with the presence of two-phase droplets and condensate. (Traditionally, steam has been measured by a differential pressure [dP] meter, which requires impulse lines where droplets can freeze and plug the lines, causing challenges.) Such reliable steam measurement means vortex meters can help plant managers use and reuse water efficiently, potentially reducing expenses.

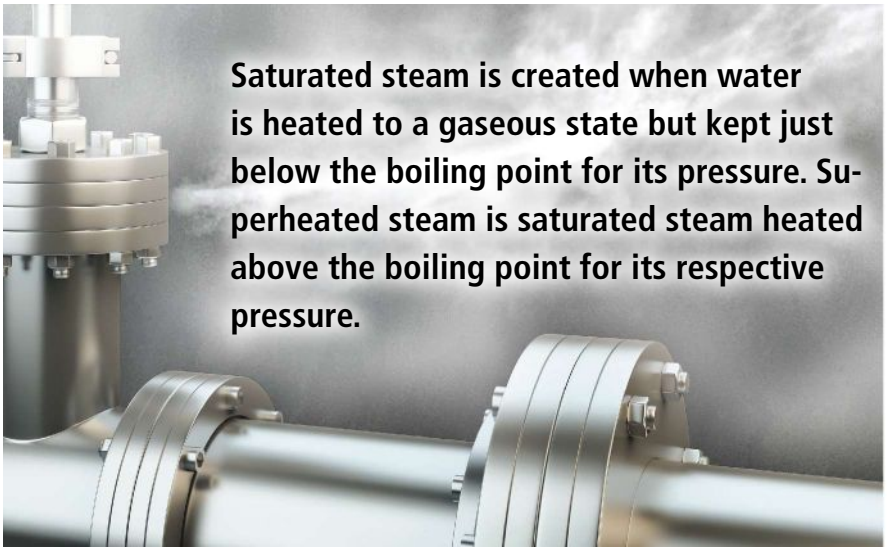
The vortex meter operates on the von Kármán effect, first documented by Hungarian-American physicist, aerospace engineer, and mathematician Theodore von Kármán. He observed the formation of vortices behind a bluff body or shedder bar placed in the path of a fluid or gas. The sensor in the vortex meter counts the number of swirls or vortices and how fast they are moving to determine the speed at which the fluid passes through the meter.

A small sensing element in the vortex meter body oscillates back and forth at a specific frequency caused by the vortices. This sensed movement is converted into an electrical signal through the vortex sensor, and from there passes through a circuit to go to the transmitter, which reads it as frequency. Calculating the volumetric rate is done by taking the frequency and dividing that by the vortex meter's unique *K* factor, which is the calibration factor.

Steam applications

Steam can be challenging to work with. Despite its many advantages, there are also inherent dangers involved in using steam, particularly when there is the danger of leaks. Superheated or saturated steam can escape from the system and injure a worker or damage equipment. However, steam is used in many industries due to its unique physical properties. The industries where steam is used range from chemical to refining, pharmaceutical, food and beverage, and power generation.

There are two types of steam commonly used in industrial applications, saturated and superheated. Each of these requires highly accurate and reliable measurements to ensure that the steam stays at the correct flow rate, temperature, and pressure throughout the process it is used for.



Saturated steam is created when water is heated to a gaseous state but kept just below the boiling point for its pressure. Superheated steam is saturated steam heated above the boiling point for its respective pressure.

Saturated steam is created when water is heated to a gaseous state but kept just below the boiling point for its pressure. Two common applications for saturated steam are heating and sterilization. In these applications, either pressure or temperature can be used to accurately compensate for changes in density in the steam.

Superheated steam is saturated steam heated above the boiling point for its respective pressure. It might seem surprising to learn that superheated steam is not very well suited to heating or sterilizing applications. This is due to its lower heat transfer coefficient. It does provide considerable work potential because of its high internal energy properties and is used in energy production, particularly in turbine applications.

With superheated steam, it is important to make sure that the steam does not condense at any point in the process, because water droplets can cause both plant and personnel danger. Water droplets increase wear and tear on machinery parts, which, if left undetected over time, can cause machinery or piping to fail.

Obtaining measurement accuracy

In most steam applications, traditionally, the measurement tool used has been the dP flowmeter. A dP meter is made up of primary and secondary elements. The primary element is installed in the pipe and creates a pressure drop, so that the pressure transmitter can measure the differential pressure, which is proportional to the square root of flow. External impulse piping is needed to connect the secondary element, the transmitter, to the primary element in order to obtain the dP measurement.

Because a significant amount of energy is expended to generate steam, which is often under considerable pressure, it is important to have flexible flow metering technology. That technology must provide accurate, repeatable, and dependable measurements of mass steam flow, as that ensures better mass balance for utilities and energy management.

The challenges with a dP flowmeter revolve around the use of impulse lines, which can get clogged or can freeze if water droplets build up in them. The addition of heat tracing—adding an external heating element to the impulse line so that it does not freeze—is an option, but not always a reliable solution. A dP flowmeter is particularly unreliable if a steam application is used to heat a material flowing through a process.

In contrast, a vortex flowmeter is a more reliable way to get an accurate measurement, because it eliminates the need for impulse lines. The meter is fitted directly into the pipe, and the steam flows over the shedder bars, which create the measurable vortices. The data collected by the sensor is sent to the transmitter, which gives an operator instant insight into the flow characteristics.

Reuse and recycle

One of the benefits of a steam heating system is that it requires only water to run through the system. The water is heated in a boiler, and the steam is sent through the system. At the end point, it can be allowed to condense and return to the boiler as water that can be heated again. This creates a relatively efficient arrangement that does not require excessive water usage.

It is important to make sure that the superheated steam does not condense at any point in the process, because water droplets can cause both plant and personnel danger.

The only time water is lost is when, for some reason, steam is vented out of the system to relieve excess pressure. The need for venting is less likely when using a vortex meter, because the meter will indicate almost instantly when there are changes in the flow. An operator can make adjustments to bring measurements back in line with the process specifications.

Making a system more efficient and reducing costs, as well as ensuring safe operations, are the goals of every plant manager. Using and reusing water, coupled with using the right tools that alert the operator when the process is out of alignment, is one way to ensure efficiency and potentially reduce expenses. The vortex meter is one such tool able to provide this added assurance and efficiency. ■

ABOUT THE AUTHOR

Cheng Vue is the global vortex product manager for Emerson Process Management (www.emersonprocess.com). He has been working with Emerson for five years and previously was the global product manager for temperature transmitters and sensors. He has a BS in mechanical engineering from the University of Minnesota Duluth and is pursuing his MBA from Hamline University.

Vortex flowmeter technology videos

The Emerson Video Library Series explains steam measurement using vortex flowmeter technology and provides details of individual flowmeter options, including the Rosemount 8800 Vortex Flowmeter. Visit https://bit.ly/33wreUa.

Enjoying driving a classic? But at what cost?

By Paul J. Galeski, PE, CAP

ABOUT THE AUTHOR

Paul J. Galeski, PE, CAP (paul.galeski@mavtechglobal.com), is the CEO and founder of MAVERICK Technologies. The company specializes in high-level operational consulting, as well as the development of automation strategy and implementation for automation technology. Galeski is also involved in expert witness testimony and is a contributing author to Aspatore Books' *Inside the Minds*, a series of publications that examine C-level business intelligence.

If you're old school, like me, sometimes you enjoy seeing or even driving that great "classic" car you remember from when you were growing up. Maybe it was your dad's car, and you couldn't wait to drive it the minute you got your license. Perhaps it was that special car you always wanted but could never afford when you were a teenager. Is it a 70's "muscle car," or that old station wagon your parents drove to take you on those memorable family vacations?

What is it we like about driving those great old classics? Well, for one thing, when you slide into that car seat, it's so familiar, so comfortable. Driving is so uncomplicated, and the machine itself is easy to understand. Want to start the car? Just turn the key . . . or hot wire it! Want the window up? Manually crank it with little risk of failure. Dim the lights? Hit the floor switch.

Oh, and the engine. It rumbles just right, with a sound you've known forever. Sure, it may cough and sputter a bit, and it gets terrible gas mileage, but you're sure Ol' Bessie will keep on rolling—it never let you down before. Add an extra quart of oil here, some fuel additive there, kick the left rear tire, and then hope it keeps on cruisin'.

Driving a classic is a lot of fun, and workarounds somehow keep the car going. Still, do you sometimes wonder if there is enough life left in it to make that road trip to visit the family over the holidays? And, really, is it safe?

Perhaps the plant or mill where you work is one of those legendary classics, loaded with history and personality. You're at home there. It's comfortable, easy to understand, and even fun sometimes. It also might feel pretty good to seamlessly and fluently navigate the system as younger engineers look on with envy. But keeping the old operation up and running is getting more and more expensive, and workarounds—not to mention parts—are harder to come by. Maybe you are thinking about modernizing, but change feels risky. It is hard to imagine leaving behind the status quo and investing in a new unknown, unfamiliar technology.

Like your legacy system, an older car will reach a point where it costs more to keep it running than it does to buy a newer one. We all know that a "classic car" is expensive to buy or restore, and it continues to be a money pit as parts become impossible to find and must often be "custom" designed. It's had a good run, but it's unreasonable to expect to drive it forever without the consequences of obsolescence.

The savvy car owner—like the smart manufacturer—must ultimately upgrade and bring in a shiny new model. It may not feel right at first, but once you've let go of the past and invested in the future . . . wow!

Your new automobile features modern connectivity, advanced safety features, improved fuel efficiency, and reduced emissions. It helps you avoid collisions and can parallel park all by itself. You now enjoy livestreaming your favorite satellite music channel while following the enhanced GPS navigation. The onboard computers make your ride stable and smooth, allowing you to select from various traction and transmission setups as the driving surfaces or your preferences change. Then you wake up one morning to find that your car upgraded itself overnight by downloading a new dashboard software from the manufacturer!

The good old days were great, but when you drive your new "smart car," you won't be able to imagine how you ever got along without it.

Are you driving a classic at your legacy manufacturing facility? Is it time to make some changes that will allow your operations to be flexible, agile, easier to operate, and more reliable? Want the total cost of ownership to be more predictable and manageable? Want to stay competitive using new technologies like augmented reality, artificial intelligence, and advanced analytics? Of course, you'd like your process operation to be safer and more profitable as well.

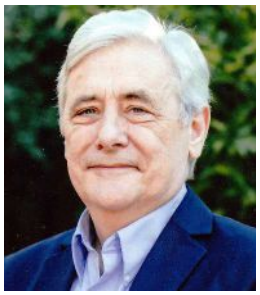
Maybe it is time to talk to a knowledgeable consultant who can help you find the right make and model to best serve your operational needs. It's time to move forward and enjoy the benefits of today's technology coupled with smart manufacturing strategies. Don't fear change. Embrace it. Drive it. Benefit from it. The old tech will always be there to visit in a museum or in your memory but, bottom line, there is no future in the past. ■

The good old days were great, but when you drive your new "smart car," you won't be able to imagine how you ever got along without it.

International Society of Automation
Setting the Standard for Automation™

2020 Executive Board

The International Society of Automation is pleased to introduce the 2020 Executive Board.



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ISA reaccredited as provider of IACET CEUs

The International Association for Continuing Education and Training (IACET) has awarded reaccreditation status to ISA. IACET-accredited providers are the only organizations approved to offer IACET continuing education units (CEUs). The accreditation period extends for five years, and includes all programs offered or created during that time.

"ISA is proud of our education programs, which educate engineers, technicians, and management each year in crucial industrial automation skills so that our members and customers maintain relevancy in today's world," said Mary Ramsey, executive director of ISA. "Our renewed accreditation with IACET is a demonstration of our continuing commitment to quality adult education and high standards for all of our programs. We are very pleased to maintain our relationship with such a prestigious organization as well as an elite group of organizations that offer excellent continuing education and training programs."

Peter Finn, president of IACET, said "ISA joins nearly 500 organizations around the globe that have had their programs vetted by third-party experts in continuing education, thereby ensuring the highest possible standards are met."

ISA completed a rigorous application process, including a review by an IACET site visitor, and successfully demonstrated adherence to the ANSI/IACET 1-2018 standard addressing the design, development, administration, and evaluation of its programs. ■

Beamex, ISA New Orleans create $25,000 scholarship fund

Using proceeds from its Annual Calibration Exchange, ISA Corporate Partnerships Program member Beamex USA teamed up with the ISA New Orleans Section to create a new scholarship fund. A scholarship totaling $25,000 was created for the University of New Orleans engineering program.

"This donation will do a lot of good for the students for a long time," said Dean Bickerton, president of the ISA New Orleans Section.

The original scholarship amount from Beamex and the ISA Foundation was estimated to be $15,000. During the check presentation, the ISA New Orleans Section announced it would add $10,000 to create a $25,000 endowment. This endowment will generate a perpetual scholarship with an award that will be given to a deserving engineering student annually.

A Beamex spokesman said the company was "delighted" to give back to future automation professionals and make a bigger impact through a partnership with the ISA New Orleans Section. The stories of the students who are selected as scholarship recipients in the coming years will be followed and shared.

"We are very grateful to have Beamex and ISA's support to establish an endowed scholarship within the University's College of Engineering," said Eric Balukonis, major gifts and planned giving officer, University of New Orleans. ■

ISA's 2020 executive board announced

ISA is pleased to welcome its executive board for 2020. **Eric Cosman**, principle consultant at OIT Concepts, LLC, is the incoming president. He is a founding member and the current co-chair of the ISA99 committee on industrial automation and control systems security, which is responsible for the development of the ISA-62443 standards. Cosman also served as past vice president of Standards and Practices. The president-elect secretary is **Steve Mustard**, **PE, CEng, CAP, GICSP**, an industrial automation consultant and subject-matter expert for ISA and the Automation Federation. He is president of National Automation, Inc. **Paul Gruhn, PE, CFSE**, takes the role of past president, and **Jon DiPietro** is treasurer. ■

The board also includes	
Mark Arkell	JMP Solutions
Don Bartusiak	ExxonMobil
Marty Bince	TEC Edmonton
Nilangshu Dey	Qatar Petroleum
Jim Garrison	aeSolutions
Carlos Mandolesi	Sigmma Automação
Matthew Maynard	Francis Tuttle Advanced Technical Center
Mary Ramsey	ISA
Scott Reynolds	Johns Manville
Debashis Sadhukhan	NASA Glenn Research Center
Dawn Schweitzer	Eastman Kodak Company
Prabhu Soundarrajan	Honeywell Process Measurement and Control
Ashley Weckwerth, PE	Burns & McDonnell
Maurice Wilkins, PhD	Yokogawa UK Ltd.
Shari Worthington	Telesian Technology, Inc.

Global security products, services firm becomes latest ISA corporate sponsor

WisePlant—a global provider of industrial solutions in secure automation and energy, industrial cybersecurity, asset security, and functional, intrinsic, and worker safety—is now an ISA corporate sponsor.

Founded in South America and headquartered in Pompano Beach, Fla., WisePlant has been providing customized safety and cybersecurity services to South America's process companies and mission-critical industries since its 2012 inception. The company specializes in consulting and training—through its independent WiseSecurity and WiseCourses Academy divisions—based on the ISA/IEC 62443 series of industrial automation and control systems (IACSs) security standards. WisePlant's mission is to provide the proactive capabilities and defenses needed to mitigate serious security and safety risks.

WisePlant was the first South American company to become a member and supporter of the ISASecure certification program, which assesses industrial automation and control products and systems to ensure they are robust against network attacks and free from known vulnerabilities, and that they meet the security capabilities defined in the ISA/IEC 62443 standards. WisePlant also has collaborated with ISA to educate industrial leaders in South America on ISA/IEC 62443 standards and ISA training courses based on the standards.

"We are very excited to be partnering with ISA to educate owners and operators of critical infrastructure about the value and significance of the ISA/IEC 62443 standards, and to demonstrate how efficiently and effectively they can be adopted and implemented," said Maximillian G. Kon, CEO and managing director at WisePlant. "We expect our alliance with ISA, a widely and long-recognized leader in industrial automation security standards, training, and education, will build on our strategic strengths and enhance our ability to deliver value to our customers around the world."

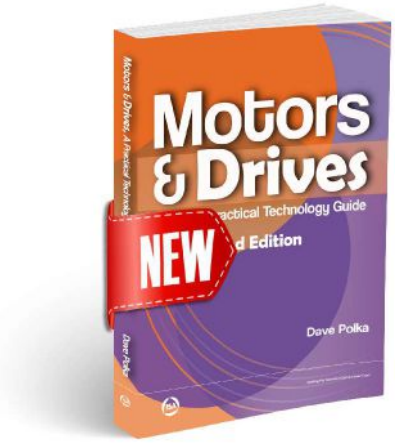
Under the agreement, WisePlant will work with ISA to codevelop a range of informational resources, including webinars. "As a company that provides ISA/IEC 62443–based cybersecurity solutions and services across the same broad industry spectrum that ISA serves, WisePlant is a natural fit for the ISA Corporate Partnerships Program," says Jennifer Infantino Halsey, ISA's director of marketing and communications. "WisePlant is well positioned, given its knowledge of the ISA/IEC 62443 standards, to complement our efforts to expand global awareness around the need to protect IACS from the growing risks of a cyberattack through internationally adopted cybersecurity standards." ■

Scholarships bolster process measurement and control

The ISA Process Measurement & Control Division (PMCD) has named six scholarship recipients for 2019–2020. Organized within the Automation and Technology Department of ISA, PMCD supports its nearly 6,000 members through active technical committees focusing on primary sensors, control hardware and software, and final control elements. Scholarship applicants had to be nominated by PMCD members and be enrolled in an undergraduate or graduate program related to process measurement and control.

Scholarship recipients include: Pankaj Goel, Texas A&M, College Station, Texas, U.S.; Abdulhussain Kanchwala, K.K Wagh Engineering Education and Research, Nashik, Maharashtra, India; Hussain Rangwala, DY Patil School of Engineering, India; Anahita Sadeghian, University of Alberta, Canada; David Scott, University of Alberta, Canada; and Rifaa Tajani, University of Texas, Austin, U.S. For more information about PMCD, visit https://www.isa.org/division/pmcd.■

Second edition of motors and drives guide released



Keeping pace with significant advances in motor speed control technologies, ISA has published a second edition of *Motors & Drives: A Practical Technology Guide* (www.isa.org/store/motors-drives-a-practical-technology-guide,-second-edition/67181686). This release has been updated to reflect innovative motor and drive technologies that are safer, smarter, and easier to program and implement; provide superior diagnostic capabilities; and deliver seamless integration.

"The second edition will continue to serve as a straightforward guide for those seeking to understand the key engineering principles of motors and drives," says author Dave Polka, a widely recognized expert on motors and drives. "However, while basic theory of AC and DC drives hasn't changed, technology certainly has. The book takes a fresh look at how market demands have advanced motor and drive technology and are pushing the industry in new directions."

Polka explains complex technical concepts and defines terminology such as "harmonics" and "power quality" in a practical, easy-to-understand way. The book is rooted in the practical side of drive and motor use, with the design engineering side of technology presented in commonly used terms. Included are clearly stated summaries, highly relevant review questions, glossaries, and reference tables for formulas and conversions. ■

New CAPs and CCSTs

Qualifying for and passing one of ISA's certification exams is a noteworthy accomplishment. The exams are rigorous and require a solid command of various disciplines in automation and control. Below is a list of individuals who have recently passed either our Certified Automation Professional (CAP) or one of the three levels of our Certified Control System Technician (CCST) exam. Congratulations to our new certification holders!

For more information about the ISA CAP and CCST certification programs, please visit www.isa.org/training-and-certifications/isa-certification. ■

Certified Control System Technicians

Name	Company	Location
Level 1		
Joseph Brown	None	U.S.
Paul Dunne	None	U.S.
William Foster	None	U.S.
Shane Gresham	None	U.S.
Michael Hilker	None	U.S.
Manuel Hernandez	None	U.S.
Joshua Westerholm	Williams	U.S.
Matthew Robinson	DTE	U.S.
Jessner Isaeus Andal	None	U.S.
Daniel Fill	Santa Clara Valley Water District	U.S.
Carlos Santiago	None	U.S.
Theresa Vanderlin	NEORSD	U.S.
Daniel Larson	None	U.S.
Tania del Rocio De La Cruz Tapia	None	Ecuador
Montana Barrall	Transcat	U.S.
Trenton Johnson	None	U.S.
John Burdette	None	U.S.
Robert Holdstein	None	U.S.
Joseph Houde	Shire	U.S.
Charles Pollock	Monore Energy	U.S.
Carlo Rapposelli	Monore Energy	U.S.
Norman Bates	Exelon Generation	U.S.
Tom Buckner	Tom Buckner Consultants	U.S.
Justin Huff	None	U.S.

Certified Control System Technicians

Name	Company	Location
Level 2		
Christopher Haglund	None	U.S.
John Herndon	None	U.S.
Dustin Robelia	Xcel Energy	U.S.
Shannon Vasseur	Williams Energy Services	U.S.
Trent Rhoads	Transcat Inc.	U.S.
Eddy Wang	Linde	U.S.
Jahmarley Samuels	Bermuda Electric Light Co.	Bermuda
Vance Hanlon	Transcat Inc.	U.S.
Ronald Jones	Transcat Inc.	U.S.
Snehalkumar Patel	None	U.S.
Matthew Derosier	Swanson Flo Co.	U.S.
Nathan Waddell	None	U.S.
Richard Barnett	Metropolitan Water District	U.S.
Level 3		
Nicholas Matthies	None	U.S.
Corey Taylor	None	U.S.

Certified Automation Professionals

Name	Company	Location
Paul Mackay Pereda	None	U.S.
Alberto Domingos	Metro Wastewater Reclamation District	U.S.
Jules Mbasso	University of Delaware	U.S.
Lakshmanacharyulu Sonthenam	PEG Engineering & Contracting DMCC	U.A.E.
Leandro Cuenca Massaro	None	U.S.
Ryan Bosio	None	U.S.
Brady Franklin	None	U.S.
Ryan Beesley	None	U.S.
Huy Truong	PV Gas Ca Mau	Vietnam
Pham Phi Bao	Petrovietnam Gas South East Transmission Company	Vietnam
Matthew Leuthard	None	U.S.

ISA Certified Automation Professional (CAP) program

CAP question

For systems built at the end-user facility, a SAT should:

A. employ both nondestructive and destructive testing techniques as appropriate.
B. include bench calibration, because vendor calibration is not performed.
C. include alarm and interlock testing.
D. perform all elements that would normally be included in a FAT.

CAP answer

The correct answer is *D*, "perform all elements that would normally be included in a FAT."

Systems that are built off site (third-party system integrator office, for example) normally include a factory acceptance test (FAT). The FAT would include tests that verify I/O addressing and tag naming, logic performance, and user graphics operation, among other tests.

If the system is built at the end-user facility, the project team would likely perform these same tests with the software loaded on the target system. This system acceptance testing (SAT) would then streamline the testing process, allow testing down to the device, and leave the system ready for commissioning.

Also, with systems that are developed and built on site, the hardware used for development is often the same as the hardware that will be placed into production. In order to streamline installation and hardware checkout, the testing that normally would be done in FAT is executed during the SAT.

Reference: Sands, Nicholas P. & Verhappen, Ian, *A Guide to the Automation Body of Knowledge, Third Edition,* ISA Press, 2018.

Certified Automation Professionals (CAPs) are responsible for the direction, design, and deployment of systems and equipment for manufacturing and control systems.

ISA Certified Control Systems Technician (CCST) program

CCST question

A thermocouple wire is brought back to a thermocouple input card in the PLC. The thermocouple cable is 10 feet long. The thermocouple is measuring a fluid flowing at 125°C. Due to gouging of the cable insulation, the two wires in the cable have been shorted together 5 feet from the PLC input card. The result of this short on the temperature observed at the PLC input is:

A. There will be no issue; the input will read 125°C at the PLC.
B. The short in the cable will cause damage to the input card channel and a fault will be displayed.
C. The input will read a temperature closer to the ambient temperature.
D. The temperature at the PLC input card will read 62.5°C since the short is halfway between the measurement point and the PLC.

CCST answer

The answer is *C*, "The input will read a temperature closer to the ambient temperature."

When a thermocouple is shorted at another point other than the intended junction used for measurement, another junction, meaning another thermocouple, is formed. The reading at the programmable logic controller (PLC) will be most influenced by the "new" thermocouple that is formed by the short circuit, which is between the intended measurement point and the PLC.

Reference: Goettsche, L. D. (Editor), *Maintenance of Instruments and Systems, Second Edition*, ISA, 2005.

Certified Control System Technicians (CCSTs) calibrate, document, troubleshoot, and repair/replace instrumentation for systems that measure and control level, temperature, pressure, flow, and other process variables.

Top four things you need to conquer cybersecurity

By Lisa Richter

Findings in Vectra's *2018 Spotlight Report on Manufacturing* revealed that attackers who evade perimeter security can easily spy, spread, and steal, unhindered by the insufficient internal access controls. (Full disclosure: Vectra sells a platform that uses artificial intelligence to automate cyberattack detection.) Intellectual property theft and business disruption are primary reasons manufacturers have become prime targets for cybercriminals, according to the report.

"Recent reports about nation-state cyberattacks against U.S. utility control systems show that cybercriminals are intent on surreptitiously taking inventory of critical industrial assets and intellectual property to disrupt manufacturing business operations," says Vikrant Gandhi, industry director at the analyst firm Frost and Sullivan.

Other key findings include:

- a much higher volume of malicious internal behaviors, which is a strong indicator that attackers are already inside the network;
- an unusually high volume of reconnaissance behaviors, which is a strong indicator that attackers are mapping out manufacturing networks in search of critical assets;
- an abnormally high level of lateral movement, which is a strong indicator that the attack is proliferating inside the network.

"The interconnectedness of Industry 4.0–driven operations, such as those that involve industrial control systems, along with the escalating deployment of Industrial Internet-of-Things devices, has created a massive attack surface for cybercriminals to exploit," warns Chris Morales, head of security analytics at Vectra.

Houston, we have a problem

So, what the hack (sorry) does that mean for system integrators (SIs)? To find out, I booked Rick Kaun, vice president of solutions at Verve Industrial Protection, for the *Talking Industrial Automation* podcast for a quick brain dump. Among other advice, here are his top four tips for proactive companies looking to step up to the challenge and create a cybersecurity program.

1. **Make a centralized team**. To the surprise of no one, there is a talent shortage. That means companies have to get creative, says Kaun. "One of the biggest challenges in this space is that there are not enough people," says Kaun. "Now, try to find people who have a combination of IT [information technology] and OT [operational technology] experience or at least know IT security but have a healthy respect for the operational environment or vice versa, it's a very short list," says Kaun. "So, you need to be creative, and that can often mean creating a centralized team to be able to scale across multiple sites and provide a cohesive and agile solution."
2. **Make a list.** Duh, okay, so this may seem obvious, but the first thing you need to do, according to Kaun, is compile a comprehensive inventory. "Inventory is key, because inventory drives all your other decisions," explains Kaun. "Not all assets are equal, so we need to know what assets are where and what's critical, because we can't do full protection on everything, everywhere."
3. **Make a program plan.** Wouldn't it be nice if you could just go to the cybersecurity store and grab a shiny new package off the shelf and then put up your feet and enjoy a beer while you watch the game? Yeah, well, the cold hard reality is that there are no one-size-fits-all solutions—and definitely no silver bullets, says Kaun. That means you have to roll up your sleeves and think big picture. "If you don't have a plan," he warns, "you'll run out and pull the trigger on a bunch of siloed solutions and create a punch list of accomplishments, but none of it necessarily comes together to provide comprehensive coverage . . . Security is a program, not a project, and it needs to be rolled out in a series of multiple phases."
4. **Make a maintenance plan.** I bet you knew this one was coming: Cybersecurity is not one-and-done. Even after you have a plan and get it all implemented and sorted, you need to stay on top of it and have the people and processes in place to ensure someone has their hands on the wheel. "Spending all the effort on the program and then having the project team high-five and go home, leaving the day-to-day people—who haven't had the training or the support or the bandwidth to keep it up—is an incredible waste of time and money," explains Kaun.

To learn more about cybersecurity, including standards and events to get up to speed, listen to episode 24 of the *Talking Industrial Automation* (www.csiaexchange.com/podcast.aspx) podcast. ■

ABOUT THE AUTHOR

Lisa Richter is industry director for the Control System Integrators Association, a not-for-profit, global trade association that seeks to advance the industry of control system integration, with more than 500 member companies in 35 countries. In her role, Richter helps members grow their businesses, share industry expertise, and advance the industry of control system integration. She is also host of the *Talking Industrial Automation* podcast on the Industrial Automation Exchange, a smart directory for SIs, suppliers, and end users to learn and do business. Send questions or comments to lmunoz@staff.controlsys.org.

New ISA84 guideline on automation asset integrity of safety instrumented systems

In 2018, ISA84, Instrumented Systems to Achieve Functional Safety in the Process Industries, approved the newest edition of IEC 61511 as ISA and American National standards. ISA/IEC 61511, *Functional Safety – Safety Instrumented Systems for the Process Industry Sector*, Parts 1–3, sets forth requirements for the specification, design, installation, operation, and maintenance of a safety instrumented system (SIS) so that it can be entrusted to achieve or maintain a safe state of a process.

At the same time, ISA84 is committed to continuing its program to provide guidance to the global process industries in applying ISA/IEC 61511 through a wide-ranging series of ISA-84 technical reports. This effort includes three technical reports that provide informative guidance related to specific phases of the SIS life cycle.

One of the three, ISA-TR84.00.03-2019, *Automation Asset Integrity (AAI) of Safety Instrumented Systems*, has now been completed. It provides guidance on establishing an effective AAI program that demonstrates through traceable and auditable documentation that the SIS and its equipment are maintained in an "as good as new" condition.

An AAI program involves many activities that occur throughout the SIS life cycle, but it predominantly focuses on the timely detection and correction of incipient/degraded conditions and complete failures to ensure that the SIS operates as specified when required. Rigorous inspection and thorough proof testing are needed for all SIS equipment whether existing or new. Although the frequency of these activities may vary due to the required safety integrity level (SIL), the intent and purpose of inspection and proof testing are not affected by the SIL. The new technical report provides detailed guidance and examples to support user-specific work processes as part of an overall AAI program.

Two other technical reports currently in revision by ISA84 also provide guidance related to specific phases of the SIS life cycle:

- ISA-TR84.00.04, *Guidelines for the Implementation of ANSI/ISA-61511*, is expected to be published by the end of 2019. It will provide an overview of the SIS life cycle with references to annexes containing more detailed guidance on various subjects. It will also provide an end-user example of "how to" implement ANSI/ISA-61511.
- ISA-TR84.00.02, *Safety Integrity Level (SIL) Verification of Safety Instrumented Functions*, will support the calculation of the average probability of failure on demand as required by ISA/IEC 61511-1, providing guidance on (a) assessing random and systematic failures, failure modes, and failure rates; (b) understanding the impact of diagnostics and AAI activities on the SIL and reliability; (c) identifying sources of common cause, common mode, and systematic failures; and (d) using quantitative methodologies to verify the SIL and spurious trip rate. The revised technical report is expected to be issued for voting to the ISA84 committee by the end of this year.

Rigorous inspection and thorough proof testing are needed for all SIS equipment whether existing or new.

Previous ISA84 technical reports include:

- ISA-TR84.00.09-2017, *Cybersecurity Related to the Functional Safety Lifecycle*, provides guidance on integrating the cybersecurity life cycle with the safety life cycle as they relate to safety controls, alarms, and interlocks, inclusive of safety instrumented systems. The scope includes the work processes and countermeasures used to reduce the risk involved due to cybersecurity threats to the industrial automation and control system network.
- ISA-TR84.00.08-2017, *Guidance for Application of Wireless Sensor Technology to Non-SIS Independent Protection Layers*, addresses wireless technology-based sensors that are used in independent protection layers (IPL) providing a risk reduction factor of less than or equal to 10 (non-SIS IPL) by the authority having jurisdiction (typically the owner/operator or local regulatory authority) and establishes guidance and considerations for their utilization in the process sector.
- ISA-TR84.00.07-2018, *Guidance on the Evaluation of Fire, Combustible Gas and Toxic Gas System Effectiveness*, addresses detection and mitigation of fire, combustible gas, and toxic gas hazards in process areas. It clarifies information to be considered when developing a performance-based fire and gas system design—including integrating the design activities into relevant portions of the safety life cycle model for safety-critical controls.
- ISA-TR84.00.05-2009, *Guidance on the Identification of Safety Instrumented Functions (SIF) in Burner Management Systems (BMS)*. This technical report is currently being revised by ISA84.

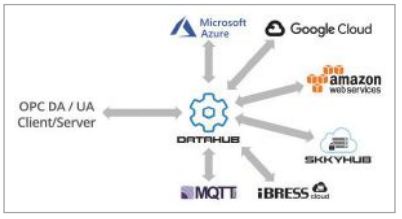
ISA standards meetings are open to all interested parties, and experts from any country are welcome to join the ISA84 committee. For more information, contact Charley Robinson, ISA Standards, crobinson@isa.org. For information on viewing or obtaining the technical reports described above, visit www.isa.org/findstandards. ■

Software enables Industrial IoT

Enhancements across the company's software portfolio make it possible to operate plants, analyze industrial data, and optimize operations. Predix Essentials, a SaaS solution, helps companies connect to disparate data sources, monitor operations, and use edge-to-cloud predictive analytics. Developed in partnership with customers including Intel, Predix Essentials is a first step toward using cloud-based Industrial Internet of Things (IIoT) technologies for digital transformation. It is also the foundation of the company's APM and OPM application suites. Asset Answers is a benchmarking tool that lets users import and assess data to compare their asset maintenance practices with similar companies or their own performance across sites. Webspace 6.0 brings the visualization and control capabilities of the company's iFIX and CIMPLICITY HMI/SCADA software to mobile devices. With encryption and a zero-install HTML5 client, Webspace 6.0 helps improve how operators receive and react to operational insights.

GE, www.ge.com/digital

Stream industrial data into MES



The DataHub IoT Gateway streams real-time OPC UA and OPC DA industrial data directly into manufacturing execution systems (MESs), device clouds, and big data analytics platforms. The gateway connects OPC UA and OPC DA (Classic) clients and servers to any MQTT broker, including Azure, Google, and Amazon IoT. It supports both publish and subscribe and automatic OPC to MQTT protocol conversion, maintaining the OPC UA data model while other gateways flatten it. The gateway lets you merge data from multiple sources into a common data set, configure a network of DataHub installations from a single location, quickly view live trends for selected data, and control access and set permissions for users and groups. Add-on options include the ability to build and display private cloud-based web pages, connect two or more data sources to share data in real time, connect OPC A&E servers and clients, connect Modbus TCP slave devices, and read/write data to any ODBC database.

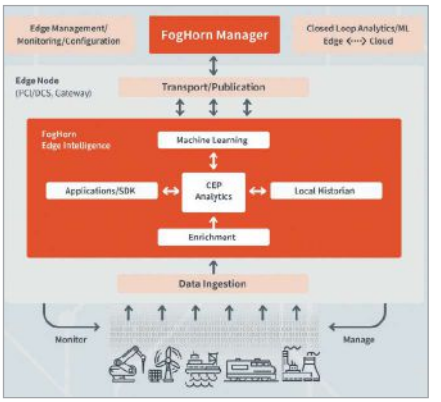
Cogent, https://cogentdatahub.com

Wireless access point combines Wi-Fi, WirelessHART

Specifically engineered to meet the smaller network requirements of remote operations, the Wireless 1410 Gateway is also secure and flexible. This compact wireless access point connects WirelessHART networks with host systems and data applications, and its small size and DIN-rail mount capability make it suitable for limited cabinet space. The device has two network capacity options (A: 25 devices / B: 100 devices) to meet various network demands. To help with digital transformation, this industrial networking approach combines the company's expertise in industrial automation and applications with Cisco's innovations in networking, cybersecurity, and information technology infrastructure. This wireless access point provides the Wi-Fi bandwidth necessary for real-time safety monitoring, including location awareness and wireless video—applications intended to enhance personnel safety practices, improve plant security, and help ensure environmental compliance.

Emerson, www.emerson.com

Real-time edge intelligence for IIoT



The Lightning Edge AI platform, which enables real-time edge intelligence via the IIoT, includes tools and enhancements for operational technology (OT) professionals. The drag-and-drop analytic programming capabilities and visualization dashboards help OT staff derive insights from real-time data without assistance from data science teams. The platform brings intelligence to or near the point where data originates and facilitates analysis with the lowest latencies to improve operational outcomes. Artificial intelligence (AI) is enabled through built-in closed-loop, edge-to-cloud machine learning, where the system can detect drifts in model accuracies and automatically trigger cloud-based retraining with Google Cloud Platform and Microsoft Azure IoT and republish new models to the edge in an iterative fashion until the expected accuracy is reached.

This latest release includes a visual programming tool, VEL Studio, that creates analytic expressions that derive actionable insights from streaming control and sensor data. A drag-and-drop library of more than 100 built-in code blocks lets OT professionals perform traditional data science tasks without the need for any programming skills. OT-centric blocks for manufacturing-specific use cases create analytics including anomaly and failure condition detection. VIZ Dashboards allows OT teams to visualize real-time data streams and monitor the efficiency and health of their environments. Data ingestion agents include OPC-DA.

Foghorn, www.foghorn.io

End-to-end security for Industrial IoT

SmartServer IoT is an open, end-to-end, extensible edge server that securely delivers operating system data to new cloud services. It enables system integrators, application developers, and original equipment manufacturers to deliver IIoT solutions for energy management and automation using both new and existing control networks. Using the IBM Watson IoT Platform enabled by NXP's A71CH secure element for IoT devices, the server is an extra layer of security for businesses connecting to the IBM Cloud. The IBM Watson IoT Platform is a managed, cloud-hosted service. The SmartServer IoT simplifies interoperability between diverse legacy systems, disparate devices, and emerging and traditional protocols.

It provides built-in device and data management for sensors, meters, actuators, and controllers through a range of protocols, including BACnet, LonWorks, and Modbus. The NXP A71CH Plug & Trust Secure Element has X.509 certificates and keys trusted by Watson IoT Platform and injected at NXP secure certified facilities. NXP's trust provisioning service ensures keys are kept safe, and credentials are injected in a trusted environment. When embedded into devices, the chips have the necessary keys to establish a secure TLS connection with IBM Watson IoT for seamless device-to-cloud connections.

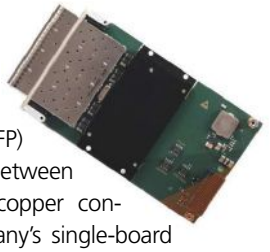
Adesto, www.adestotech.com

IIoT HMIs and controllers

The cMT series with CODESYS integrates high-performance HMI with a CODESYS programmable logic controller system on an architecture where a duo-core CPU runs two independent operating systems. With the multicore processor, cMT HMI + CODESYS provides data visualization with an operable user interface and also runs controller logic. The two systems run independently without mutual interference. The cMT-CTRL01 IIoT programmable logic controller has built-in CODESYS in addition to working with all iR modules. It has IIoT gateway protocol translation and EasyAccess remote access service. The cMT-G01/G02/G03/G04 is a smart communication gateway with the data processing capability of an HMI to facilitate IIoT integration. With OPC UA built-in, the gateway fits well into lots of applications to provide a standard communication interface and to integrate data.

Weintek USA, www.weintekusa.com

Four-channel SFP Gigabit Ethernet card



The XMC477RC four-channel SFP Gigabit Ethernet interface supports four small form-factor pluggable (SFP) modules, allowing users to choose between 1000BASE-X optical or 1000BASE-T copper connectivity. When paired with the company's single-board computer, the XMC477RC reportedly delivers functional density that can reduce the number of cards in a chassis. This can, for example, eliminate the requirement for a dedicated Ethernet switch and help minimize the size, weight, and power of a subsystem.

Able to operate in temperatures between –40°C to +85°C, the XMC477RC is suitable for naval/marine, land, and air platforms including fire control and radar systems. It supports a high-speed link to the host via an x4 PCIe connection, allowing all front I/O ports to run at full line rate. It has an industry-standard Intel I350-AM4 quad port Gigabit Ethernet controller that gives native support for enhanced virtualization elements, such as VMDq, and up to eight virtual machines allocated per port. Native drivers for common operating systems include Microsoft Windows, Linux, and LynxOS. VxWorks and Solaris drivers also available.

Abaco Systems, www.abaco.com

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Is the current attention to cybersecurity justified?

By Steve Mustard

ABOUT THE AUTHOR

Steve Mustard, PE, CEng, FIET, CAP, GICSP, CMCP (steve.mustard@au2mation.com), is an industrial automation consultant and subject-matter expert for ISA and its umbrella association, the Automation Federation. He is president of National Automation, Inc. as well as the incoming 2021 ISA president.

Although I agree with some of the points that Dean Ford made in the Final Say column "Beware of the hype" (www.isa.org/intech/201906final) in the May/June 2019 issue, I must disagree with the key message: "The cyberthreat is merely one of many threat factors to overall risk management, and it gets far too much attention."

I agree that cybersecurity, like many new things, is something that gets pushed by sales teams eager for opportunities to sell their products and services. But is all that attention to cybersecurity justified? In the article, Ford states that if cybersecurity truly was a top-five biggest perceived threat to operations, "every utility would be budgeting lots of money to address it. That is not happening, and the more advanced utilities and companies are not wasting resources on it for very good reasons."

A typical oil and gas supermajor will fend off 50,000 cyberattacks every day, so it is no surprise that they invest so heavily in managing this risk.

In fact, advanced utilities and companies do invest heavily in cybersecurity. According to consulting and services firm Leidos, cybersecurity spending in 2018 by the oil and gas industry was $1.87 billion. Cybersecurity is a top five risk for oil and gas supermajors, who take this risk so seriously that they fund a consortium called LOGIIC (Linking the Oil and Gas Industry to Improve Cybersecurity) to share best practices and research new solutions. LOGIIC is managed by the Automation Federation on behalf of the Department of Homeland Security. A typical oil and gas supermajor will fend off 50,000 cyberattacks every day, so it is no surprise that they invest so heavily in managing this risk.

It is true that some organizations do not take the cybersecurity threat seriously and do not invest in managing this risk. ISA's training relating to the ISA/IEC 62443 standard goes to great lengths to dispel the common myths that result in a failure to address the cybersecurity risk. Still, the perception that the risk is overblown persists, not helped by articles like Ford's.

One of the most common misunderstandings is that an organization needs to be a target to be affected by a cybersecurity incident. The WannaCry and NotPetya incidents of 2017 should dispel this myth once and for all. Both incidents swept up many organizations that were not specific targets. In the case of WannaCry, this included the U.K.'s National Health Service, Nissan, and Renault, all of whom were forced to stop operations until the issue was resolved. In the case of NotPetya a few months later, it was Maersk and Merck & Co., amongst others. Recovery from the incident cost Maersk an estimated $300 million.

All the organizations affected were ill-prepared for a cyberattack. Most were running old Windows machines without critical patches, and none had incident response plans to cover such an attack.

I agree with Ford that "with a sound risk management and disaster recovery plan, you not only address cybersecurity incidents, but you also mitigate fires, theft, weather events, rogue employees, etc." However, if done properly, I doubt that cybersecurity will not be one of the top risks to be addressed.

According to Cisco, one in three organizations have experienced cyberattacks on operational infrastructure but, according to IBM, only 38 percent of global organizations claim that they are equipped and able to handle a complex cyberattack. Although these figures are bad, many cyberincidents go unnoticed or unreported, so the situation is likely much worse.

It is true that a lot of risk reduction can be achieved with relatively low-cost activities. It is not necessary to invest in expensive tools and services to achieve a good risk posture. ISA's whitepaper "Industrial Cybersecurity for Small- and Medium-sized Businesses" (https://www.isa.org/technical-topics/cybersecurity/cybersecurity-resources) is a great place for any size organization to start its journey.

As ISA members, we need to do a better job of quantifying the cybersecurity risk to industry so that it is properly managed. There is no need for hype, but, at the same time, we should not underestimate it. For organizations, it is not a matter of if they will be impacted by a cyberattack, but when. ■

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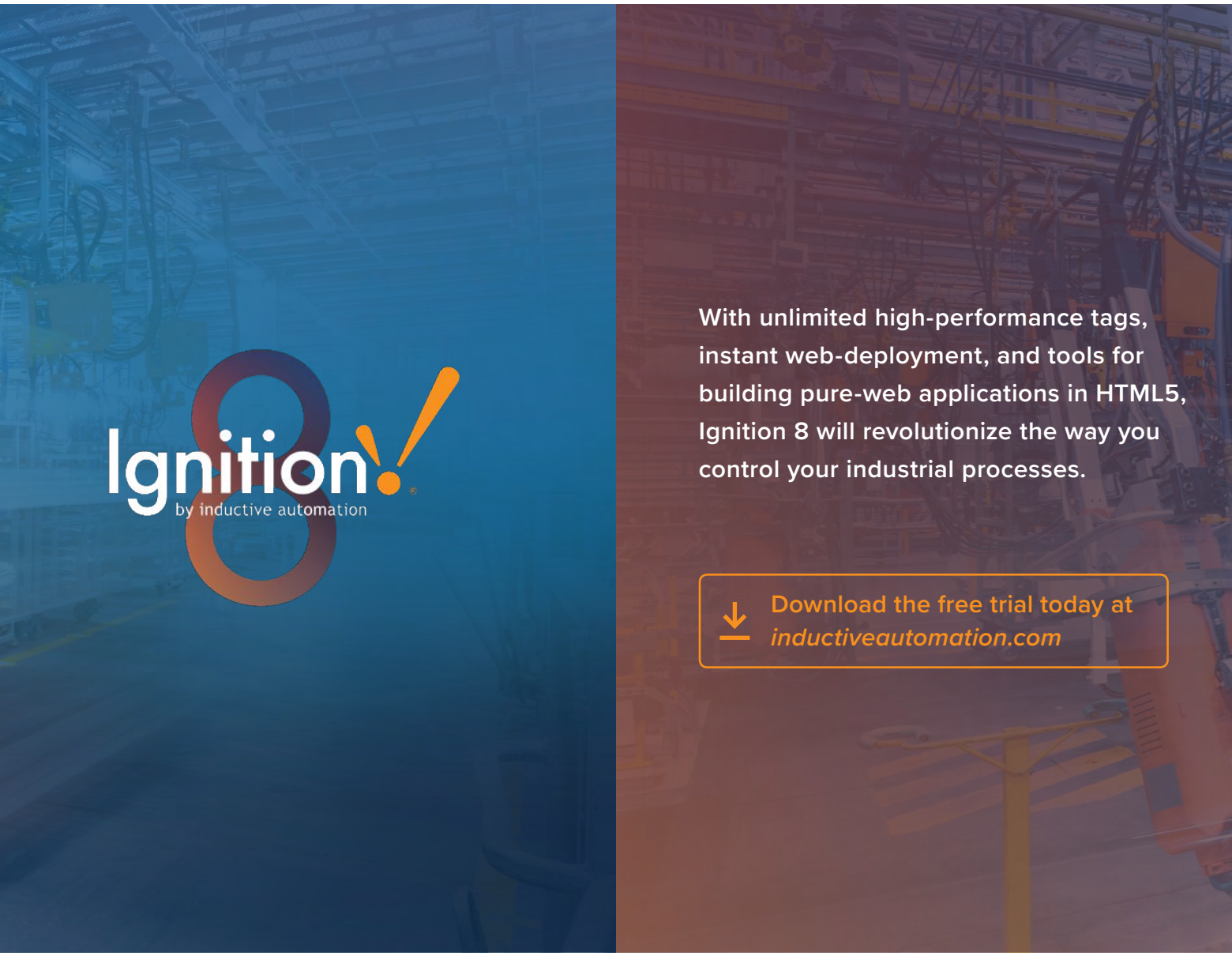
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