Technology Report: Edge Devices Take on New Roles

Like a child heading off for college, industrial technology is maturing and leaving the plant. Edge devices are becoming smarter, smaller, and more capable of performing tasks that enable field workers to operate in ways we could not have dreamed of just a few years ago. This is a terrific development for those businesses—and their employees—with the ability to confidently push the limits of what can be accomplished at the edge.
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New technology pushes machine smarts to the edge

By Dave Perkon, Control Design technical editor

With the advent of the Industrial Internet of Things and Industry 4.0, the use of smart edge devices is becoming more common in factory automation. A wide variety of these smart edge devices are being used for data collection and control, but what exactly one is depends on who you ask. Smart edge devices don’t necessarily make a smart machine.

What exactly is a smart edge device? What real work are these computing devices and microcomputers doing at the edge? And do these smart edge devices make machines smarter and improve manufacturing?

Taking a step back from the edge, Rich Carpenter, general manager controls platforms, GE Automation and Control asks, “In today’s modern era, are smart edge devices re-defining the traditional control loop that has been in place for about 50 years? Collect your inputs, run your logic and set your outputs is how we have been doing it for a long time. In today’s world and moving forward, you have to incorporate the results of analytics and optimization that happen outside of the normal control loop. The smart edge device is a critical link between what the traditional control system can do and the rich set of information available at the plant, enterprise and even the ecosystem level that can be incorporated into the day-to-day control decisions.”

WHAT IS A SMART EDGE DEVICE?

“A smart edge device is something that’s able to communicate one or many plant-floor protocols in a way that isolates that network and traffic from the Internet,” says Greg Giles, executive director, MES/Argonaut at RedViking in Plymouth, Michigan. “Sometimes data can be processed on the edge device; sometimes the edge device can simply be a pass-through. In both cases, it’s responsible for passing information to an enterprise- or cloud-level server.”

The edge device that RedViking uses as part of its Argonaut Manufacturing Performance Platform is called a Spearhead. “Sometimes these more complex versions of a Spearhead are incorporated into a hardened HMI or drive some other type of external display,” says Giles. “The simpler implementations are usually small devices without a display.”

Smart edge devices perform information computing, such as data gathering, data storage and analytics, at the device level, says Mike Pantaleano, global business manager—analytics & cloud at Rockwell Automation. “These devices may have cloud gateway functionality, but what truly makes them smart is their ability to manage data and help drive decisions locally,” he says. Manufacturing systems have always used edge devices that are located close to or in contact with the workpieces or material, says Christian Fell, Posital-Fraba. “These include the sensors, actuators, drives and so on that provide real-time information to the control system and carry out its instructions,” he says. “Smart edge devices are just devices that have some level of built-in intelligence, often in the form of an embedded microprocessor. These local microprocessors can
perform tasks such as signal processing to turn analog readings into calibrated, temperature-compensated digital data; condition monitoring; and management of high-level communications interfaces such as fieldbus or industrial Ethernet.”

CONTROL AND ANALYTICS
Smart edge devices may provide control at the edge. “However, a larger use case for edge devices has to do with data analysis, which allows the device to perform some basic analytics onboard and off-line,” says Keith Blodorn, director of the wireless program at ProSoft Technology. “The immediate value of this is reducing the torrent of data that would otherwise need to flow to an analytics engine in the cloud, since transporting that data remains the most expensive part of the big data puzzle.”

That said, an edge device performs a mission-critical role in production at the edge, continues Blodorn, but a smart edge device takes this a step further by continuing to reliably function while offering secure enhanced access, control and visibility into that edge function and edge devices.

Smart edge devices can be used for both the control and monitoring of industrial machines and equipment, notes Nick Butler, Sr., group manager, data acquisition & control product marketing at National Instruments. “The purpose of the edge device is to make the asset itself smart,” he says. “This is done by connecting the asset to the network and allowing the asset to sense and react to its own operating conditions and environment. This results in assets that are not only smarter, but safer, more reliable and better performing.”

At National Instruments, smart edge devices must have the following features or capabilities:

• Ability to interface with sensors to measure conditions inside of and around the machine
• Ability to interface with actuators or other motion systems to control the operation of the machine based on input from the sensors
• Connectivity to other devices in the deployment environment, such as fieldbuses, other machines and SCADA systems, as well as connectivity to the IT/enterprise network, so that the asset becomes a “thing” on the network that can be remotely monitored, managed and controlled
• Durability and a rugged enough exterior to withstand the conditions of a factory or industrial environment
• Internal processing and analysis capabilities to process incoming sensor data and make decisions or control outputs at the asset.

CONTROL, DATA AND SMARTPHONES
“The set of possible smart edge devices that can be used for industrial control is rapidly expanding as ever more compute and sensing capability moves to the edge,” says Greg Olsen, senior vice president, products, at Falkonry. “As long as the device can transform signal observation into operational commands or guidance, it can be considered a control device. Smartness is clearly subjective, but the range can include anything from advanced process control all the way up to artificial intelligence.”

A smart edge device enables communication between operators and ICS/SCADA systems in near real-time, without disrupting, interrupting or altering existing networks and device configurations,” says James Scott, senior fellow, Institute for Critical Infrastructure Technology (ICIT). “Many smart edge devices are able to make coordinated decisions even in low-bandwidth settings or on unreliable networks.”

A smart edge device is some type of connected industrial device designed to gather large amounts of manufacturing data and to have the flexibility to process data or conduct analytics on the device, says Eric Reiner, industrial PC market specialist at Beckhoff Automation. “This same device must also be able to
transmit data vertically to the cloud or other higher-level database systems, such as MES or ERP,” he says. “In terms of the Beckhoff portfolio, these include PC-based controllers, such as compact industrial PCs and embedded PCs that can conduct advanced analytics at the machine and/or push data up via recognized IoT standards such as OPC UA, MQTT and AMQP.”

Edge devices are generally routers or switches that act as a portal for machines to the outside world, says Tom Moolayil, senior technical manager at Universal Robots. “Smart edge devices, in this case, would be smartphones, tablets, car, TV and other devices that are Internet-enabled,” he says. “These devices would have access to the factory floor via standard edge devices, so in tandem I suppose you could refer to them as a smart edge device. The reason it’s smart is it gives unprecedented and easy access to the factory floor.”

**SOME KEY SMART FEATURES**

“Smart devices alone don’t automatically make machines smart,” says Rockwell Automation’s Pantaleano. “A machine requires controllers to orchestrate the proper sequence, turn things on and off at the right time and survey various conditions to optimally control production. In this way, the controller adds a critical layer of context in addition to its control responsibility.”

One example is Rockwell Automation’s upcoming Allen-Bradley CompactLogix 5480 controller, which will have Windows 10 built right into it, continues Pantaleano. “This will create a marriage of mission-critical control with analytics and information,” he says. “New software tools can help to bring analytics to existing edge devices. For example, our new FactoryTalk Analytics for Devices appliance can provide analytics on devices such as drives to transform them into smart edge devices.”

New mobile apps are turning the everyday smartphones in our pockets into smart edge devices, states Pantaleano. “Our FactoryTalk TeamOne mobile app, for example, allows smartphones to be securely added inside the IT network and automation layer rather than coming in from outside Internet,” he says. “Today, industrial companies are using this app to diagnose issues, collaborate with colleagues and instantly connect to automation devices.”

The next generation of the control loop will have an inner and outer loop, says GE Automation and Control’s Carpenter. “The inner loop is the traditional read inputs, do logic and set your outputs,” he says. “The outer loop will gather the intelligence and smart information to make better decisions. This is what drives the need for a smart edge device.”

For brownfield, existing applications, GE has an outer loop smart edge device called a Field Agent—a secure authenticated device that can connect into other information, run analytics and send the information to the control to make better decisions, continues Carpenter. “For a greenfield application, GE has a two-in-one programmable automation controller (PAC) called the RX3i CPE400,” he says. “Part of the controller’s processor is used for deterministic control, and part is used for implementation of the field agent. This is a connected controller smart edge device that can run the inner and outer loop, simultaneously. The industrial Internet control system (IICS) has arrived.”

Other key features include the connection and user interface. “Smart edge devices typically have a serial/Ethernet port or a wireless connection, it may include a TCP/IP stack, and it contains a mechanism for remote users to connect to the smart device using device capable of hosting a, typically HTML5, Web browser,” notes ICIT’s Scott. “Authenticated users can monitor or adjust the system settings through configurable rich graphical interfaces,” he says. “Many smart edge devices do not require proprietary code/
firmware, contain extensive object libraries and have built-in GUI functions."

Hilscher defines the edge as that point of contact where OT control environments connect to IT environments, says Craig Lentzkow, IIoT business development manager at Hilscher. “Hilscher Edge Gateways make the connectivity between OT and IT environments,” he says. “Depending on the product, the Edge Gateways can run customer applications on them to facilitate edge computing, or only stream data from the manufacturing floor to servers, on premise or in the cloud.”

WHY BE SMART?
“There are new IIoT devices designed every day,” says RedViking’s Giles. “We’ve had decades of experience customizing MES, incorporating multiple brands of controllers and software and networks, and, if you’re a very large corporation with millions invested in your legacy systems, you don’t have much choice but to keep recoding that black-box MES software. That’s the whole reason we developed Argonaut. It’s designed to be an anything-to-everything platform. It can receive data from any plant-floor machine or device and send it to anything that can receive an API call. Manufacturing companies won’t have to write new code for every new device or software application, and they won’t be tied to any specific type of equipment. Smart devices are important to the future of manufacturing data, but we believe that flexible software is just as important, if not more so.”

An important reason for building intelligence into an edge device is to off-load tasks from the central controller hardware and have the work done by the edge device, says Posital-Fraba’s Fell. “This can be achieved by using higher-level communications systems such as fieldbus or industrial Ethernet,” he says. “These systems, which make use of local microprocessors or ASIC devices to manage the interface, take care of data communication tasks, such as data packaging, handshakes and error-checks, without burdening the central PLC or microcontroller.”

The two advantages to using a separate edge device for collecting and analyzing data are avoiding load on the PLC processor and providing a configuration paradigm that is geared toward data management rather than machine control, says ProSoft Technology’s Blodorn. “As it relates to machine control, the PLC is an edge computer,” he says. “With the tremendous growth in machine analytics, some of these edge data collection tasks will surely fall on the PLC, while others will find better homes in other devices throughout the system.”

Smart edge devices, such as smart instruments, are especially important for process skids, where the system may be installed in a remote area or not connected to the main control system, says Michael Robinson, national marketing manager, projects, services and solutions, at Endress+Hauser. “Data and analytics from the smart instruments can be sent directly to a plant’s control systems or operators without involving the skid’s control system.”

HOW TO USE THEM
“Using our Argonaut platform, smart device data is captured on a Spearhead edge device and forwarded to a server or the cloud,” says RedViking’s Giles. “It’s all managed from a central location, with apps and updates deployed as needed. It’s efficient because it doesn’t require a plant-floor PC to run or an on-site engineer to perform updates. It’s secure because it uses TLS, token-based authentication.”

Another example of a smart edge device starts with a control system upgrade, by Chicago Electric, in Carol Stream, Illinois, using standard PLCs, drives, sensors and HMI screens. Chicago Electric builds control systems for a variety of applications, including the corrugated container industry. “When a component needs to be replaced or some new functional-

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TECHNOLOGY REPORT: EDGE DEVICES TAKE ON NEW ROLES
ity is required, updating the old software can be a nightmare,” explains Bob Kaska, Chicago Electric’s president. “A control system upgrade frees our customers from the limitations of proprietary components and software.

The task of measuring the precise location of machine components is handled by smart absolute encoders, says Kaska. “Posital absolute encoders have been a key part of our design philosophy since 2008,” he says. “They provide a complete picture of exactly where each component of the machine is positioned, even after a power failure or cold startup. More than 500 Posital encoders have been built into Chicago Electric control systems. The available EtherNet/IP interface supports both operational data communications and full device condition monitoring.”

MAKING ROBOTS SMARTER

“In essence, a smart edge device is a tool that sits on the edge of your private network and allows it to connect to external resources, including the cloud,” says Eric Foellmer, chief marketing officer at Tend. “We use a smart edge device, called a sidekick, as part of our smart cloud robotics software solution, in.control,” explains Foellmer. “The device essentially acts as a router, which connects any robot to our cloud-based control system,” he says. “The user can now control and monitor a Universal Robot, for example, that is tending 3D printers or CNC machines from anywhere using a secure software app on a smartphone (Figure 4). This is a smart edge device using Smart Manufacturing/Industry 4.0 principles today.”

The in.control software and sidekick also give the robot smart vision. “Using a vision-based approach to interfacing with machines is actually a more versatile and forward-thinking approach, for a number of reasons,” says Foellmer. “First, there are many older production machines in use today which can’t be feasibly connected or integrated via a physical network. Our solution leverages the customer’s own cameras to interface with those machines visually, like a human would. For example, it can read a display screen, check on part status or look for errors.”

More importantly, this approach is a more versatile way of interacting with machines in general. “It overcomes the fact that there are so many different networking protocols, proprietary software interfaces and other variables to contend with when integrating directly between machines,” explains Foellmer.

The one thing that all machines have in common, new and old, is that they were designed to interface visually with human beings, says Foellmer. “Because our system interacts with those machines in that way, it eliminates the need to have a standard technology platform that creates those connections,” he says. “So by leveraging a vision-based approach, the robot responds to those visual prompts in the way a human would, and the way it’s been instructed to during the training process—that is, ‘part not ready; move to the next machine.”

SOFTWARE MAKES THE EDGE SMART AND CONNECTED

“One of the main advantages of choosing a software-plus-edge-device approach is that data and configurations aren’t lost in the event of some kind of interruption,” says RedViking’s Giles. “Data is sent from the edge device and stored centrally, so if the plant has some kind of hardware or network failure, they’ll be able to quickly restore normal operating conditions. All of the data and configurations are centrally managed and deployed.”

Another important benefit of smart edge devices is their flexibility and versatility. “The performance characteristics of a smart device can be largely defined in software,” says Posital-Fraba’s Fell. “For example, the current generation of Posital’s incremental encoder can be programmed to have a resolution—number of pulses per revolution (PPR)—anywhere between 1 and 16,384 PPR,” he says. “There is no need to make
mechanical changes to the device. This is useful for system designers, since they can specify exactly the performance characteristics they need, without compromise.”

We have examples of smart edge gateways collecting real-time data of manufacturing processes from one to more than 30 plants, says Hilscher’s Lentzkow. “Data is brought to one centralized location via a software platform running in each plant,” he says. “The platform provides process visualization and sends data in MQTT format to IT software. The Hilscher Edge Gateways connect to the machines collecting process data and the software platform also runs in the Edge Gateways providing the IT connectivity.”

PAST, PRESENT AND FUTURE

“How can smart devices connect and communicate on a plant floor, to a controller and to the cloud, all efficiently and securely,” asks Daniel McGinn, director of business development, SecurePower—IT Business at Schneider Electric. “This is the ultimate question. We are already sitting on a mountain of untapped data and capability. Smart devices and open networks have been finding their way into industrial applications since the early ’90s, often unconnected or only connected in a hierarchical way to upstream controllers.”

While we hear one conference presentation after another and see new articles everyday about the benefits of smart devices, the Industrial Internet of Things, Industry 4.0 and Big Data for Manufacturing, we often ignore the longstanding reasons that there have been specifications in place to prevent that very type of open connectivity, continues McGinn. “Concerns such as uncontrolled access, network intrusion, cybersecurity and system management become front and center in such an enterprise,” he says.

“We used to install these systems and effectively forget about them for years,” notes McGinn. “In an open and connected environment, edge infrastructure needs to be managed and maintained in much the same way as IT systems, but with additional consideration since we are talking about physical systems that can cause harm to themselves or product or even people if not managed properly. Policies, practices and system architectures need to be aligned around these needs. This means specifying high-availability hardware, including network redundancy and UPS backup, much like in IT environments. It also means having strategies for software deployment, patch management, anti-virus and, quite possibly, virtualization.”

The future trend will be to push the data analytic engines from the edge devices down to the actual devices themselves, says Nathan Hedrick, national product manager, flow, at Endress+Hauser. “There are two objectives that the sensor and its associated data are fulfilling,” he says. “First is to control the process, and that will need to be performed by a supervisory element outside the device, and, second, to ensure that the measurements and devices are healthy and performing optimally.”

These smart edge devices will bring the business thinking to the way your equipment runs and get a better outcome for your organization, says GE Automation and Control’s Carpenter. “A whole series of apps will be available to be operated on the various edge devices,” he says. “The creativity will be through the industrial community to deliver value-added applications. Find the app that works best for the application, download it and run it.”

The smart edge devices will help to fuel the app economy for control that doesn’t really exist today. Security is the most important concern. “But you also don’t want some errant app to adversely affect the way a machine runs,” says Carpenter. “The rules for interacting have been defined,” he says. “The deterministic side needs to be perfect all the time, and the smart-edge-device side, such as a Field Agent, uses dialog and negotiation to keep the operators and equipment safe and optimized.”
Empowering workers at the edge

By Chris McNamara, Smart Industry content director

Lockheed Martin’s Rick Boggs presented on empowering humans at the edge during the third-annual Smart Industry conference. Here he shares his thoughts on rethinking how workers work.

**Smart Industry:** How can the value of the IIoT be extended to the human at the edge?

**Rick:** The response depends on the definition of value. Value to the organization is the effect technology has on the cost and schedule of the product being produced. Can the technology really save the organization money and time? At what cost? From the workers’ perspective, they view technology differently than as a cost driver. They want technology that can improve their quality of life on the job while not replacing them. They must think of technology as a job aide or something to assist them to perform their function, not as a threat.

**Smart Industry:** What are the benefits to be gained from considering each human worker a sensor? What pitfalls exist?

**Rick:** There is process-improvement data that can be gained from sensoered workers that could affect the cost and schedule of goods and services produced. An organization could find unneeded/duplicated steps, unseen safety issues, or inventory placement or locations of sub-assemblies that could reduce production costs. Another potential cost reduction comes when an organization starts to trust data provided by these sensors and is able to reduce items like paper reports, quality checks, excess inventory, etc. These are all items that drive up the cost of manufacturing. The biggest pitfall is acceptance by the worker and the organization. Change is hard to implement—critical is the trust issue between management and workers. What is the workers’ trust level that management is not trying to replace them with technology and is not spying on them? Management has to change and accept new policy and procedures that are counter to the way they have always run their organization and controlled their employees. Another management issue is trusting the data gathered and not becoming overwhelmed by it. Data for the sake of data is not a good thing.

**Smart Industry:** What reception have you seen among human workers asked to adopt these tactics/technologies? Are there methods to prompt warmer reception to advances that might spook personnel?

**Rick:** In my experience, it’s the age and education of the employee that drive their acceptance to technology and the changes that it can have on them. By education I don’t mean schooling; I mean the knowledge of the difference that the technology can provide to the worker. And workers that have grown up with technology and show no fear of it have a tendency to adopt new tools easier. The better an organization shares with employees information about the technology or process change, the better it will be accepted. Realizing the cost benefits of these changes requires trust between management and workers... an understanding that implementing this technology benefits the organization, the management and the workers.
Enabling the mobile worker, optimizing performance

By Keith Larson, Smart Industry VP of content

Scott Berg, chief operating officer of ServiceMax, chats with us about the experience gap with technicians in this era of enhanced edge devices, the greatest needs of mobile workers in adopting this new technology, and the industries poised to take most advantage of the Industrial Internet of Things.

Smart Industry: In the modern world, why do fewer operations and maintenance technicians have the depth of experience to act autonomously?

Scott: There are two challenges for today’s technicians. The first is that the nature of the work is changing. Machines are becoming increasingly digital and less mechanical. In addition to learning a broad range of product lines, technicians must also be skilled in software, internet connectivity and a new set of environmental factors that impact the machines they service. Technology has matured to the point where it has democratized access to in-depth information about the installed base, parts and equipment troubleshooting, thanks to proliferation of the cloud, mobile-device-based process management and the Internet of Things (IoT).

These factors are coming together to enable the field-technician workforce to easily access that information and service equipment faster, but technicians also need to have or acquire the digital skills to take full advantage of the technological advances.

At the same time, it’s no secret that the field-technician workforce is aging—experienced techs are getting closer to retirement. So while the industry is indeed looking to smart technology and connectivity to fill skills and tribal-knowledge gaps, it’s also yielding a workforce with an evolving skillset. Some of our customers are applying full-blown data science to their field-service operations, so it’s definitely changing the skillsets that are in demand among large industrial manufacturers.

Scott: GE’s Predix and the integration of IoT into medical devices are the gold standards. GE Predix is in operation today in the energy, transportation and aviation industries. They are leveraging their experience in making and operating magnificent machines and extending it to propel other industries’ journeys to an industrial internet. The medical-device industry is the other early adopter and contemporary benefactor of IoT platforms. Elekta’s Intellimax IoT platform nearly eliminates unplanned downtime for their cancer-treatment machines. In their case, IoT not only improves the efficiency of their business, but it also ensures their machines are available for a patient’s life-saving cancer treatment. What is more exciting than saving a life?

Smart Industry: What industries/fields do you see most benefiting from mobile worker enablement?

Scott: It’s hard to think of an industry with field-service organizations that wouldn’t benefit from mobile enablement, just given the industry norm of frequently being out in remote places. But I would say I see the biggest upticks in productivity, effectiveness and safety lie within the heavy manufacturing, energy, transportation and medical-device spaces. Because these industries are so heavily distributed—with large, immovable machines dispersed across territories—
mobility enables techs to be more efficient in communicating with contacts, conducting business from the field, and freeing them up to finish more jobs at a faster clip. The access to data is also a big one, helping techs on the move reach specific information at any point. For these workers that don’t use a desk as a home base, mobile-device access to conduct business will change their work drastically.

Someone once described the day-to-day challenge of being a field technician to me. The technician wakes up to an anxious situation every day, where they know they need to go out and face unknown problems, alone, and hope that they have the knowledge to resolve the issue. The customer is counting on them. Today’s mobile solutions can alleviate that anxiety and empower technicians by taking away the unknown and not leaving the technician alone. The mobile solution provides detailed service and failure history, access to machine data through IoT, and can even provide real-time, digital collaboration with other experts. The technician now arrives informed, aware and supported by experts.

Smart Industry: What are the greatest challenges for those trying to optimize their mobile workers?

Scott: The transfer of tribal knowledge from technicians with decades of experience to new technicians with a steep learning curve is likely the most challenging aspect. No matter how much technology you infuse into a field-service organization, experience still counts more than anything. To navigate this reality, companies will need to optimize new-hire programs and streamline training to make up for the time it would take for more-experienced technicians to personally transfer sustainable knowledge to their more junior co-workers. The value that mobile technology delivers is providing a mechanism for new technicians to access asset data and maintenance history in order to build knowledge and understanding and apply it at scale. But as I said, that won’t matter so much if the experiential knowledge doesn’t transfer through the ranks, too.
The evolution of the screwdriver

By Chris McNamara, Smart Industry content director

The screwdriver has evolved. Tools on the machine floor are increasingly equipped with sensors, which increasingly makes them data-delivery devices, alongside their primary functions. We chatted with Göran Näslund, head of digital machining at Sandvik Coromant, to explore the challenges and opportunities connected to sensor-equipped tools in use at the edge.

Smart Industry: How do you define sensor-equipped tooling?

Göran: In short, we define sensor-equipped tooling as all cutting tools and tool holders with embedded electronics adding functionality to said tool. That includes various kinds of sensors, processors, energy sources and wired or wireless communication protocols.

Theoretically, there is no cutting tool that cannot be equipped with sensors. However, the smaller the tool is, the more challenging it gets to make this work. Here, the number of sensors plays a role as well. The number of sensor communicating simultaneously are a critical factor, but very much needed for multi-sensing analytics.

Smart Industry: What challenges arise when adding smart tooling to a manufacturing platform?

Göran: Very often the lack of a standard interface or API to communicate machine data bi-directionally at a high bandwidth and higher frequencies is a challenge. Other areas posing potential difficulties are most often connectivity, efficiency, security and data integrity transfer. We have a close relationship with machine-tool builders and others in the value chain, and we believe that we must work together to address these areas and show that we can overcome challenges and together bring solutions to the market. It’s a give-and-take, but some will lead and others will follow.

We have started this journey and shown the potential of intelligence tooling, which is just one area of our integrated Industry 4.0 platform, called CoroPlus.

Smart Industry: What’s on the horizon of edge technology that most excites you?

Göran: It’s not so much a specific tool that’s exciting and fascinating, it’s more the sum of possibilities this technology can ultimately offer to customers. The potential for process security and reliability, efficient resource utilization, close-loop process automation, just to name a few. But there are other aspects that come to mind, like low threshold plug-and-play manufacturing with embedded knowledge in machines, systems and tools. I believe that, once fully utilized, this technology offers efficiencies we have not seen in industry in a very long time.
“We look for people constantly willing to learn new things and to not be satisfied with the status quo.” Boeing Research & Technology’s Paul Davies on the attitude he seeks to cultivate among workers within the company’s Advanced Production Systems group.

Preparing a new generation of workers for careers in industry is challenging enough. Add to that a demographic wave of retirement among experienced workers, new technologies with undefined requisite skills, and our propensity to informally pass knowledge from senior workers to new recruits like tales around a campfire, and industry today finds itself in a skills-development crisis.

“One of the things we’ve been wrestling with is how to digitize that tribal knowledge and essentially institutionalize things like best practices and present it in a medium that the new workforce can take advantage of,” explained Schneider Electric’s Rob McGreevy during a panel discussion on these and other personnel productivity issues at the Smart Industry conference. McGreevy said that the new generation of workers come in expecting things to be mobile and solution-oriented. This is a large change for an industry where the environment has traditionally been more modular and protected. “Simulation and training using virtual reality,” said McGreevy, “is one way of taking counter-performing test activities and, for example, instead giving a test simulation on how to deal with a fire.”

New tools simulate, augment industrial reality

By Naomi Price, conference content director at UBM’s Advanced Manufacturing Expos & Conferences

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“One of the things we’ve been wrestling with is how to digitize that tribal knowledge and essentially institutionalize things like best practices and present it in a medium that the new workforce can take advantage of,” explained Schneider Electric’s Rob McGreevy during a panel discussion on these and other personnel productivity issues at the Smart Industry conference. McGreevy said that the new generation of workers come in expecting things to be mobile and solution-oriented. This is a large change for an industry where the environment has traditionally been more modular and protected. “Simulation and training using virtual reality,” said McGreevy, “is one way of taking counter-performing test activities and, for example, instead giving a test simulation on how to deal with a fire.”

New workers also find it difficult to prepare for future needs when they don’t know what tools they will be using in, say, three years’ time, said fellow panelist Paul Davies, associate technical fellow in the Advanced Production Systems group at Boeing Research & Technology. “We look for people constantly willing to learn new things and to not be satisfied with the status quo, but being open to change. That has worked out well for me and for my team,” he explained.

In the past, operators were taught using a manual paper-based or flat human-machine interface (HMI) visualization screen. Now with virtual reality (VR) programs, the worker can be fully immersed in the environment, even at the edge. They can do a simulation where they literally walk through a virtual refinery and simulate a shutdown in a fire scenario. In this simulation, McGreevy said, workers even pick up the gear needed for the exercise. Going through the scenario, they experience not only a projection of the physical plant, but also the control systems.

ENGAGEMENT BOOSTS LEARNING EFFICIENCY

A major benefit of VR is that it gives workers the opportunity to get out of the classroom and onto the floor more quickly, said Barry Po, senior director of product development at NGRAIN, a provider of interactive 3D augmented reality and virtual reality technology. He pointed out that workers are able to engage with the content and become expert much more quickly, because of the improved student to object connection gained by the simulation.

“Spending less time in the classroom is obviously a big thing, especially when you work with a lot of workers who may have high turnover,” continued Po. “It’s very expensive to train people in the classroom. It’s even more expensive when you realize that training them up to the level where they are expert is very
difficult when all they’re doing is passively accepting knowledge. One of the things you can do in VR that you can’t do by reading a textbook is to actually get the student engaged with the content, because they’re actually doing the task as opposed to just learning about it through rote knowledge.”

JUSTIFYING INVESTMENTS
If the training method being used at your plant right now seems sufficient, how do you justify the expense of improving training with new virtual technologies? Sometimes the simplest solution is still the best. In some situations, taking a video of a task being performed and using that for training may be the best way to pass along the necessary information.

If the task is more complicated, then a higher-technology solution may be worth the investment. At Iowa State University, for example, Davies worked with a group to test the value of augmented reality (AR) training over more traditional training methods. Student participants were asked to put together a mock airplane wing. One group had instructions on a desktop computer, another on a mobile tablet. The last group had the instructions converted to an AR registered as an overlay on the assembly. In this case, a blue digital object in the form of a 3D model was rendered on the screen in the proper position for assembly, as if it were in the physical world.

The testers found that the group using the AR instructions experienced a 90% reduction in the number of errors during the assembly when compared to the group using instructions on the desktop computer. The time to build the wing was also reduced by about 35%.

McGreevy suggested identifying the training areas that will deliver the most value—start smaller where you will see the biggest returns. Start with the current state as a benchmark and then do an assessment. Look for others who have implemented similar improvements instead of reinventing the wheel. It also makes sense to standardize processes so that you can roll out one solution across multiple sites rather than making changes piecemeal.

“We try to dissuade companies from doing a big bang investment,” added Po. “It’s better to set aside a certain amount of capital for improvements so that, when the technology becomes available, you have the capital ready.”

PRACTICAL IMPLEMENTATION
There can be great value in involving workers early in the design process. “If people are engaged in the design cycle, their willingness to adopt is much greater,” pointed out Po. “If change is forced upon people, then acceptance will be far less.”

Davies agreed that it’s critical to involve end users through development to get the best adoption. “First we would tell them what we’re trying to do so they understand the goal. Then we develop the first iteration, and work with them while they do their job with the tool. Then, after a couple weeks using the new tool, we’d ask what the workers liked and what didn’t work with it,” Davies explained. “Then we’d make changes. For example, they might have suggestions for new features that they’d like to see, so we would add those features and really get them engaged in the whole development process. You just get much better adoption if you make the user a stakeholder.”

“One of the things that’s really important as well as having the technology,” Po said, “is to have the culture to embrace change and just accept it as the natural course of how the business will operate going forward.”

Technology can sometimes become a crutch, and planners are cautioned not to view technology as the replacement for a skill. Keep in mind that you should balance the need and desire for new technology with the fact that it will sometimes fail—and you need to be able to cope without it.