Panasonic

The Engineers' Guide to Smart Sensors

Connecting every link in the supply chain

For manufacturers, the transition to Industry 4.0 has meant the accumulation of data, massive data. Indeed, the accumulation, distribution and evaluation of data are driving virtually every decision on the manufacturing plant floor and supply chains shaping those decisions. Given the striking fact that ninety percent of the data in the world has been created over the last two years, it isn't surprising that more than 60 percent of large companies report having a Chief Data Officer. But what has opened the floodgates to this deluge of information in manufacturing? Ordinary sensors have been transformed into smart sensors with the advent of IoT technologies and are being deployed by manufacturers along every step of the supply chain. Sensors are now detecting everything from when a piece of equipment will need maintenance to controlling energy costs inside factories.

Eyes and ears and hands

A new wave of IoT sensors is wringing ever-increasing value out of manufacturing machinery. Temperature and pressure sensors use AI to monitor machinery and trigger maintenance by predicting failures. Proximity sensors keep workers out of harm's way from dangerous machinery. Optical sensors enable self-driving cars. Pressure sensors detect leaks in hydraulic equipment and optical touch sensors let workers perform repetitive motions without the risk of carpal tunnel syndrome. The common element found in today's IoT sensors is that they utilize built-in microprocessors that digitize data which is transmitted to a local computer for edge processing or directly to the cloud. The data is often combined with information from multiple other sensors and converted into actionable information that's leveraged to enhance value.

Making machinery work harder and smarter

The Industry 4.0 manufacturing facility couldn't be further from the sometimes dirty and dangerous shop floor of previous generations. Manufacturers are taking risks with enormous capital outlays on robotics and other costly machinery. Maintenance based on the age of a piece of equipment has proven inefficient over time with only a small percentage of machine failures being attributed to age. Preventive maintenance hasn't fared much better at increasing productivity as technicians would often discover unexpected wear upon removing a service panel, leading to unscheduled downtime.

Smart sensors combined with machine learning are turning traditional maintenance schedules upside down and machine downtime right side up. IoT sensors detect and output data on vibration, temperature, friction and other key metrics which undergo cloud-based analytics using sophisticated algorithms combined with AI to generate predictive maintenance schedules. A recent Deloitte study estimates that sensor-based predictive maintenance scheduling can increase productivity by 25% by reducing breakdowns by 70% and lowering maintenance costs by 25%.

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Sensors making shop floors safer

IoT sensors on the shop floor are keeping workers safer and out of harm's way. The oil, gas and mining industries have begun outfitting workers with wearable sensors that transmit vital signs to the cloud where they're analyzed in an attempt to pinpoint activities or locations that might trigger increased heart rate or elevated blood pressure. Remote physicians can recommend reassignments lessening the risk of a costly job-related injury. Insurance companies have taken a keen interest in wearable sensors, especially as it relates to workers compensation claims.

The proliferation of smart sensor technology along with their increasing miniaturization is also giving manufacturers a more cost-effective method of complying with often demanding standards set by OSHA. Panasonic safety light curtains are a prime example. "The factory floor is a valuable asset and every square inch is expected to contribute to the bottom line," says Josh Ardus, Group Sales Manager at Panasonic Industrial Devices Sales Company of America. "The sensor technology we've developed has allowed us to greatly reduce not only the size but also the cost of our light curtains to the point that ROI is almost immediate, not only in terms of costs associated with worker injuries but also with compliance. OSHA is pretty unforgiving when it comes to installing safety equipment around machinery and a single fine is typically more than double the cost of the device," he points out.

Saving energy with sensor technology

For most manufacturers, energy usage constitutes a significant portion of operating costs. When you consider the extraordinary amounts of power consumed by large manufacturers with 24/7 operations, the ability to reduce consumption by even a small percentage could result in hefty increases to the bottom line. IoT sensors can gather and deliver data in real time to a central hub for sophisticated analysis. Downtime for energy-hungry machines can be predicted and those machines can be powered down automatically during lags. Electric motor-powered equipment can be monitored in real time and consistent overloads, which trigger costly spikes in energy usage, can be corrected by either changing the manufacturing method or switching to larger motors. Factory scheduling can be flipped so some equipment is used only during off-peak hours when energy from the local utility is discounted.

Sensor retrofits: challenges and opportunities

Industrial application IoT sensors often conjure images of high-tech shop floors powered by robotic arms and workers in sterile uniforms – think the Droid Factory in Star Wars. The reality, however, is often markedly different. In many cases, manufacturers are still trying to recoup investments in machinery that's 20 or 30 years old. Upgrading older equipment to Industry 4.0 capabilities requires, among other things, retrofits with smart sensor technology which presents its own set of formidable challenges beyond the obvious fact that legacy equipment rarely has any kind of built-in connectivity. A comprehensive analysis of each piece of equipment must be conducted to determine exactly what needs sensing and why. Where should we measure vibration? On what part of this machine would elevated temperature indicate a problem?

One vehicle manufacturer was profiled in a Wall Street Journal Article for its ongoing effort to retrofit older equipment with IoT sensor technology at a large factory. In the article, the plant manager talked about the challenges involved. "Often plant managers can't tell which sensor will most accurately collect the data they want from a machine without a series of test runs – a time-consuming process. But with the complexity comes opportunity." Once the vehicle manufacturer determined the type of sensors needed and the optimal position, they moved on to the challenge of installation and calibration which required highly-skilled engineers. Despite a series of frustrating setbacks, the end result was worth it. The company's newfound confidence in the system has allowed them to rid the factory of redundant equipment kept around as emergency backups. The plant manager offered praise for the factory's newly established sensor-based predictive maintenance plan saying "the machines are (now) lasting longer than the electronic components that control them."

Overcoming the language barrier

Sensors have the ability to generate large amounts of data but processing and getting it securely to the cloud poses multiple challenges. Newer sensors have sophisticated data transmission capabilities including Bluetooth, Wi-Fi or direct connection via ethernet. Legacy sensors, however, often depend on PLCs which necessitate an additional layer of data processing at the edge. Determining and then configuring an effective architecture that accounts for disparate protocols is critical to successful IoT implementation.

Sensor-enabled Autonomous Vehicles – driving more than just people

The gee-whiz reaction by pop science aficionados to the reality of self-driving cars has overshadowed a parallel and perhaps equally important application for autonomous vehicle technology. Without question, the space in which autonomous vehicles are poised to cause the largest disruption is in the extended supply chain where trucks account for nearly 63% of the tonnage and 62% of the value of all goods shipped in the U.S. Researchers believe the era of self-driving trucks is just around the corner.

And we're not as far away as you might think. Daimler trucks began testing highly automated vehicles on Virginia highways in September of 2019 with Level 4 capabilities. The Society of Automotive Engineers defines Level 4 as full, self-driving capability but with some restrictions, second only to Level 5 which defines unrestricted driverless operation.

Autonomous Vehicle technology has in fact moved from the drawing board and has been fully implemented in certain industries. Caterpillar's Cat Command Hauling System uses radar and lidar for obstacle detection and proximity awareness to autonomously drive multiple off-highway haul trucks in open pit environments, according to a recent report in Industrial Vehicle Technology. Trucks load and dump materials while navigating a network of haul roads – all without human intervention. Additional sensors monitor machine health with data fed to software that generates predictive maintenance schedules. The results have been impressive. "Command has achieved a 30% production improvement compared with standard trucks with operators onboard. The trucks have moved over 700 million tons of material safely over the last 5 years ... and the number of mining companies deploying the system is growing," Caterpillar Automation and Autonomy Product Manager Joe Forcash told Industrial Vehicle Technology.

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Driverless forklifts are nothing new, but their newfound freedom enabled by smart sensor technology certainly is. No longer limited to following a painted stripe on the floor, a new generation of autonomous forklifts use camera-based sensors to "see" an environment and make onboard decisions accordingly based on interpreted data. These forklifts can navigate complex routes from the loading dock to anywhere on the factory floor, while choosing the fastest and safest route.

But adoption of autonomous vehicle technology by manufacturers is moving slowly as the cost of sensors – and the challenges of correctly implementing them – remains a stumbling block. A 2018 study by PwC found that only 9% of U.S manufacturers had adopted some type of autonomous mobility within their operation with 60% citing costs as the primary barrier to entry. Those costs are directly related to the three types of sensors found in the majority of AV sensor suites – image (cameras), radar and lidar. As each technology has its strength and weakness, at least two must overlap and work in complementary fashion.

Sensing what's over the horizon

IoT driven sensor technology will no doubt follow the well-worn path of other technologies with industrial-application roots and eventually migrate into the consumer sphere. Ali Akansu, Ph.D, is a professor of Electrical and Computer Engineering at New Jersey Institute of Technology and sees a future where smart sensors have an oversized influence in our everyday lives. "You're already seeing smart clothing with sensors built into the fabric that monitor your heart rate and other vitals. Next they'll have the ability to call 911 should you become incapacitated." Shoe manufacturers including Nike and Under Armour are already marketing smart shoes that sense how far you've walked or whether they're laced too tightly.

Whether they're looking at products or product lines, manufacturing leaders increasingly rely on disruptive technologies to accelerate their businesses. They're investing to improve things like personalization and communication and see how IoT, artificial intelligence, robotics and other key Industry 4.0 technologies will play a critical role in their business – if they don't already. These technologies are expected to generate trillions in economic value in the decade ahead. Panasonic is deeply engaged in these technologies. We believe that connecting them into integrated solutions is essential to creating entirely new experiences, increased efficiency and ultimately profitability across the entire integrated supply chain.

Laser Markers and the Internet of Things

From R&D to transport and supply chain management, the ability to connect equipment over Wi-Fi and Bluetooth networks is transforming the way manufacturers operate. Companies expect productivity to grow over the next half-decade at a rate seven times the growth industry has seen since 1990, according to market research firm CB Insights. As network technology continues to advance – consider, for instance, Bluetooth 5.0 and the rise of mesh networks – the potential to connect entire factories utilizing IoT technologies becomes more feasible.

Not only is IoT having a major impact on the development, operation and output of sensors, the disruptive technology is also changing laser marking. Previously, large manufacturers with many laser marking machines would manually register a new job each time a new order came in. The process proved time consuming and inefficient. Today we have systems to meet the needs of smart manufacturers by streamlining this process – connecting automation and laser marking to the Internet of Things.

The connection can work in different ways, one of which uses a programmable logic controller that serves as a smart board, allowing one factory manager to manage multiple jobs or automation lines simultaneously and remotely. The approach allows a manufacturer to integrate automated part marking into their processes. Many systems use a remote API built for bi-directional communication and that enables factories to connect their PLCs to their laser marking devices.

> Panasonic has pioneered laser marking system innovation for the past two decades, and we're always looking at how to bring new and disruptive technologies to the factory floor.

We have a broad range of laser marking systems and thanks to the wide variety of products, our expert team can develop customer-specific marking solutions for any number of applications and industries.

Want to learn more about how Panasonic's tech can help power your manufacturing project? Visit us at **na.panasonic.com/us/industrial-devices/industrial-automation**.