INSIDE: Road to IANA 39, *Control Engineering* International 14, 28

CONTROL ENGINEERING

JUNE 2016

Covering control, instrumentation, and a ns worldwide

Additive manufacturing advancements 22

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We have designed many "field-friendly" features into the Productivity2000 PLC because we understand the pressure that can come with field installations and start-ups. We want you to have everything you need to keep your install on track and your startup on schedule. From OLED displays to QR codes, the features listed here are just a few examples of the many ways Productvity2000 can save you time in the field, which also saves you money!

To get the whole story and see even more ways to save, head on over to www.Productivity2000.com

Field-frie

1 Trouble-free Troubleshooting

The standard OLED message display on the P2-550 CPU gives you instant status on your controller and can be used to display system faults. Also, each analog I/O module includes a high-contrast OLED so you can view fault conditions and analog values such as voltage, current, and temperature without having to disconnect signal wires to get a reading with a meter.

2 Convenient QR Codes

When the pressure is on, don't waste precious time searching for needed documents. Get wiring diagrams, installation instructions and specifications by simply scanning the QR code tab on each Productivity2000 I/O module.

3 Configurable Hot Swappable I/O

Don't lose production for simple I/O module changes. The Productivity2000 CPU can remain in the RUN mode without the user-selected I/O modules installed. Choose to allow any module to be removed or configure each module separately.

4 ZIPLink Pre-wired Solutions

The Productivity2000 I/O modules have multiple wiring options available. Use standard terminal blocks, or our ZIPlink pre-wired cables and connector modules (available for most modules). ZIPlinks not only provide tremendous wiring time savings but can also provide fused isolation from field devices, clean wireways with easy, field-traceable connections, and confidence that your panel wiring is correct.

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Productivity2000

endly Features for LESS!

Don't forget that our field-experienced and highly-trained technical support specialists are ready to help, FREE of charge. Give us a call at 1-800-633-0405, we're available 9am - 6pm ET on weekdays.

We also offer FREE 2-day shipping and a 30-day money back guarantee for any of those last-minute modifications.

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1-800-633-0405 www.AutomationDirect.com

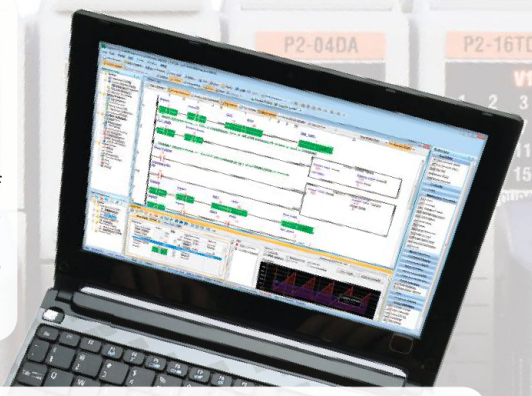
Break FREE from the traditional PLC experience and save!

Save time and money NOW...

Productivity2000

Built-in Cost Savings

The Productivity2000 PLC is designed with many built-in cost savers. The CPU comes standard with on-board data logging and more communication options than anyone else (5 comm ports). It also includes three of the most widely used protocols in the industry (Modbus RTU, Modbus TCP/IP, EtherNet/IP) so no separate communication modules are needed!



5 COMM PORTS

Ethernet
Remote I/O
USB
RS-232
RS-485

FREE Intuitive PLC Software

The **FREE** Productivity Suite PLC software works hand-in-hand with many field devices and third party software. This integration gives this PLC a clear advantage, and gives you a head start with system development. Here are just a few examples:

- **Built-in Function Blocks:** Specialized, fill-in-the-blank style function blocks for many operations including communication with EtherNet/IP devices and servo/stepper motor control.
- **Shared Tagname Database:** Export the tagname database from the software and easily import it into C-more HMIs, Point of View SCADA software or other 3rd party database software to jump start your project development.
- **Auto-discovered Hardware:** The Productivity Suite PLC software will automatically configure installed I/O modules - your system is recognized and configured without any manual setup. Up to 16 GS Series AC drives can also be auto-discovered and their parameters stored in the CPU for future reference.

PLC CPU and I/O Comparison	AutomationDirect Productivity2000	vs.	Allen-Bradley CompactLogix
Base (if required)	$69.00 P2-04B		N/A N/A
Power Supply	$69.00 P2-01AC		$427.00 1769-PA4
CPU	$255.00 P2-550		$3,220.00 1769-L33ER
16 AC Inputs	$105.00 P2-16NA		$264.50 1769-IA16
16 24VDC Inputs	$69.00 P2-16NE3		$222.00 1769-IQ16
8 Relay Outputs	$51.00 P2-08TRS		$275.50 1769-OW8I
8 Analog Input Channels (mA)	$199.00 P2-08AD-1		$797.00 1769-IF8
ASCII Comm Module	$0.00 Built in to CPU		$752.00 1769-ASCII
Modbus RTU Comm Module	$0.00 Built in to CPU		$736.00 1769-SM2
Total System Price with USB, Ethernet and Serial	$817.00		$6,694.00

All prices are U.S. published prices. AutomationDirect prices as of 4/27/2016.
Allen-Bradley retail prices taken from www.plccenter.com 4/18/2016.

Own It, Don't Owe On It!

Buying direct with us saves you money. With Productivity2000, you get many standard features that you would pay thousands for elsewhere. Our P2-550 CPU is priced at $255 and I/O modules start at just $40 (P2-08NE3). We aren't a traditional PLC company - we are here to serve YOU! So check us out!

Visit: www.Productivity2000.com

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COVER: Liberty Science Center in New Jersey created an exhibit with a robot named SARA (Stevens Artistic Robot Animatron), created by students at Stevens Institute of Technology in Hoboken, N.J. SARA integrates 3-D printed parts and motion controls. Courtesy: Stevens Institute of Technology

Features

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Want to Stay Ahead of the IIoT Curve?

As an operations manager or engineer, one of your first challenges will be getting **all of your devices connected** to the internet.

Luckily, we've collected some great resources to guide you with this.

Here are some of the topics we cover:

- Calculating payback on your investment
- Addressing cyber security concerns
- Achieving device interoperability
- Connecting industrial devices to the internet

Learn more at

pages.moxa.com/IIoT

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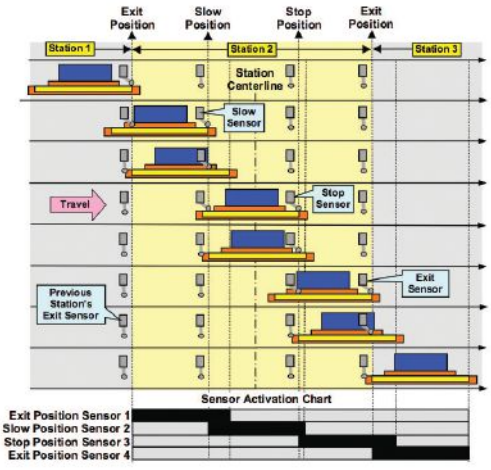
Inside Machines

Appears after page 41; If not, see the Digital Edition:
www.controleng.com/DigitalEdition

Departments

News



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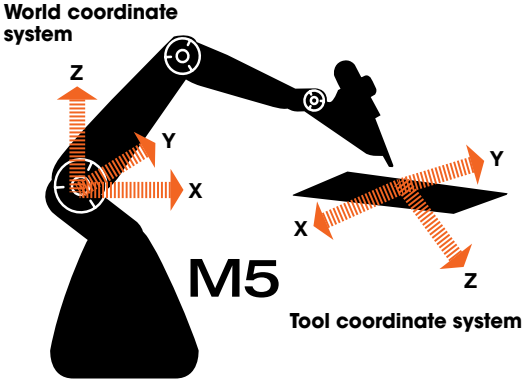

Products

77 Robots for manufacturing, automotive applications; Mass flow control for OEM and process integration applications; Ultrasonic sensor for detecting layers and splices; Photonics alignment platform for automated production environments; Servo motor and amplifiers for designers and end users

78 Power distribution boxes for long cable runs; Stainless-steel, explosion-proof junction box; Explosion-proof, linear position sensor

JUNE
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More resources posted daily at:
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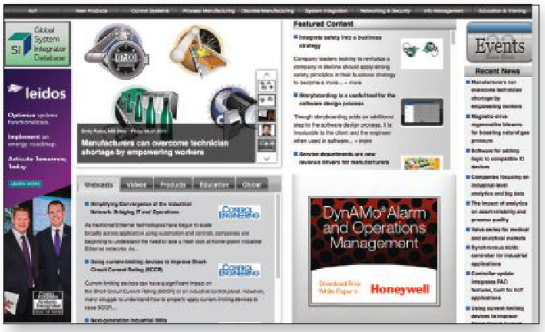
Trending | New Products | Control Systems | Process Manufacturing | Discrete Manufacturing | System Integration | Networking & Security | Info Management | Education & Training

Manufacturers can overcome technician shortage by empowering workers.

There's a lot more to read online. Go to www.controleng.com/news to read *Control Engineering's* exclusive Web content.

- Storyboarding is a useful tool for the software design process
- Integrate safety into a business strategy
- U.S. continues to lead in natural gas production
- Taking safety measures to prevent a Black Swan event.



NEWSLETTER:
PROCESS & ADVANCED CONTROL

Neural networks in process control: Neural network training, implementation

Keep up with the latest industry news by subscribing to *Control Engineering's* 14 newsletters at www.controleng.com/newsletters

- Process historians can be an integral part of the IIoT
- Modern control valves offer communications, diagnostics
- Managing automation upgrades retrofits.

Point, click, watch

VIDEO:
Engineering Leaders Under 40

Control Engineering and *Plant Engineering* are now accepting nominations for the 2016 Engineering Leaders Under 40 program to those who have made significant contributions to their plant and to the control engineering and/or plant engineering professions. Nominees must be working professionals who are under the age of 40 as of Sept. 1, 2016. Nominations close June 24, 2016.
www.controleng.com/videos

engineering leaders <40

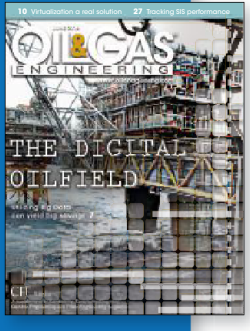
On-demand webcasts

Couldn't catch a recent webcast? See it on-demand at www.controleng.com/webcasts.

CONTROL ENGINEERING Webcasts

- June 2: IIoT Webcast Series 2016, Part Two: Information Management for IIoT
- May 18: Using current-limiting devices to improve Short-Circuit Current Rating (SCCR)
- May 17: Simplifying Convergence of the Industrial Network: Bridging IT and Operations
- April 14: Next-generation Industrial HMIs

Oil & Gas Engineering June issue



Oil & Gas Engineering provides industry-specific solutions designed to maximize uptime and increase productivity through the use of industry best practices and new innovations, increase efficiency from the wellhead to the refinery by implementing automation and monitoring strategies, and maintain and improve safety for workers and the work environment. Read the digital edition at www.oilandgaseng.com

Digital Edition

The tablet and digital editions have unique content for digital subscribers. This month has digital exclusives on: IoT to IoAT: Internet of Autonomous Things: 7 ways to qualify for the research and development tax credit.

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Help with IIoT, digital manufacturing

Why organizations are helping with Industrial Internet of Things (IIoT), Industrie 4.0, and digital manufacturing: No one wants to miss opportunities to accelerate.

Many organizations are offering to help with implementation of Industrial Internet of Things (IIoT), Industrie 4.0, and digital manufacturing methods and technologies, in part because of the large measured and perceived benefits of using these frameworks, as explained at the MESA 2016 North American Conference last month.

There's business value at the intersection where manufacturing meets information technology (IT), according to Mike Yost, president, Manufacturing Enterprise Solutions Association (MESA) International. MESA offers education to help resolve issues in the way of success. Yost noted: "We see more people interested in intersection of manufacturing and IT than ever before."

Many organizations involved

Academia, industrial companies, technologies partners, and others are collaborating on how to build technology systems for smart manufacturing, said Mark Besser, a Smart Manufacturing Leadership Coalition (SMLC) board member and an SMLC technology advisory committee member. That's happening with a confluence of traditional plantwide options and connectivity that reaches deeper into organizations and farther into the supply chain, making data visible, in an agile and sustainable way, Besser said.

Digital manufacturing is the clever use of data at every stage of design and manufacturing, capturing, analyzing, and making sense of data to move products down line more competitively to retain and bring more U.S. jobs, explained Jacob Goodwin, director of membership at the Digital Manufacturing and Design Institute (DMDII).

Goodwin said a digital thread connects software and tools, intelligent machining uses sensors to monitor conditions in real time to keep processes with specifications, and advanced analytics are used to get data and derive benefits. DMDII is a federally funded research and development organization of UI Labs that encourages U.S. factories to deploy digital manufacturing and design technologies to become more efficient and cost-competitive.

Imagine that regulations require updates to a product design where detailed documentation no longer is available. Digital tools might allow needed design changes within hours that might have otherwise taken months, Goodwin said.

Accelerating changes

Adoption, Yost said, may not be as much technological in challenge as cultural hesitation about investments and changes required within organizations.

That said, test beds demonstrating benefits are well underway, so think again if you haven't yet begun.

Within 18 months, Goodwin suggested, anyone not yet deploying these concepts will be left far behind competitors. **ce**

Mark T. Hoske, *Content Manager*
MHoske@CFEMedia.com

MORE ADVICE

MORE ADVICE

To help subscribers and other site visitors accelerate, *Control Engineering* gathered related IIoT coverage: Click on IIoT, upper left, at www.controleng.com.

See also related newsletters.
www.controleng.com/e-newsletters

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Mobile electrical apps

Electrical mobile applications have potential to help engineers do their jobs. CFE Media's Apps for Engineers is an interactive directory of engineering-related applications for Apple iOS and Android operating systems from various companies. Apps are organized by category, company, and type. These are listed in the app as of May 2016.

22mm Operator Interface Visual Product Configurator

iOS 5.1+

Cost: Free

Company: Schneider Electric USA Inc.

Website: www.schneider-electric.com

The 22 mm Visual Product Configurator is an interactive tool which simplifies the selection of Schneider Electric 22 mm chrome and plastic push buttons, selector switches, pilot lights and available accessories. Users select an operator type, its available options (such as voltage and color) and add available accessories. The selected items are added to a parts list which contains links to each part number's detail page on our Web site. The parts list can also be sent via email.

Baldor VFD Selector

iOS 5.0+, Android 2.1+

Cost: Free

Company: Baldor Electric Co.

Website: www.baldor.com

This easy to use app will select the appropriate Baldor VS1 or ACB drive for your application. The app uses the electric motor's full load amperes (amps), the source voltage and a few required attributes such as enclosure type and overload capability to select the appropriate drive. The results are displayed on screen and can be emailed as a PDF document.

Conduit Fill Calculator

iOS 6.1+, Android 4.3+

Cost: Free

Company: Southwire Co.

Website: www.southwire.com

The Conduit Fill Calculator provides quick and easy navigation to all NEC needs. Enter the Conduit type and size and specify your conductors. The App will calculate the Conduit Fill % as per NEC Guidelines.

Electrical Wiring Pro

iOS 9.0+, Android 1.6+

Cost: $0.99, $3.99

Company: Intineo LLC

Website: www.intineo.com

Electrical Wiring Pro has more than 40 useful electrical calculators and tools. It is intended for engineers and other electrical professionals.

Intelligent RTU

Cloud-Ready for Industrial IoT

ADVANTECH

Enabling an Intelligent Planet

The ADAM-3600 RTU is an unique combination of a rugged RTU and versatile protocol gateway. It easily integrates and controls field devices such as motors, valves, smart meters, and sensors via its flexible Advantech TagLink and IEC 61131-3 software. The ADAM-3600 has many Cloud-Ready connectivity and protocol options to enable rapid Industrial IoT application development.

Robust & Open Control Kernel

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- Built-in SQLite databases for time stamped data logging

Cloud-Ready Communications & Protocol Gateway

- Modular wireless support
- Supports Modbus, DNP3, IEC-60870, RESTful, NTP protocols
- Pre-integrated with Advantech WebAccess/SCADA software for true edge-to-cloud communications

ADAM-3600-C2G
Linux-based Intelligent RTU with 8x AI, 8x DI, 4x DO, and 4-slot expansion

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ADAM-3656
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ADAM-3617
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CONTROL ENGINEERING research

2016 CYBERSECURITY STUDY:

Six cybersecurity key findings

Respondents to the *Control Engineering* 2016 Cybersecurity Study identified six high-level findings impacting control systems today:

1. Threat levels: 48% of respondents perceive their control systems to be moderately threatened by cyber attacks, while 25% say theirs are highly threatened and 9% are at a severe threat level.

2. Most concerning threat: Malware from a random source is the most concerning control system threat for 37% of respondents. Another 21% are worried about an attack through a vulnerable device, and 17% fear theft of intellectual property or attacks as part of a larger attempt to disrupt critical infrastructure.

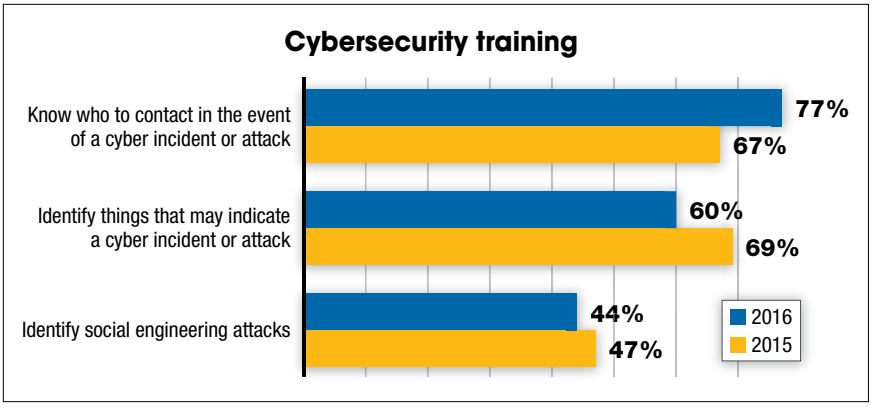
3. Vulnerable system components: The most vulnerable system components in respondents' organizations are computer assets with commercial operating systems (70%), network devices (68%), and connections to other internal systems (64%).

4. Vulnerability assessments: 26% of respondents reported that their organizations have performed some type of vulnerability assessment within the past 3 months. On average, facilities have checked vulnerabilities within 8 months.

5. Cyber-related incidents: Six in 10 respondents have experienced a malicious cyber incident into their control system networks and/or control system cyber assets—that they are aware of—within the past 24 months. Forty-six percent of these attacks were accidental infections, 18% were targeted in nature, and 36% were both accidental and targeted.

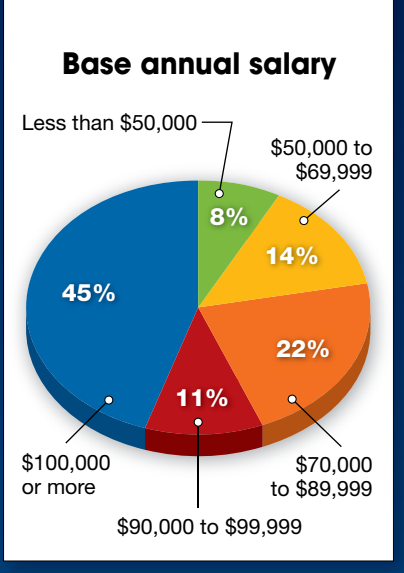
6. Mobile devices: Thirty-two percent of organizations do not allow mobile devices—such as smart phones and tablets—to connect to networks or enter work areas. Of the facilities that do allow mobile device use, 47% allow them to connect to networks and enter work areas. **ce**

View more information at www.controleng.com/2016CyberSecurity.
***Amanda Pelliccione** is the research director at CFE Media, apelliccione@cfemedia.com.*



Seventy-seven percent of organizations inform their employees about who to contact in the event of a cyber incident or attack, compared to 67% in 2015, although fewer were taught about things that may indicate an attack. Courtesy: *Control Engineering*

www.controleng.com/ce-research FOR MORE RESEARCH INFORMATION



The average base annual salary earned by respondents to the 2016 Salary and Career Survey was nearly $95,000. Source: *Control Engineering* 2016 Salary and Career Study

$246,309: Average system integration project size survey respondents are involved with. Source: *Control Engineering* 2015 System Integration Study

40% of facilities are currently using elements of both the Industrial Internet of Things (IIoT) and Industrie 4.0. Source: *Control Engineering* 2015 IIoT, Industrie 4.0, Information Integration Study

53% of end users consider the lack of appropriate technologies and lack of training or enforcement to be major risk factors to control system cyber security. Source: *Control Engineering* 2016 Cyber Security Study

More research

Control Engineering covers several research topics each year. All reports are available at www.controleng.com/ce-research.

Standard unmanaged 10/100 options and now Gigabit 5-, 10- and 20-port options!

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Industrializing Ethernet, Simplifying Industrial Communication

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Industrial Big Data: Core competiveness of manufacturing enterprises in the future

At the Big Data and Intelligent Manufacturing Salon held in Changsha, China, experts from various disciplines discussed how industrial Big Data will shape future manufacturing and bring new services that focus on customization and commercial needs, according to *Control Engineering China*.

The Industrial Big Data Application and Intelligent Manufacturing Salon was held in the Sany Heavy Industry headquarters in Changsha this month. The salon gave participants deep understanding on how to create intelligent plants in the Industrie 4.0 era by using Big Data.

One of the first intelligent manufacturing demonstration projects in China is the Sany No. 18 factory building. The total building area is about 100,000 square meters, with multiple assembly lines: concrete machinery, pavement construction machinery, and harbor machinery, etc. Digitalized factory emulation technique has been applied for scheme design and verification. The factory moved from a traditional discrete manufacturing model to high-flexibility, mixed loading of multiple product types and flow mode.

"This is a smart factory building integrating [a] large-scale computing system, traditional operating tools, and large-scale production equipment. Each production process, quality test, and the workload of each worker will be recorded; over 1TB data will be produced weekly for the factory building; the data is used to boost production and improve intelligence and flexibility. Multi-type and small-batch production can be achieved. This will improve efficiency, reduce cost, and guarantee quality," said Dongdong He, the vice president and chief process information officer, Sany Heavy Industry.

"We perform networking and status monitoring for 200, 000 engineering machineries; 200 million pieces of data are uploaded each day, and now the accumulated Big Data resource has exceeded 40TB. These data can help us learn the equipment position and track real-time working conditions to monitor early warnings, conduct remote fault diagnosis, and improve predictive maintenance.

"It [can] help us improve the product quality to win the market," said He. "We also can provide finance services based on customer and equipment usage data, expanding innovation to the commercial side....industrial Big Data will become the core advantage of Sany Heavy Industry in the future."

Jie Li, professor at the University of Cincinnati, said, "In the past, we pursued machine quality, speed, and efficiency. All of these are visible....intelligent services [will be] based on customer demands and different commercial scenarios. Th[ese] type[s] of intelligent services need to be analyzed and explored from industrial Big Data." Li also pointed out that industrial Big Data is only a technical tool. The core objective of industrial Big Data is to create value, and the value involves avoiding and solving intangible problems and creating new knowledge in the intangible world.

Building industrial Big Data architecture involves hardware technology as sensing, acquisition, and transmission, along with the corresponding data analysis and processing software platform. For the enterprise specializing in industrial R&D and production, it is not easy to build a Big Data application platform.

Cui Peng, industrial market manager at National Instruments (NI), introduced embedded hardware to industrial data building, based on an open and flexible software architecture. It can perform acquisition and control for different types of sensors, which can realize the data acquisition of different industries, devices, and signals. An online status monitoring software is used for data management, data analysis, and alarm generation. This simplifies the remote management for large-scale deployment of related monitoring systems.

Professor Li Jie cooperated with NI to develop a patented pre-diagnosis toolkit. Feature extraction, main composition analysis, and pattern matching can detect and forecast faults, providing forecasts and analysis for customers. **ce**

Stone Shi *is executive editor-in-chief,* Control Engineering China. *Edited by Joy Chang,* Control Engineering, *CFE Media, jchang@cfemedia.com.*

MORE ADVICE

KEY CONCEPTS

In the future, the competition in intelligent manufacturing lies in Big Data.

The core objective of industrial big data is to create value and solve intangible problems.

GO ONLINE

More details are available with this article online.

www.controleng.com/international

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CONSIDER THIS

What is your plan on building the big industrial data infrastructure?

Industrial Big Data will shape the future manufacturing and bring new services that focus on customization and commercial needs. Courtesy: *Control Engineering China*

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Reasons to start a career in automation

Outside of the new technologies and typical buzzwords the automation industry is enthralled with, there is a worrisome trend developing: there seems to be a shortage of experienced automation talent and interested college recruits. Increased efforts in science, technology, engineering, and math (STEM) education fields along with exciting technology applications and opportunities may help.

Markets change, such as the influx of experienced oil and gas personnel on the job market due to falling oil prices. The available interested talent pool in the automation industry doesn't seem to be meeting market demand. Finding experienced engineers is a must, and recruiting new automation talent is just as important.

MORE ADVICE

The 2016 *Control Engineering* Salary and Career Survey has more information on the latest trends in automation and engineering careers. Go to www.controleng.com to learn more.

Autowhat? Automation?

A common question from recent college graduates is "Why automation?" followed closely by "Why automotive?" The latter question, although humorous, speaks volumes to the need for college branding focused on industrial automation.

Recognition is improving. Some companies sponsor First Robotics and similar programs; some focus on automation to engineering labs or donating equipment; some provide grants to universities and educational facilities. Original equipment manufacturers (OEMs), system integrators, and end users are opening the door to more automation internships and co-ops.

In 2005, a group of research organizations issued a report, "Tapping America's Potential," seeking a significant increase (doubling the pool) in college graduates in the STEM education fields. This was a great catalyst for government programs and corporate coalitions that began pushing STEM outreach, increasing the number of engineering-related graduates.

Research and Markets released a report titled, "Global Industrial and Factory Automation Market Analysis and Forecast." The report says by 2018 the industrial automation equipment and services market will grow at a compounded annual growth rate (CAGR) of more than 7% to reach a market size of $283.2 billion. Not only that, it had a higher estimated CAGR than any other U.S. industry except infrastructure.

The need for automation will always increase. There isn't a trend to add physical labor to manufacturing processes; there is a trend of adding more automation. Industry advancements help build a case to migrate what's obsolete and help push life cycles ahead. Technology advancements increase efficiency and productivity and build a stronger case for increasing automation based on return on investment (ROI).

William Aja *is vice president of customer operations, Panacea Technologies. Edited by Chris Vavra, production editor, CFE Media,* Control Engineering, *cvavra@cfemedia.com.*


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Take Your Place at the Height of Innovation

Five leading international trade fairs from Germany's HANNOVER MESSE will co-locate with IMTS in 2016, creating the most comprehensive event for industrial and manufacturing technology in the western hemisphere. Cutting-edge technology, products, services, and visions for the fourth industrial revolution will be on display for 6 action-packed days – giving you the chance to find exactly what you need to bring your company to the next level.

Industrial Automation
NORTH AMERICA

Industrial Automation North America

Industrial Automation North America is quickly becoming the North American hub for innovation and networking in industrial automation.

From robotics and automation services, to micro sensors and nanotechnology, Industrial Automation North America showcases the most important products in the industry. It covers a broad spectrum of automation and manufacturing product categories, including:

- Industrial automation systems
- Microsystems technology
- Electrical systems
- Industrial IT and software

In 2012, Industrial Automation North America became the first co-located show at IMTS. Visitor response was so overwhelmingly positive that the show returned in 2014 and will appear again at IMTS 2016.

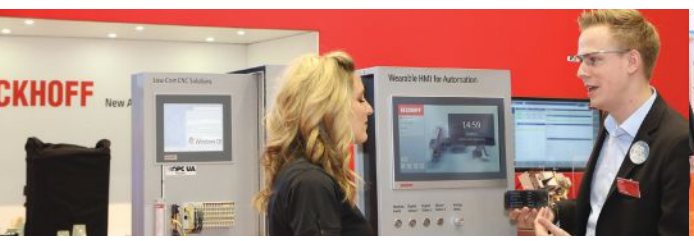
MDA
NORTH AMERICA

Motion, Drive & Automation North America

From chain and belt transmissions to sealants, bearings and gears, Motion, Drive & Automation North America showcases the most important products in the industry. It covers a range of automation and manufacturing product categories, including:

- Linear drives, gears, motors and mechanical transmission systems
- Bearings
- Industrial hydraulics and pneumatics
- Condition monitoring and vibration reduction
- Sealing technology and lubrication
- Production equipment
- Services and software for drives, gears, hydraulics and pneumatics

Motion, Drive & Automation North America made its debut at IMTS 2014, attracting industry experts and the latest innovations from all over the world.



ComVac
NORTH AMERICA

ComVac North America

ComVac will make its North American debut at IMTS 2016. A powerful platform for business development and network expansion, ComVac North America will cover a wide variety of compressed air and vacuum technology, including:

- Air compressors
- Compressed air equipment
- Compressed air processing equipment, dryers, coolers, etc.
- Compressed air storage and distribution equipment
- Compressor accessories and components
- Vacuum technology
- Water filtration and treatment equipment

Surface Technology
NORTH AMERICA

Surface Technology North America

Building on its highly successful reputation at HANNOVER MESSE, Surface Technology will make its North American premiere in 2016 at IMTS.

With more than 70 exhibitors attending Surface Technology North America, the event will cover the entire spectrum of industrial surface treatment and finishing, including:

- Cleaning and pre-treatments
- Green surface treatment
- Industrial liquid surface treatment
- Plasma surface treatment
- Surface micromachining
- Microsystems technology
- Electroplating
- Finishing and coating solutions

Industrial Supply
NORTH AMERICA

Industrial Supply North America

Industrial Supply has earned international recognition at Germany's HANNOVER MESSE and throughout Asia. Expanding its reach across the globe, Industrial Supply makes its North American debut at IMTS 2016.

More than 70 exhibitors will attend the inaugural Industrial Supply North America. The show will cover industrial subcontracting, supply-chain solutions, innovative materials, and lightweight construction across a vast range of sectors, including:

- Manufacturing
- Biotechnology
- Food
- IT
- Transportation
- Aerospace
- Automotive
- Machinery
- Clean technology

Conference Programs

We've partnered with industry experts to create a conference program to give industrial manufacturing professionals the insights and knowledge needed to make this the best year yet.

Integrated Industries Conference

Integrated Industries Conference

The inaugural Integrated Industries Conference will bring together industry experts with the goal of addressing solutions to current manufacturing concerns, sharing new trends & best practices, and ultimately helping companies thrive in today's dynamic manufacturing environment.

GAMS

Global Automation & Manufacturing Summit

The fourth industrial revolution is in full swing, bringing about swift changes to the manufacturing environment. The Internet of Things is setting new standards but at the same time creating new problems to solve. Hear from experts on adapting to this new age of industry and participate in panel discussions that will provide insight on topics such as robotics, big data, and cloud-based manufacturing.

NATIONAL FLUID POWER ASSOCIATION NFPA

Fluid Power Conference

Pneumatics and hydraulics continue to be a key component in the manufacturing process. Industry 4.0 and the increasingly smart factory are pushing the bounds of efficiency, speed, and communication. Hear from industry experts on how to adapt, optimize your fluid power components, and maximize energy conservation.

Conference Schedule-At-A Glance

September 13

Integrated Industries Conference

Track A: Motion, Drive & Automation

- Miniature Low-Vibration High Pressure Air Compressor
- Total Cost of Ownership: Electric Actuators vs Pneumatic Cylinders
- Increase Production with Machine Safety
- Reduction of Common Mode Noise to Almost Zero Using High Performance All-Pole Slne-filters
- Synchronous PM Linear Motor Motion Technology

And more!

Track B: Internet of Things/Industry 4.0+

- Taking a Doctor's Approach to Automation
- Where is Industry 4.0/IIoT Leading Us and More Importantly, for How Long?
- How the Industry 4.0 Philosophy Brings Greater Flexibility, Faster Turnaround Times, and Lower Costs to Design and Production
- Clusters of Excellence – Successful Industrial Networking Made in Germany

And more!

Track C: Surface Technology

- Powder Coating Spray and Recovery Technology Offers Great Production Flexibility and Output
- Addressing traditional Failure Modes in Combustion Engine Components
- New Trends with Laser Texturing
- Cleaning with Non-halogenated Hydrocarbons in Comparison to Water Based Cleaning
- CO2-Based Atmospheric Spray Cleaning and Surface Preparation: Technology Applications, Equipment Configuration, and Operating Costs

And more!

September 14

Global Automation & Manufacturing Summit

- Cloud-based Manufacturing: Setting the Standard
- Robotics: Rise of the Machines
- How Maintenance and Big Data Can Co-Exsist

And more! Including a Keynote and Networking Reception

Fluid Power Conference

- Energy Conservation in Pneumatic Systems
- How to Fix the Biggest Leak in Actuation Systems
- Compressed Air: Use Only What You Need
- Energy Efficiency in Hydraulic Systems of Machining Centers

And more!

September 15

OPC Conference

Hosted by the OPC Europe Foundation, The Interoperability Standard for Industrial Automation.

Track sessions and description coming soon.

www.IndustrialTechnology.Events

VIP Program

Making the right contacts with the right people at the right time can make or break your business. Don't leave it to luck. Attend our shows as a VIP and get the knowledge, connections, and product information you need to make this your best year yet.

Our VIP Program offers industry buyers the opportunity to do business with suppliers from the U.S. and around the world in an inventive and efficient environment; at the same time as learning from the best in the industry and networking with peers.

The five co-located shows take place at IMTS, where 114,000 buyers and 2,000 exhibiting companies come together for an unparalleled networking opportunity for one incredible event.

Why Be A VIP?

- Make the most of your time and connect with suppliers from around the world that specialize in the products and innovations you are looking for, all in one place
- Source and find solutions to your specific manufacturing problems
- Benefit from insights and perspectives shared in keynote addresses, interactive briefings and lively panel discussions

To apply, visit
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Your VIP Contact:
Adrienne Zepeda
773-796-4250, azepeda@hfusa.com

- Make connections on a scale impossible at any other event in North America
- It's free! There is no charge for qualified industry professionals who are serious about doing business

VIP Benefits

- Free entrance to all 6 shows
- Complimentary full-conference passes to all four of our conferences: Integrated Industries Conference, Global Automation and Manufacturing Summit, Fluid Power, and OPC.
- Full access to the VIP lounge – including lunch daily
- Exhibit hall tours available on request
- Pre-scheduled appointment setting with exhibitors

Who's Eligible?

- Product developers
- Engineers
- Plant managers
- Purchasing managers
- C-Suite Executives
- Other

* subject to show management approval

Guided Tours

Take this opportunity to see our curated selection of top innovators, technologists, and solutions-providers. Gain insight on what it takes to help your organization adapt to the future of the industry.
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Exhibitor List

4D Technology Corporation E-5962
Abraham Innovations E-4063
Ace Electronics E-4662
ADLINK E-4266
Aerzen USA Corporation E-5361
Alkin Compressors E-5365
Allied Sundar Corporation E-5681
Amerimation, Inc. E-4233
ANCA Motion E-4263
ARC Advisory Group E-5695
ATC Automation E-4139
Atlanta Drive Systems, Inc. E-4829
Auspicious Electrical Engineering Co., Ltd. E-4049
Austin Engineering Co., Ltd. E-5162
Avantek Precision Components Pvt. Ltd. E-5671
Axcen Photonics Corporation E-4162
Aydin Trafo Mak. San. A.S. E-5363
B&R Industrial Automation E-4115
Bajrang Engineering Works E-4726
Balluff, Inc. E-4057
Beckhoff Automation E-4410
Bedrock Automation E-4455
BEPA (Busan Economic Promotion Agency) E-5697, E-5698, E-5797
Bimba Manufacturing Company E-4821
BLCH Pneumatic E-5252
Bomatec International Corporation E-4363
Bonanza Metal Products Co. Ltd. E-5789
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Bruker Corporation E-5848
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Canon U.S.A., Inc. E-4062
CCPIT Machinery Sub-Council E-4563
CGI, Inc. E-4857
Chang Da Precision Industry Co., Ltd. E-5777
Changzhi Huayang Machinery & Electric Co., Ltd. E-5775
Changzhou FTX Motors Co., Ltd. E-5692
Cheng Dai Co., Ltd. E-5192
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CS-iTEC GmbH E-5188
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Storyboarding is a useful tool for the software design process

While storyboarding has long been considered a tool employed by those in the film and entertainment industry, its use in the software design process is becoming more expected and appreciated by both the developer and the client.

Though storyboarding adds an additional step to the software design process, it is invaluable to the client and the engineer when used in software development. Storyboarding also offers transparency and clarity to the client, while streamlining the process for the developers and engineers.

Focus on innovation

During the specification phase of development, screens that the software will display are drawn, either on paper or using specialized software, to illustrate significant elements of the user experience. This illustration assists in converting analytic data into the actual human experience. The client is able to offer feedback and suggest changes to improve the final result. This collaborative process helps the client feel connected to the product and promotes innovation.

Focus on savings

Storyboards can be configured to run with accurate navigation and user interaction. This provides a visual representation of the software as well as a process flow with the feel of a completed solution. Altering the storyboard is less time-consuming than making changes to an implemented piece of software representing a significant time and cost savings.

Focus on real-world use

While a verbal description of a screen or product is useful, there is room for misinterpretation. Sample images provided by a storyboard allow little room for misunderstanding and help the user understand exactly how the software will be employed in real-world circumstances.

Basic sketches of a storyboard on paper can be helpful, but there are a variety of more advanced and efficient tools available to software engineers. These programs feature an intuitive interface that allows the designer to create images and link them into a practical and attractive presentation. Many of these programs allow presentations to be saved online.

Storyboarding is a crucial part of the software design process that allows designers, in collaboration with their clients, to capture all the relevant information needed to produce the most custom and tailored product. This step keeps the focus on the real people who will use the end product in real-world situations while managing expectations and expense most efficiently.

David Tesche *is senior developer at Maverick Technologies. Edited by Chris Vavra, production editor,* Control Engineering, *cvavra@cfemedia.com.*

Standards groups sign agreement

Thomas J. Burke (left), president and executive director of the OPC Foundation, and **Holger Zeltwanger**, CAN in Automation managing director, agree to advance interoperability. Courtesy: OPC Foundation, CAN in Automation

The OPC Foundation and CAN in Automation (CiA) agreed to collaborate in development of specifications, white papers, guidelines, and processes that provide necessary infrastructure to promote interoperability. Deliverables are designed to benefit both organizations' members to develop and achieve information integration across multiple domains. The organizations agreed, at Hannover Fair, to cooperate in development and marketing of shared deliverables to foster interoperability. The OPC Foundation is a nonprofit international standards organization that provides specifications, technology, certification, and processes to achieve multivendor, multiplatform, and interoperability to move data and information. The OPC Unified Architecture (OPC UA) helps the Internet of Things (IoT) and is domain-independent. CiA international users' and manufacturers' group develops the internationally standardized CANopen technology. CiA specifies application programming interfaces (API) and middleware mappings to CANopen.

Edited from a press release by CFE Media.

PMI index grows

Led by strength in new orders and production, the Institute for Supply Management's (ISM) monthly Purchasing Manufacturers' Index (PMI) continued growth in May, for the third straight month. The PMI reached 51.3%, an increase of 0.5 percentage points from April. The 12-month average for the PMI increased to 50.3%, indicating growth for the manufacturing sector.

Chris Vavra, production editor, CFE Media, cvavra@cfemedia.com.

Companies collaborate on test bed for sensor data

TE Connectivity (TE), ifm, SAP, and the OPC Foundation have collaborated together to develop a test bed that shows how all sensor data can be transmitted from machines to an information technology (IT) system and evaluated there. This allows the efficiency of a factory to be considerably enhanced through, for example, a reduction in energy consumption. The solution is designed to be easy to retrofit in a production facility and increase productivity and resource efficiency. The partners developed the test bed within the Industrial Internet Consortium (IIC).

The four partners presented an application for the test bed from the field of plastics processing at this year's Hannover Messe at the ifm booth (Hall 9, Booth D36). They demonstrated how energy consumption can be reduced through optimum regulation of the airflow for drying material used in the process.

Smart processes require comprehensive information from the sensors. "The necessary data is frequently available via the sensors, but the controllers generally only process a fraction of what is available," said Dr. Myriam Jahn, managing director, ifm datalink GmbH. With the solution presented at the exhibition, it is now possible to have all sensor data transferred to IT systems without needing to reprogram the controller.

This solution makes it possible to use data in numerous ways; for example, for condition monitoring, to monitor energy consumption, or to ensure the quality of manufactured products through their seamless traceability. Not only can the efficiency of the processes be improved as a result, but the implementation of energy management processes such as ISO 50001 is also supported at the same time. The test platform covers the entire infrastructure required for connecting machine sensors to IT systems. Data communication takes place via IO-Link, OPC UA, and Profinet.

Edited from a TE Connectivity press release by CFE Media.

Rising industrial PC market

IHS reports that the industrial PC market is expected to recover from a recent downturn in 2016 and stabilize by 2018 due to an expected improvement in the outlook for process industry investment and continued industrial PC use beyond industrial automation applications. Europe, the Middle East, and Africa (EMEA) remains the largest market for industrial PCs with Asia Pacific not far behind. Robotics is the fastest growing industrial sector for PCs followed by material handling equipment, food and beverage, and packaging machinery.

Edited from an IHS story by CFE Media.

Manufacturers: help with talent shortage

The demand for skilled technicians has been on the rise for years. With a proactive business mindset, however, service organizations can make the most of the qualified technicians by equipping the service team with an all-in-one service management solution.

The AED Foundation researched and analyzed the growing skills gap in field service and manufacturing and the impact it's having in the industry. According to AED manufacturing executives surveyed in the report, 87% believe the high school systems are to blame in the lack of technical workers. Adding to the current problem, those who do attend a two-year technical program are not gaining the preparation and experience they need. As the number of new, qualified technicians continues to dwindle, the number of job openings continues to increase as the baby boomer technician generation retires.

Manufacturers need to make the most of their existing technicians during this shortage by equipping them with the tools and information to do their jobs efficiently and accurately. Eliminate paper by automating the process with a mobile service app so techs can complete a work order and sync with the back office for instant accessibility and faster billing. Using visual schedule software as part of a field service management suite allows companies to schedule work orders in the most efficient pattern for each technician. Dispatchers can filter by tech availability and skillset to assign the best worker for each job. Give techs access to service history, parts and inventory information so they know what they need before they get to the job site.

Emily Poklar is a content marketing specialist at MSI Data. MSI Data is a CFE Media content partner. Edited by Chris Vavra, production editor, Control Engineering, *cvavra@cfemedia.com.*

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Top 5 *Control Engineering* articles

May 16-22: The most visited articles included the 2016 Salary and Career Survey, the annual energy outlook from the EIA, robot programming languages, robots and smart factories, and offshore risk management.

Seven vital tools for a 'go bag' in the field

For field projects, it's good to bring a bag with tools that might come in handy for specific purposes or to prepare for any unforeseen challenges that sometimes come up.

Filling the technology gap in the warehouse

Many startups and established companies are looking to fill the void after Kiva Robotics' technology, warehouse software systems, and robots were removed from the marketplace after they were acquired and absorbed into Amazon's business.

OSHA will 'nudge' workplace safety by posting records online

OSHA is putting the safety records of manufacturers and other businesses online as a way to call attention to both safe and unsafe workplaces starting Aug. 16.

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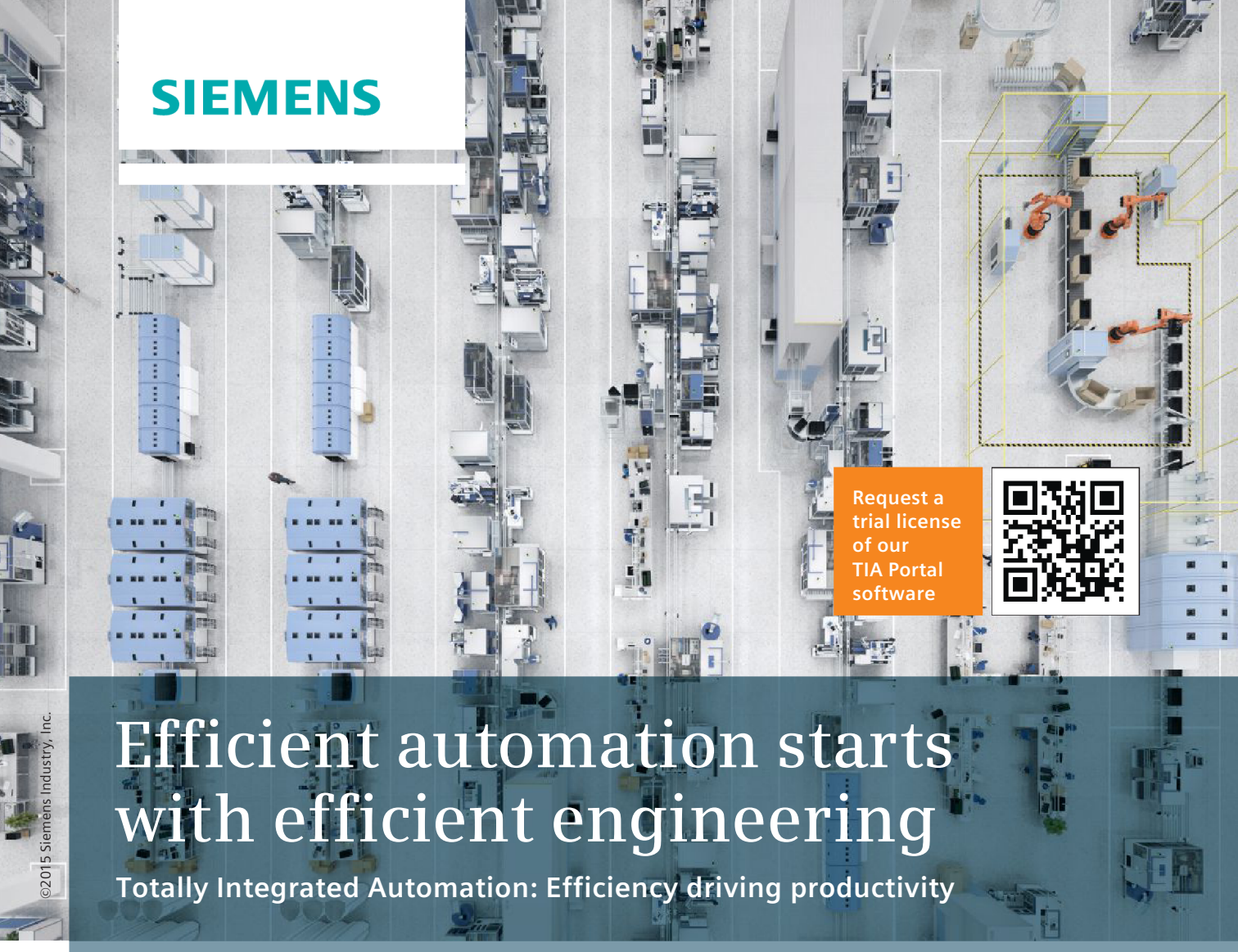

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Digital Factory

3-D additive manufacturing advancements

Advancements in 3-D printing have made the technology more sophisticated and affordable. The automotive, aerospace, and medical industries have made some major strides recently, and 3-D printing is expanding as a means of engineering education.

A car was built with parts 3-D printed at last International Manufacturing Technology Show (IMTS) in Chicago (2014), gathering attention from many for the results, for the machine and motion control technologies used, and the material science advances. The car itself was made of carbon fiber reinforced polymer, and the wheels and hubcaps were printed using the direct metal process. The process took 44 hours and consisted of 40 parts. When it was completed, the car was taken for a test drive and gained a great deal of press attention.

Since then, 3-D printing, or additive manufacturing, has remained in the spotlight as new developments and enhancements gain the attention of industrial designers, manufacturers, and engineering-minded educators.

Microfactories for 3-D printed cars

Cincinnati Inc.'s Big Area Additive Manufacturing (BAAM) system was used to produce the 3-D printed car at IMTS 2014. Recently, they sold two of their systems to Phoenix-based Local Motors for their microfactories. BAAM features a work envelope of up to 2.4 x 6 x 2 m (8 x 20 x 6 ft), and the large-scale additive machine uses the chassis, drives, and control of Cincinnati's laser cutting system as the base. BAAM is linear motor-driven and extrudes hot thermoplastic to build parts layer by layer at speeds 200 to 500 times faster and up to 10 times larger than existing additive machines.

The microfactories will manufacture highway-ready, 3-D-printed cars, premium off-road vehicles with on-road capability, and neighborhood electric vehicles at the 40,000-sq-ft facilities, and each will be able to produce an output of up to 250 cars per year. Customers will visit the microfactory to design and purchase their vehicle, which is then produced on-site. Local Motors plans to open 100 microfactories around the world in the next 10 years.

3-D printing for aerospace, medical industries

A report by IDTechEx indicated that 3-D printing in metal is the fastest growing segment in the industry with sales growing by as much as 50% and material sales growing at over 30%. High-value, low-volume industries such as aerospace and biomedical, in particular, are taking advantage of 3-D printing because of how quickly items can be printed. Both the medical and aerospace industries are investing in alloys such as cobalt, nickel, and aluminum to provide versatility in what can be produced and printed.

Recently, GE Aviation and France's Snecma developed an engine for Airbus and CFM International's LEAP-1A engine. The engine was produced that uses fuel nozzles that are 3-D printed from a superalloy and carbon-composite fan blades woven from the ground up. The engine also uses parts from light- and heat-resistant ceramic matrix composites (CMCs).

The result is an engine that is designed to reduce carbon emissions as well as be more fuel-efficient. In the medical industry, 3-D printing is being used for static applications such as orthopedic implants. They are also being used to create models of teeth, bones, complex structures, and even a human heart for educational purposes. The models are designed to help doctors prep for complicated surgery by giving them a picture that isn't on a CT scan. They're also useful in an educational setting by giving doctors something tangible to work and experiment with instead of as an abstract concept.

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KEY CONCEPTS

Additive manufacturing/3-D printing technologies continue to advance.

Real-time monitoring and feedback improve large-scale printed metal quality.

Gee-whiz engineering helps encourage new engineers.

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See related Road to IANA in this issue and read this online to link to other 3-D printing articles.

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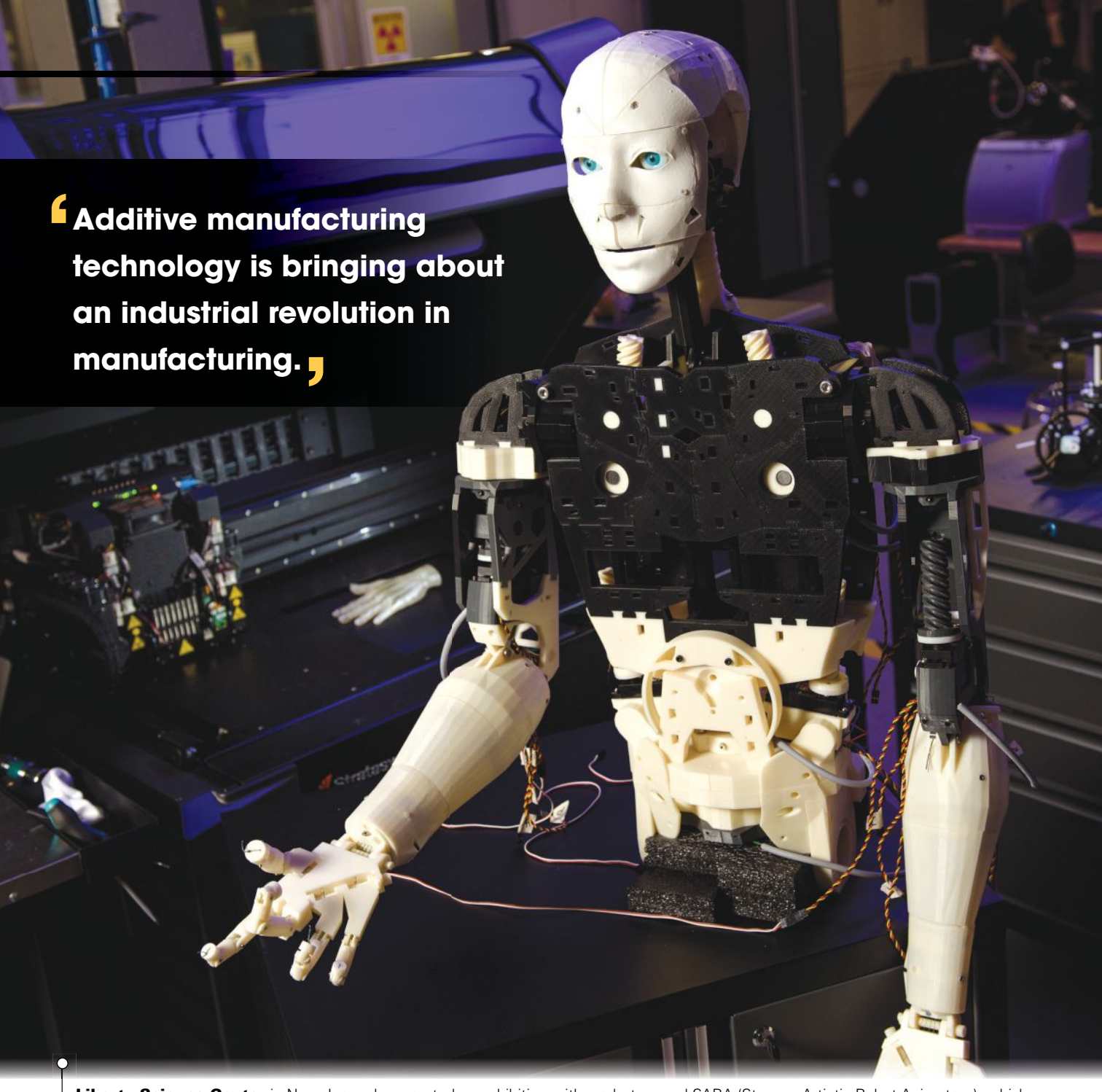
Is additive manufacturing disrupting your markets or erupting your opportunities?



> "Additive manufacturing technology is bringing about an industrial revolution in manufacturing."

Liberty Science Center in New Jersey has created an exhibition with a robot named SARA (Stevens Artistic Robot Animatron), which was created by students at Stevens Institute of Technology in Hoboken, New Jersey. Courtesy: Stevens Institute of Technology

Industrial interest in 3-D printing

As 3-D printing becomes more cost-effective, manufacturers are becoming more interested in potential benefits.

Siemens and HP, for example, are looking to use technology to more easily advance 3-D printing from prototyping to full production utilization and create functional production parts that can be made from multiple materials in multiple colors. The technology is intended to increase print control, including material characteristics down to the voxel-level. (A "voxel" is a 3-D pixel.)

"Additive manufacturing technology is bringing about an industrial revolution in manufacturing, allowing business to use 3-D printing to realize creativity and innovation in product development," said Chuck Grindstaff, president and CEO, Siemens PLM Software.

Sciaky Inc., a subsidiary of Phillips Service Industries Inc. (PSI), has produced a metal 3-D

printing technology called IRISS, or Interlayer Real-time Imaging and Sensing System. IRISS is designed to provide consistent process control for part geometry, mechanical properties, microstructure, and metal chemistry for large-scale 3-D printed parts. This technology monitors the metal deposition process in real-time and makes adjustments to the process parameters that compensate for variation throughout the build process. Sciaky's EBAM systems are designed to produce parts ranging from 8 in. (203 mm) to 19 ft (5.79 m) in length, but can also manufacture smaller and larger parts, depending on the application.

Cincinnati Incorporated's Big Area Additive Manufacturing (BAAM) system was used to produce the 3-D printed car at IMTS 2014. Courtesy: Cincinnati Inc.

3-D printed robot for educational purposes

Imagine meeting a robot that can play "Simon Says," responds to commands, and even takes a selfie. At Liberty Science Center in Jersey City, N.J., one can do those things—and more—with SARA (Stevens Artistic Robot Animatron). SARA is a full upper-torso, interactive, human, 3D-printed robot. Students at the Stevens Institute of Technology in Hoboken, N.J., created the robot, which can move, swivel, raise its arms, pick up items, and wiggle its fingers.

LSC president and CEO Paul Hoffman said, "Many of our guests are in middle and high school—not much younger than the Stevens students. It is particularly exciting for us, and inspiring for our young guests, to have the Stevens team [members] sharing their amazing work with our community."

> "We hope it inspires young people to become interested in science and engineering education and careers themselves."

Based on work from French designer Gael Langevin and his InMoov open source project, SARA was transformed by computer-aided design (CAD). Approximately 100 components including joints, "bones," and other mechanical parts of the robot were printed in polyvinyl chloride (PVC) plastic.

Stevens Prototype Object Fabrication (PROOF) lab director Professor Kishore Pochiraju coordinated the exhibit with Liberty Science Center to inspire young people who visit the center.

"We're so pleased to be able to bring Stevens' student ingenuity and a fun application of our own technology to their diverse audiences," Pochiraju said. "We hope it inspires some of these young people visiting the Science Center to become interested in science and engineering education and careers themselves."

Future of 3-D printing

Further developments will likely be on display at IMTS 2016 in September. Given the recent investments and dedication from companies on an industrial and educational level, AMT's Emerging Technology Center and other demonstrations seem likely to include additional advances in 3-D printed parts and additive manufacturing demonstrations, perhaps multiple cars or other transportation, as the next step for a technology that has the potential to change manufacturing processes. **ce**

Chris Vavra is production editor, CFE Media, Control Engineering, *cvavra@cfemedia.com.*

Robotic vision systems: What is doable?

Although robotic vision is constantly evolving, there is still a technological gap between the interpretation of what a robot sees and what a human sees. What about 3-D versus 2-D vision?

When someone is inexperienced with robotics, it's easy to misunderstand the robot's vision capabilities. How the robot sees things is probably the most complex part of the robotic process. Robotic technology is closing the gap in flexibility and grasping abilities, but there is still a large technological gap between what a robot sees and interprets and what a human can see and interpret. Robotic vision is evolving.

Evaluating robotic vision systems

When talking to a customer a few years ago about robotic vision, there was some hesitation. Since industrial cameras were not as advanced as then and considering that robotic logic could be unreliable, most "dream applications" customers were considering were not technically possible. Now with the democratization of camera technology (thanks to smartphones) and the advancement of user-friendly "smart cameras," vision technology is easier introduce into a robotic cell. Limits include:

- **Adaptability:** Most robotic vision applications rely on very well-defined applications with pre-programmed features. They can detect a particular pattern and detect it really well. However, if something really unusual passes in front of the camera, it might be missed by the application. An example would be the completely automated public turing test (CAPTCHA) in Figure 1, where letters are slightly deformed, and a vision system or character analysis system cannot detect them. This example is likely to be overcome by robotic vision systems in time.
- **Detecting Trends:** Unless the vision system has been programmed to detect trends or patterns, it won't be able to detect them. While humans are really good at interpreting and associating things, robotic vision systems have issues with associations. Each feature detected is often treated individually, so it is listed in a report for a human to analyze. When conducting quality checks, for example, a list of errors will be shown to a human worker where he/she can analyze them and determine if there is a problem with a machine somewhere within the manufacturing process. At present, a vision system cannot determine that the milling machine has a broken tool and stop the production line.
- **Reliability:** The main advantage of a vision system is its consistency and reliability. If a robotic vision system looks in the right place, it will see when something is wrong. A robotic vision system will not get tired like human eyes and always will use the same parameters. Humans are more error-prone throughout the day as a worker may become increasingly tired and less attentive. One reason manufacturers are introducing robots is because of consistency and accuracy; it makes sense to fit them with a vision system that has the same attributes.

Robotic vision camera location

Depending on the application, the vision system will be placed in different locations in the robotic cell. With many types of robots, cameras, and applications, there are an infinite number of solutions as to where a camera can be placed and what to do with it. Principal ways to set up the camera follow.

- **End of arm:** Since different applications need to monitor what the robot is grasping, some robot manufacturers are embedding cameras directly on the robot wrist. This allows the camera to move in various directions in space, locate a part, and, according to the robot's kinematics, grasp a part. Since the camera is often close to the gripper, it can also monitor if the part has been grabbed properly or if it has been dropped during manipulation.

Placing a camera on the end of a robot's arm means it's constantly moving. If a picture of the grasping area is required, stop the robot in the right position, ensure the camera is stable, and then take a snapshot. If an application requires a really short cycle time, you may have to rethink this option.

- **Scene application:** Another type of vision system can be fixed and looking at a scene, where parts are presented in different positions and orientations on a conveyor. Once the part passes in front of the camera, a snapshot is taken and analyzed to see where the part is and its orientation relative to the

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KEY CONCEPTS

Limitations of vision technology and robotic cells

How to integrate robotic vision systems

The benefits of robotic vision systems

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Do the benefits of integrating robotic vision systems create more solutions or raise more questions?

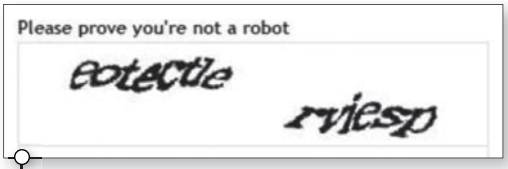

Figure 1: A CAPTCHA image prevents robot vision system detection. Courtesy: Robotiq

robot. (See Figure 2.) Then, the robot can grab it.

■ **Cell monitoring:** Robotic vision can be used for safety. A camera or a set of cameras can be installed on robot or looking at the robot to see if a human enter the robot's workspace. Since most collaborative robots do not have external safety guarding, this method can regulate robot speed according to the distance between the robot and the worker. Each robotic cell integration requires a risk assessment according to regional rules and regulations.

2-D and 3-D camera differences?

Vision technology is evolving quickly. In recent years, 3-D movies have been growing in popularity because of the realistic aspect they bring while watching a movie. The same is happening with industrial applications; 3-D vision technology is one step further along in terms of complexity and can provide more information on an object that has to be manipulated by the robot. However, improvements still need to be made.

Two-dimensional vision systems have a better track record and are simpler to use. Many 2-D cameras have really good features. The price of high-quality 2-D cameras is dramatically dropping because of the widespread use particularly in smartphones and other high-tech applications.

Two-dimensional vision systems have problems with shadows. Most 2-D vision applications will use flash or lights placed in the same orientation as the camera to limit shadows. Other applications will install parts on illuminated tables, so the camera can see the contour of the part clearly. Popular 2-D vision applications include inspection, part location, Q-code, and barcode reading.

Three-dimensional vision is the next big thing, but it is still not technologically ready for widespread use within the industry. Since it is more complex to use and program, it still requires a very good understanding of this technology to be able to introduce 3-D vision into a robotic cell. Few vision libraries and camera models available on the market. Price and reliability of the cameras are still a long way away from a 2-D camera's reputation. Three-dimensional vision systems are generally used for scene observation, part location, part modeling, and complex vision applications.

Figure 2: A camera can be placed over an inbound conveyor to take photos of each blank. Courtesy: Robotiq and Universal Robots

Machine vision system integration

Integrating a vision system depends on what needs to be done with the device. There are tips for introducing a vision system into a robotic cell:

■ **Document the actual process the operator.** If "blowing on the part" is not written anywhere in the operation guidelines, but the operator does it every day because the parts are always dusty when he/she receives them, then an air blower could be integrated into the automated system.

■ **If the parts' normal surface appearance** is variable, keep in mind that the robot won't be as adaptable as humans are. Consider revising process steps to make the vision process easier for the robot.

■ **Define the boundary numerically** between what is acceptable and what is not—the maximum defect length, the accepted color, etc. When it cannot be defined numerically, more examples will be needed to train the system.

■ **Include the operator in the automation process.** Operators know about part specifications, defect definitions, and other variables that influence the part appearance; use their knowledge.

■ **Train the system** with parts from various batches, made on different days, to have multiple "normal" surface appearances. The vision system will be adjusted to account for some variations. Keep in mind that it's desirable to have an accurate system that can be flexible and not too desensitized.

What is the level of acceptance and flexibility needed for the application? Start small and build on that from experience. Walk around the shop floor, look at existing applications, and choose the one that is easiest to automate with a vision system. Once this application is set, learn from errors and move on to more complex applications. Always make sure to work with the operator of the robotic cell to make sure every part of the process has been identified. And most importantly, remember to control a process before automating. **ce**

Mathieu Bélanger-Barrette *is a Robotiq production engineer. Edited by Emily Guenther, associate content manager,* Control Engineering, *eguenther@cfemedia.com.*

> "It requires a very good understanding of this technology to introduce 3-D vision into a robotic cell."

Machine vision lighting tips for overdriving LEDs

Lighting quality can make or break a machine vision system. *Control Engineering Europe* looks at machine vision lighting that integrates lighting control into the other elements of a vision system. See five tips for safely overdriving light-emitting diodes (LEDs).

> "Timing can matter: systems may need to capture many images of each product in a sequence of varying lighting."

Lighting is a vital element of an optimized inspection using machine vision. Even the best camera can capture what it can see, and the best image processing software relies on good results from the camera. Illumination consistency, intensity, and resolution will have an effect on the final accuracy of an application. Despite this, lighting historically has not been an integrated part of a machine vision system.

A fundamental element of a successful and effective vision system is the visibility of the target object to be inspected, especially the specific objectives for an inspection: missing parts, color differentiation, blemishes, character recognition, or sizing, for example. The starting point for the quality of these source images is the suitability and effectiveness of the lighting for a machine vision system to perform consistently. The primary images need to be consistent, making undefinable variations in lighting unacceptable.

Five LED overdriving tips

Most machine vision applications are short of light, so overdriving light-emitting diodes (LEDs) is a common practice–it allows users to increase intensity from LED lights for a short, defined, period of time (with up to 1,000% overdriving capability). However, LED overdriving limits are based on generalized parameters that are considered safe for all LEDs so are usually set lower than is possible in reality for a specific light.

Five tips for intelligent LED overdriving include to:

1. Ensure generation of maximum brightness from a light. This is achieved by having data readily available on the actual light being used, therefore enabling the overdriving of a particular light to its safe optimized limits.
2. Calibrate lighting brightness to allow more repeatability of lighting intensity.
3. Set thresholds and feature detection to be more sensitive, while maintaining good repeatability and reliability of detection.
4. Use actual temperatures. Overdrive limits also are based on the maximum operating temperature, but most lights run at a lower temperature. So, by measuring the actual temperature of the light, it is possible to allow for more overdrive in systems which run below the maximum temperature.
5. Pay attention to timing. Some systems need to capture many images of each product item in a sequence of varying lighting requirements. With application-level visibility of the timing of the system, and a fully featured lighting controller, such systems are easier to set up, monitor, and maintain.

An intelligent lighting solution can offer benefits throughout a machine vision project cycle for original equipment manufacturers (OEMs), systems integrators, and end users. End users will see benefits with their final applications, such as long-term stability of brightness, which helps to enhance the reliability of machine vision systems over many years. **ce**

*- **Edited by Mark T. Hoske,** content manager, Control Engineering, CFE Media, mhoske@cfemedia.com from an April 22 article, "Seeing the light," posted by* Control Engineering Europe. *See more product-related information from Gardasoft Vision Ltd. in that article.*

MORE ADVICE

KEY CONCEPTS

Lighting quality is critical to machine vision quality.

LED lighting can run brighter (overdriving) for limited periods.

Careful control and system integration of machine vision LED overdriving helps.

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How much more accurate could your machine vision system be with better lighting?

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- New feature allows an end-user to request a quote for a project directly from the database site
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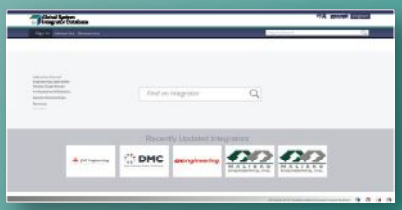

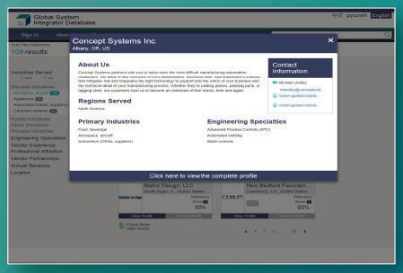

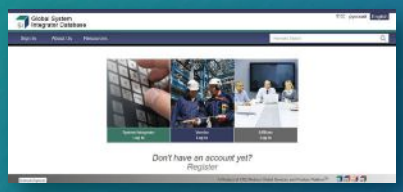

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Ethernet as a leading machine automation protocol

Although there are still dozens of industrial fieldbus protocols used in machine automation, industrial Ethernet is replacing many of them due to a number of factors. Online, see protocol table.

Fieldbus technology was a welcome advance from point-to-point wiring when it emerged during the last few decades of the 20th century, and it's had a nice run in industry since then. Many fieldbus protocols have come and gone, but all have connected sensors, input/output (I/O) devices, and other field devices to automation systems.

For today's industrial networks, Ethernet can be a more attractive option than competing protocols as performance can match and exceed fieldbus technologies. Setting up an Ethernet network is also typically less expensive and easier to configure than with other protocols.

In the early years, there were the basic open-communication serial standards such as RS232 and RS422/485. These, among others, were the basis for standards such as Modbus, which used serial communication standards as the foundation for what became the leading industrial protocol.

Ethernet was not yet mature, and fieldbus protocols offered sufficient performance and reliability in many applications. However, fieldbus technology was often expensive and difficult to setup, and different protocols were incompatible on both the hardware and software levels.

Many initial fieldbus implementations were designed for connecting remote I/O to programmable logic controllers (PLCs). Many communication standards were based on the RS422/485 standard, but most were proprietary before being transferred to independent foundations and made open.

For example, DeviceNet, Modbus, and Profibus DP each started out as proprietary protocols with Rockwell Automation, Modicon, and Siemens respectively. Each eventually became an open standard administered by an independent foundation.

Today, there are several fieldbus options for linking PLCs to remote I/O and other simple devices such as motor starters, sensor manifolds, and pneumatic valve manifolds.

Current fieldbus protocol options

While Industrial Ethernet's growth is exceeding fieldbus growth for accessing devices and is expected to become the more dominate technology over the next 15 years according to IMS Research, other fieldbus networks have a very large installed base because they were the only option before Ethernet technology matured. Many applications still benefit from the highly deterministic architecture that fieldbus networks such as DeviceNet and Profibus DP offer. With such protocols, it can be convenient to add devices using field-mounted I/O blocks.

Another fieldbus protocol is IO-Link, which is a point-to-point (P2P) network used for tying field devices to controllers, often through a converter (see Figure 2). Some newer devices can provide process data, configuration data, identification, operating parameters, and diagnostics. The ability to transmit diagnostic data can reduce machine downtime by intelligently diagnosing the exact item of failure or, in some cases, preventing downtime by providing information that failure is imminent.

Although IO-Link and low-level fieldbus protocols work well for linking simple devices to controllers, more complex connections can benefit from the power, speed, and flexibility that Ethernet offers.

An industrial Ethernet protocol may be considered instead of fieldbus communications in many new machine automation applications that require a high degree of information exchange, such as linking a vision system to a PLC. As hardware costs drop, it's becoming more cost-effective for even simple applications such as remote I/O and for fieldbus device connections.

MORE ADVICE

KEY CONCEPTS

Ethernet's performance can often match and exceed levels of fieldbus technologies today.

EtherNet/IP and Modbus TCP are among leading networks in North America for manufacturers.

More users will adopt Ethernet hardware as costs decline.

GO ONLINE

Comment: When selecting a new network, are you more likely to choose Ethernet over a traditional fieldbus? See the site poll at www.controleng.com; link to more articles on industrial networking.

CONSIDER THIS

With wider use of gateways to translate, is network selection less of a concern?

Figure 1: Ethernet is widely used in industrial automation systems to make a wide variety of connections. All images courtesy: AutomationDirect

The case for Ethernet

Many people still consider Industrial Ethernet as something different than fieldbus, but if one considers what fieldbus technology has traditionally accomplished in the past with what Ethernet can do today, they are really one in the same. Fieldbus technologies have traditionally boasted highly deterministic data delivery, and Ethernet can do the same with its increased speed and low level time synchronization methods. Power can be delivered to devices over many fieldbus cables, and the same is true with Power over Ethernet. There are very few industrial networking applications where a properly specified Industrial Ethernet protocol won't work.

With early Ethernet networks, determinism was poor and jitter was significant, which resulted in slower processing speeds. Less intelligent network devices, such as simple Ethernet hubs, were the norm. As a result, data collisions and retries were frequent. With the advent of cost-effective, industrial Ethernet, unmanaged switches and then eventually managed switches, collisions have become a nonissue. Processing power has increased, and it has reduced data transmission delays to an insignificant level in most applications.

Even with standard, off-the-shelf Ethernet chips, jitter is low enough for most applications, with use of scheduling mechanisms, such as Class 1 I/O Messaging in EtherNet/IP. For more time-critical applications, protocols such as EtherCAT use precision time protocol synchronization (IEEE 1588).

While most Ethernet networks use a star topology where the Ethernet switch or switches forms the center and the devices branch out, many devices include switch ports with multiple RJ-45 interfaces to make daisy chaining more cost-effective.

Protocol selection

Unlike other communication technologies, Ethernet permits multiple protocols to run over the same network. Some leading Ethernet protocols include EtherCAT, EtherNet/IP, Modbus TCP, Powerlink, Profinet, and SERCOS. (See more on protocols with this article online.) The automation supplier often drives selection of the proper Ethernet protocol for the application; different suppliers favor different protocols.

Most suppliers favor a specific Ethernet protocol, but they often aren't just limited to one. It's often advantageous to use the supplier's favored protocol because this will yield the best support and widest range of compatible products. If an application requires a mix of suppliers and both protocols are available in the controllers and field devices, timing and speed requirements are often deciding factors.

The application will help define which fieldbus technologies to use. In many applications, it may make sense to use several protocols, with each applied at the most appropriate level. Mixing protocols and communication architectures to get field devices connected to controllers, controllers connected to human-machine interfaces (HMIs), and HMIs connected to higher level computing systems is often the right choice. To do this, it's necessary to pick a controller that supports multiple protocols.

IO-Link or a similar protocol is often used to link multiple field devices to a controller because it's a much more cost-effective option than hard wiring each field device to a controller input point. With IO-Link, it's common for an IO-Link to EtherNet/IP gateway to connect to field devices and back to the controller via EtherNet/IP.

The gateway acts as a multiplexer by connecting to multiple IO-Link field devices and making information from them available to the controller via one EtherNet/IP cable. Although IO-Link supports a relatively short distance between the sensor and the IO-Link master device, it can connect to a variety of gateways and related protocols to extend its reach to the controller.

In large manufacturing and warehouse conveyor applications, longer distances between the controller and devices can be achieved by using gateways that sit on an EtherNet/IP network. The use of easily available managed and unmanaged switches also helps distribute Ethernet connections.

For connections among controllers, or for controllers to HMIs, some variant of Ethernet is the preferred option; hardware support may determine selection of which protocol.

Ethernet dominates higher-level connections, and lower-level connections from controllers to remote I/O and field devices can be made via IO-Link, DeviceNet, Profibus DP, or some variant of Ethernet.

As Ethernet hardware declines in cost and as capabilities continue to expand, particularly with higher speeds and more determinism, engineers should expect it to become more widely used in industrial communications. **ce**

Chris Harris *is team lead–technology assistance group at AutomationDirect. Edited by Chris Vavra, production editor,* Control Engineering*, CFE Media, cvavra@cfemedia.com.*

Figure 2: IO-Link is often used to connect field devices to controllers using conversion devices, such as this fiber optic manifold.

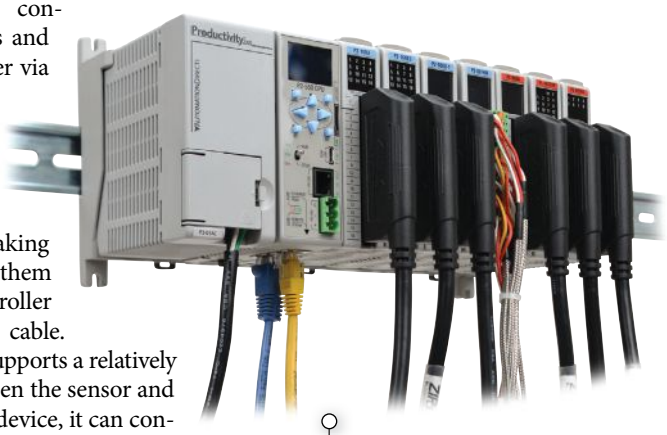


Figure 3: EtherNet/IP is supported by a wide variety of PLCs and other controllers, including this AutomationDirect P2000 PLC.

Hazardous location certifications 101

Tutorial: It is important to know precisely which certification scheme is required for the installation of electrical equipment in a hazardous (classified) area and what precautions need to be taken in each circumstance.

"Certifications for electrical equipment can vary; type of protection depends on the risk involved in the area."

Electrical equipment that is used in a hazardous (classified) area is regulated by local laws and guidelines and is required to be compliant to the relevant protection schemes and certifications as specified within these areas. There are a multitude of certification schemes around the world, but the three mainstream certifications for electrical equipment in hazardous areas are ATEX (Europe), IECEx (International), and either the Class/Division or Class/Zone System (North America). While each of these certification groups require unique standards and verification procedures for certification they also leverage similar terminology and practices with respect to testing, marking, and ensuring standards are attained for safe operation of electrical equipment.

A "hazardous area" is defined as an area in which the atmosphere contains, or may contain, in sufficient quantities, flammable or explosive gases, dusts, or vapors. In such an atmosphere, a fire or explosion is possible when three basic conditions are present—fuel, gas, and an ignition source. To protect an application from a potential explosion, an appropriate protection method is required.

Classifying the specific type of hazardous area that the equipment will be operating in is required in determining the appropriate certification scheme. To determine what protection method is appropriate, a method of analyzing and classifying the potentially hazardous area is required. The particular method chosen will again depend on local rules and the certification scheme required. The type of protection required depends on the risk involved in the area. Once the area is classified, an appropriate protection method can be chosen.

Proper certification marks are the customer's assurance that the electrical products in operation meet rigorous standards for electrical safety and are suitable for use in the classified area.

ATEX

ATEX is a European Directive and is used for controlling explosive atmospheres and the standards of equipment and protective systems used in them. The ATEX Directive 94/9/EC provides the most current requirements regarding equipment and protective systems intended for use in potentially explosive atmospheres.

Manufacturers and suppliers or importers (if the manufacturer is outside of the EU) must ensure that their products meet essential health and safety requirements and undergo appropriate conformity procedures. This usually involves testing and certification by a third-party certification body, known as a notified body.

Once the notified body certifies the equipment it is marked by the "EX" symbol to identify it as such.

IECEx

The objective of the international IECEx scheme is to facilitate international trade in electrical equipment intended for use in explosive atmospheres (Ex area) with the following benefits:

- Reduced testing and certification costs to manufacturers
- Reduced time to market
- International confidence in the product assessment process
- One international database
- One evaluation with worldwide market potential.

An Ex area is also known as a "hazardous location," "hazardous area," or an "explosive atmosphere" and is generally an area where flammable liquids, vapors, gases, or combustible dusts are likely to occur in quantities sufficient to cause a fire or explosion. Equipment used in an Ex area is termed "Ex equipment."

MORE ADVICE

KEY CONCEPTS

A "hazardous area" is defined as an area in which the atmosphere contains, or may contain, in sufficient quantities, flammable or explosive gases, dusts, or vapors.

Proper certification marks are the customer's assurance that the electrical products in operation meet rigorous standards for electrical safety and are suitable for use in the classified area.

Manufacturers that produce, or companies that sell, equipment for use in hazardous locations need to be aware of the main certification schemes.

GO ONLINE

Read this story online at www.controleng.com for more information not found in the print/digital edition.

CONSIDER THIS

Which standards do you use the most and what challenges do they bring?

The IECEx Certificate of Conformity System provides for the issuing of IECEx Certificates of Conformity, covering Ex equipment for use in explosive atmospheres. IECEx Certificates of Conformity are issued by approved IECEx Certification Bodies (ExCBs). An IECEx Certificate of Conformity confirms that a sample of the Ex product, described on the certificate, has been independently tested and found to comply with the international standards listed in the certificate. It also proves that the manufacturing site has been audited to verify that the manufacturer's quality systems meet IECEx requirements.

Classes and divisions

Hazardous locations are rated with an area classification that in the IECEx and ATEX schemes are generally based on equipment category, gas presence, and gas group. In the North American system Classes, Divisions (or Zones), and Groups are used to define the level of safety required for equipment installed in these locations.

Equipment Category and classes define the general nature of hazardous material in the surrounding atmosphere. Gases are categorized as "IIG" by ATEX and "Class I" in the North American System.

The "Zone" or "Division" defines the probability of hazardous material being present in an ignitable concentration in the surrounding atmosphere. The "Gas Group" is based on the gases present in the area.

Manufacturers that produce, or companies that sell, equipment for use in hazardous locations need to be aware of the main certification schemes, understand what is involved in certifying their products, and be able to interpret customer requirements to insure a product is safe to use in a specified environment. **ce**

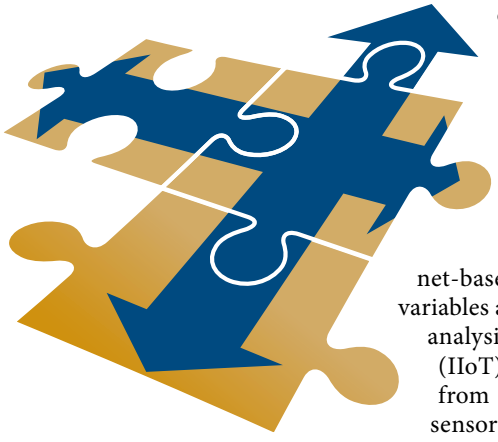
Mike Bange is a product engineer and engineering department manager for Watlow Electric Manufacturing Co. Edited by Chris Vavra, production editor, Control Engineering, *CFE Media, cvavra@cfemedia.com.*

Immersion heaters such as Watlow's flange immersion heaters possess IECEx and ATEX Ex'd' or Ex'e' ratings certifying that the flange heater enclosure is flameproof. Every enclosure is pressure tested to ensure heaters are safe and reliable and meet rigorous standards for electrical safety. Courtesy: Watlow

Real-time, plant-floor data for Industrial Internet of Things (IIoT)

Industrial Internet of Things (IIoT) and Industrie 4.0 platforms will enable rapid manufacturing of new products, dynamic response to product demands, and real-time optimization of manufacturing across the production and supply chain networks by networking equipment, sensors, controls, and business systems, according to Matrix Technologies, a 2016 System Integrator of the Year.

Real-time, plant-floor data has always played a critical part in the analysis of the plant-floor operation. Recently, there has been tremendous advancement in automation, data exchange, and manufacturing technologies. Until recently, sensors would typically collect one piece of process data and were transmitting that data via input/output (I/O) cards into programmable logic controllers (PLC) or distributed control systems (DCS) for display to operators or for historical trending. Current day sensors are more advanced and can capture a lot more variables.



With the adoption of Ethernet-based communication, many more variables are available for visualization and analysis. Industrial Internet of Things (IIoT) is enabling data to be collected from more and different devices and sensors than in the past, bypassing the traditional control systems.

IIoT helps OEE, diagnostics

Traditionally, the key focus of the factories has been on producing good products with least manufacturing costs. Understanding current operating conditions, detecting faults, and alarms using tools like overall equipment effectiveness (OEE) helped understand the root causes of failure and downtime. The key focus of the Industrie 4.0 platform is to advance this diagnostic capability. This will make the systems more intelligent so as to be aware of the operating conditions and be capable to predict their own health and take preventive actions. These features are made possible by more peer-to-peer communications and additional health information provided from other connected resources.

Cyber-physical systems

Modern information and communication technologies like cyber-physical systems, big data analytics, and cloud computing are enabling technologies that will help make these systems more self-aware of their health and conditions. The basic principle of Industrie 4.0 is that by connecting machines, equipment, control, and other business systems, we are creating an intelligent network that can communicate with each other and control each other autonomously. These technologies will assist in productivity improvements, better quality products, and manufacturing flexibility as well as agility.

Big Data analytics plays a critical role within the Industrie 4.0 platform. Data has to be processed with advanced tools to generate meaningful information. The use of advanced algorithms and analytical models help in identifying invisible conditions such as machine performance degradation and predicting component failure on the factory floor.

Optimization, integration

IIoT and Industrie 4.0 platforms will enable rapid manufacturing of new products, dynamic response to product demands, and real-time optimization of manufacturing across the production and supply chain networks by networking equipment, sensors, control, and business systems.

As manufacturers consider the application of these new technologies, it will be more important than ever to build a solid foundation to support the advancements. System integrators are in the forefront of these applications and will help the manufacturing community to prepare for the future. **ce**

Divya Prakash *is director, manufacturing systems and solutions, Matrix Technologies Inc., which is a 2016 System Integrator of the Year. Edited by Mark T. Hoske, content manager,* Control Engineering, *CFE Media, mhoske@cfemedia.com.*

MORE ADVICE

KEY CONCEPTS

IIoT helps with data analytics, OEE, and diagnostics.

Industrial information and communications technologies are becoming more integrated.

System integrators help establish the right foundation of technologies for IIoT advancement.

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CONSIDER THIS

Can your technology foundation support IIoT advances and advantages?

System integration enables Industrial Internet of Things, Industrie 4.0 platforms

Data mining and analysis tools can improve operational decisions within the Industrial Internet of Things (IIoT) and Industrie 4.0 platforms, and that happens more effectively with system integration, explains Michael Gurney, CEO of Concept Systems Inc., a 2016 System Integrator of the Year.

System integration is among the enabling tools of the Industrial Internet of things (IIoT) and the Industrie 4.0 platform. Through 23 years in systems integration, I've learned the importance of focusing on a scope of work that produces measurable results. IIoT has emerged as an important consideration for investment by offering the possibility of using ever-increasing amounts of data to make operational decisions. Given the quantity of available data, and the multitude of ways to use that data, managers will be wise to take the time to establish the return on investment (ROI) they want from the data they choose to mine.

Minimal, viable product

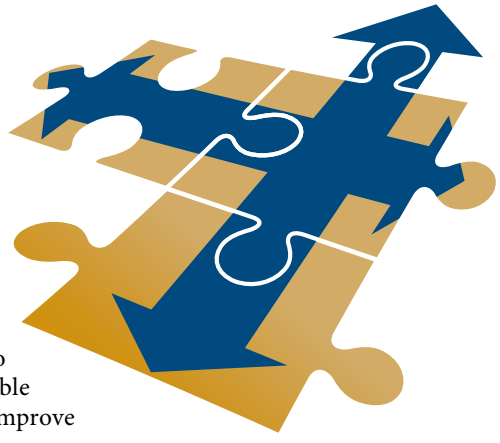
Concept Systems uses a term that applies to implementing IIoT: Minimal, viable product (MVP). To explain, many software products that promise to deliver on the IIoT have a large footprint and come with a lot of costly bells and whistles that don't add much value. They are designed to be all things to all people and to collect all the data and generate all the reports imaginable. This level of robustness requires a large investment to implement and a lot of time to do it right.

What often happens is the investor loses patience with the cost to implement and gives up on the idea before the value is ever realized. It's better to focus on the essence of what must be accomplished and use software with a small footprint that is scalable.

Probably the best kept secret of the IIoT is the existence of these lean, scalable, foundational software packages. With this approach, it's easier to build a solid foundation that provides an immediate ROI, while giving clients a way to add functionality in a cost-effective, efficient manner.

IIoT roadmap

It all starts with the MVP and developing the roadmap from there. A lot of data can be found on the plant floor. It's possible to plug into every piece of equipment and capture every data point in the cloud. That may be the ultimate destination but be mindful that it takes a lot of work to mine data, put it into an actionable construct, and analyze it to improve performance.



> "With IIoT information, corrective action can happen quickly, avoiding repetition of costly errors."

A roadmap simply identifies how to get there–in smaller discrete projects–and minimizes risk of losing the investment along the way. This approach provides rapid, incremental returns on investment.

For instance, consider a steam generation power plant with eight boilers. Uptime and downtime would be valuable, so let's start with those. I can store that data in the cloud and get a status report at any time, on any device, local or on a mobile. It's a small investment in IIoT, yet I get actionable data that is of real-time value. With the software tools in place, it is now easy to build on that foundation, to collect that next piece of data, and expand the value of the reports. With a few small projects, available mobile, real-time information includes uptime/

MORE ADVICE

KEY CONCEPTS

Establish ROI goals for IIoT.

Don't get overwhelmed with everything; take a usable subset.

Have a plan for data collection and analysis.

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At www.controleng.com, click the IIoT pulldown menu, upper left.

CONSIDER THIS

It's easy to get overwhelmed in data; make a plan to use a smart subset to improve operations.

> "Take the time to develop a roadmap to integrate data collection in a way that provides the greatest ROI."

downtime, fuel usage, and power output trends.

IIoT application example

A client that transports high-value goods by air between factories finds that it's critically important to load and unload parts properly. An installed software appliance on the loading/unloading equipment logs precise position during these operations. If any damage occurs during flight, it's easy to review the log (like a digital video recorder that replays the sequence) and verify that damage was not due to loading or unloading.

With this information, corrective action can happen quickly, avoiding repetition of costly errors. With these foundational pieces in place, it is now easy to add those next data points that add value.

Industrie 3.0 brought automation to the plant floor with "brains" in programmable logic controllers (PLCs). They monitor work flow and operate entire lines from one box.

Industrie 4.0 promises to open the plant floor to a tremendous amount of data with smart devices, in many cases wireless-enabled, being able to provide resident data beyond what the PLC has traditionally received.

The shift moves from data concentrated in a controller to having access to every configurable and monitored parameter in every device hanging on a network with an IP address. Those smart devices host a lot of information, which opens up a lot of opportunity. But again, it's important to identify what data to look at, collect, and how to use and manage it.

Data availability, info analysis

If you thought you had a lot of data in your PLC and have been struggling to figure out what to do with it, brace yourself, more is coming. It can be navigated effectively, but you need to plan and manage how you use the data.

Rather than embarking on a quest to collect even more data, why not consider doing more with a smaller subset of data? One exciting aspect of all this newfound data is the ability to use statistical process control (SPC) in new ways. SPC allows us to monitor and potentially control devices to ensure reliability by predicting anomalies that lead to failures. SPC can be set up to monitor normal operation on any data point and detect statistical variances that identify problems well before they become unscheduled downtime. Predictive maintenance is a great example of a solution that does not drive the need for more data; but rather it's a tool to get more out of the data. Look for opportunities like this, before just mining more data.

Technology value

New technologies certainly improve automated control systems, because we can gather and analyze more data, and do it more precisely and faster. That also means that we have to be clear about which data provides high value and what's most critical to ensure a smooth line. Taking the time to develop a roadmap will allow manufacturers to integrate data collection in a way that provides the greatest ROI. Make it a gradual process to receive significant returns on each phase of making the system function effectively. That's how system integrators will use IIoT and Industrie 4.0 to once again transform the plant floor. **ce**

Michael Gurney is CEO of Concept Systems Inc., a 2016 System Integrator of the Year. Edited by Mark T. Hoske, content manager, CFE Media, Control Engineering, *mhoske@cfemedia.com.*

IIoT enables services businesses

Service departments are manufacturers' main revenue driver; some companies still lag behind with outdated methods and technology, said a Salesforce survey. The Industrial Internet of Things can help.

Many businesses view service departments as revenue generators and are changing manufacturing business standards. According to a Salesforce report, manufacturing is transforming to the point where service will be the main revenue driver for companies.

Salesforce interviewed 200 manufacturing executives in their recent report and found that while 90% state their top priority is to improve field service, some companies are still using paper-driven, outdated technology to manage their businesses. As service takes over as the primary revenue driver, manufacturers can prepare for the shift with these key technological advances.

1. Connected equipment with the Internet of Things (IoT)

By connecting equipment with IoT sensors, service departments can be proactive rather than reactive to faulty parts or broken machines. Manufacturers can utilize IoT sensors to monitor how individual parts are performing and how systems are working together. They are able to quickly see when something is underperforming and proactively solve a problem before it becomes a bigger issue.

It is essential for manufacturers to provide more by investing in IoT-connected equipment because customers demand and expect more from their equipment and service. Manufacturers can save on costs by predicting breaks while keeping their customers happy and more willing to sign another contract. With only 19% of manufacturing executives reported utilizing an IoT strategy, this is an easy way to get ahead of competitors and generated.

2. Using mobile devices in the field

According to surveyed executives, 78% of field service technicians carry mobile devices to their service calls. Most of these are also using a mobile app to manage their activities. It is clear technicians enjoy managing their service activities, schedule, and filling out documents through their mobile devices on-site. Giving technicians access to customer information and the back office through a mobile device will reduce manufacturing organization costs in the long run.

For example, 70% of executives report that their service technicians have to return to their service sites on occasion. For those who do return, it's because of a missing part or tool 40% of the time; 45% are unable to complete the transaction on-site; and 35% have a lack of customer information on-site. Manufacturers will be able to increase their operational efficiency by giving these technicians access to a cloud-based mobile service application.

3. Measuring analytics

More than half of surveyed manufacturing executives are measuring analytics and gathering insights on what is and isn't working. For example, analytics will be able to clearly show if someone is taking too long at one service on a regular basis or if a service site is spending too much time on one problem.

Within 10 years, manufacturing executives believe service will be the primary source of revenue for their companies. By investing in the connected technologies today to fuel service management, manufacturers will be ready to capitalize on the opportunity in service revenue. **ce**

***Emily Poklar** is a content marketing specialist at MSI Data. MSI Data is a CFE Media content partner. See the original article here. Edited by Chris Vavra, production editor,* Control Engineering, *cvavra@cfemedia.com.*

2016 Global Automation & Manufacturing Summit

September 14th, 2016

Join *Control Engineering*, *Plant Engineering* and Hannover Fairs USA for the Global Automation and Manufacturing Summit, part of the Industrial Automation North America (IANA) pavilion at the 2016 IMTS Show at McCormick Place in Chicago. This one-day summit is designed to bring plant managers, control engineers, and manufacturing business leaders together to highlight plant improvement opportunities and deliver strategies that manufacturing personnel can take back to their plants and implement immediately.

Industrial Automation NORTH AMERICA

Global Automation & Manufacturing Summit Agenda

11:00am: **Registration**

12:00pm: **Lunch and Keynote**
Sponsored by: Advanced Technology Services, Inc.

Jack Nehlig, president and CEO of Phoenix Contact USA, will discuss his company's initiatives on the Industrial Internet of Things, both as an industry supplier and as a manufacturer.

1:30pm: **Cloud-based manufacturing: Setting the standard**

An overview of industry attitudes toward and adoption of IIoT in manufacturing, followed by a panel discussion with representatives from GE, Schneider Electric and others on how those standards will be achieved.

2:30pm: **Robotics: Rise of the machines**

An industry overview on the adoption and use of robotics in manufacturing will be provided, followed by a panel discussion led by Rick VandenBoom of Applied Manufacturing Technologies.

3:30pm: **How maintenance and Big Data can coexist**

Sal Speda of ARC Advisory Group will provide the framework for the panel discussion on maintenance in the age of IIoT, which will include Franz Gruber, founder and CEO of FORCAM; Aurelio Banda, president and CEO for North America of Beckhoff Automation and Chris Lebeau, IT Director of Advanced Technology Services.

4:30pm: **Reception and networking event**
Sponsored by: FORCAM

Presented in partnership with: HANNOVER MESSE

Sponsored by: BECKHOFF, ATS, FORCAM we speak machine

CFE Media® CONTROL ENGINEERING PLANT ENGINEERING®

Smart manufacturing solutions get attention at IANA 2016

In an integrated age, IIoT is the focus of CFE Media event Sept. 14.

Industrial Automation North America (IANA), which is co-located at the International Manufacturing Technology Show (IMTS) Sept. 12–17, 2016, at McCormick Place in Chicago, will focus on intelligent solutions as a key theme.

Intelligent solutions remain one of manufacturing's hottest topics. As part of the Hannover Messe portfolio, IANA will mirror the industry-leading discussions occurring at April's Hannover 2016, the world's largest manufacturing trade fair where the United States participated for the first time as Partner Country. Themes at both events focus on intelligent technology to unite manufacturing operations as well as supporting Industrie 4.0 and the Industrial Internet of Things (IIoT).

Those topics also will be the themes when CFE Media, the official media partner of IANA, presents its Global Automation and Manufacturing Summit on Wednesday, Sept. 14. The event begins at noon in conjunction with the 2016 IANA Pavilion.

"The high interest in this trade show underscores the excitement about intelligent solutions," said Larry Turner, president/CEO of Hannover Fairs USA, a subsidiary of Deutsche Messe, the organizer of Hannover. "Industrial Automation North America offers a one-stop event to learn about this fast-changing technology."

According to surveys conducted in 2014 at IMTS, IANA and Motion, Drive & Automation North America, 86% of visitors found solutions to specific manufacturing problems, 85% planned to make a purchase within one year, and 64% initiated new business contacts.

Industrial Automation NORTH AMERICA

Value of data and security

As manufacturers wrestle with options for connecting systems, there's agreement on two key issues: the business advantages of using integrated data and the importance of security.

"Production equipment is at the heart of any manufacturing business, but information and planning are the nerve center," said David Kaley, marketing communications manager at Mitsubishi Electric. "Today's technologies make it simple to connect real-time production data to enterprise planning systems. This allows for quicker business decisions and better foresight into potential failures."

According to Ed Johnston, North America industry manager for automotive and tire at Rockwell Automation, today's auto manufacturing plants have to be flexible to produce multiple vehicles in multiple variations on a single line. A connected enterprise that has the ability to exchange secure information from the plant floor to business systems and onto the supply chain is vital.

Once connected, manufacturers must also consider how to protect valuable data.

"The key now is to ensure that you are getting that critical data to the enterprise systems in the most secure manner possible while making certain that the automation and process control networks are properly protected," said Dan Schaffer, business development manager for networking and security at Phoenix Contact USA. "The same path used to get data out can be compromised to let the bad guys in. The companies that are most successful in walking the tightrope between security and availability of data will be the ones who are most successful in the IIoT landscape." **ce**

The Industrial Automation North America pavilion at the 2016 International Manufacturing Technology Show (IMTS) in Chicago will feature exhibitors and speakers focused on the Industrial Internet of Things. Image courtesy: IMTS

Collaborative robots ready to take on a larger role

When used strategically, robots can improve operations.

By Larry Turner
Hannover Fairs USA

Robots continue to offer big benefits for manufacturers, according to exhibitors at the upcoming Industrial Automation North America (IANA) 2016. The trade show, co-located at International Manufacturing Technology Show (IMTS), takes place Sept. 12–17, 2016, at McCormick Place in Chicago and will feature high-interest robotics topics, such as collaborative learning, core isolation and even setting standards.

According to the Robotics Industries Association, robotics orders have set new records, reporting a 14% growth in 2015 as North American companies placed orders valued at $1.8 billion. By 2018, there will be 1.3 million industrial robots operating in factories around the world, according to the International Federation of Robotics.

Rapid advances in robotics continue to drive this interest. Today's robots are lightweight, highly flexible and easy to implement. Robots can weld, assemble, handle materials and even package food.

The increased use of robotics, and their increased flexibility in manufacturing, will be one of the points of focus at the 2016 Industrial Automation North America Pavilion at the International Manufacturing Technology Show in Chicago, Sept. 12-17. Image courtesy: IMTS.

Sensing and core splitting

More sophisticated technology has created smarter robots that can collaboratively learn and sense what is going on around them. "Collaborative robots are going strong, and you will see a larger role in force sensing and control," said Steve Somes, president of Force Robots. "Responding to external forces not only makes robots safer for collaboration, it also enables more tasks like assembly, grinding and deburring."

Will Sobel, CEO of System Insights, said that automation needs to move from teach-based to intent-based. Sobel adds that robots simply need to perform dynamic path planning with vision and sensors instead of static instructions.

"The increase in multicore CPU power and the ability to implement core isolation enables software engineers to run, for example, kinematics on one processor core and spread functions across other cores, such as PLC, motion control and human-machine interface (HMI) software," said Prellwitz. "The Microsoft Windows operating system (OS) on these PC-based controllers can also receive its own core. That means all machine and robot-control functionality can run independently of the OS, which helps elevate performance and pushes kinematic applications to an exciting new level."

Robots and employees

By taking advantage of these robotics advancements to manage mundane tasks, manufacturers also gain the benefit of motivating employees with more interesting responsibilities.

"We can better utilize the talent we have when robots handle the more mundane work," added Sobel. "There will be some processes that we cannot automate. But when we increase productivity through robots without impacting the workforce, we can move to a more efficient and larger manufacturing base."

Robots do have their limitations. Due to their mechanics, conventional robots have difficulty with fine-resolution force control. "If control of force is needed for more than safety or manual guidance, manufacturers should look to new, lightweight designs that either incorporate direct-joint torque measurement (like Baxter, Kuka iiwa and ABB Yumi) or have direct-drive-style actuation like our Touch Robot," said Somes.

For more information on the wealth of resources and solutions available at IANA 2016, visit http://industrialtechnology.events. **ce**

Larry Turner is president and CEO of Hannover Fairs USA Inc.

IIoT the focus of 2016 GAMS Conference

The 2016 Global Automation and Manufacturing Summit (GAMS), presented by CFE Media, will bring together experts from all areas of the Industrial Internet of Things (IIoT) to look at the current state of IIoT, added the potential benefits of deployment for the manufacturing industry.

The third GAMS conference takes place Wednesday, Sept. 14, beginning at noon. It is held in conjunction with the Industrial Automation North America (IANA) pavilion at the 2016 International Manufacturing Technology Show at McCormick Place in Chicago. The event is co-presented by Hannover Fairs USA and is sponsored by Phoenix Contact, Forcam and Beckhoff.

"While the Industrial Internet of Things is top of mind with our readers, we also know they are still learning about how IIoT will help them improve their operations," said Bob Vavra, content manager for *Plant Engineering* and the emcee for the half-day event. "We've lined up consultants, technology experts and industry leaders to help explain IIoT and how they can best leverage this new strategy to improve operations."

"We're pleased to once again be working with Hannover Fairs USA on the Global Automation and Manufacturing Summit," said Jim Langhenry, CFE Media publisher. "They've been an outstanding partner since the first IANA pavilion in 2012, and we look forward to an outstanding conference in 2016."

The agenda of the day's events is:

- **12 p.m.** — Lunch and networking
- **12:30 p.m.** — Keynote address from Jack Nehlig, CEO of Phoenix Contact USA and winner of the 2015 *Plant Engineering* Top Plant Award.
- **1:30 p.m.** — *Session 1:* Cloud-Based Manufacturing
- **2:30 p.m.** — *Session 2:* Robotics: Rise of the Machines
- **3:30 p.m.** — *Sessions 3:* How Maintenance and Big Data Can Coexist
- **4:30 p.m.** — Networking and cocktail reception, sponsored by Forcam.

To register for the 2016 GAMS, go to http://industrialtechnology.events/gams. **ce**

Support-focused enterprise controls: sensor actuation charts

To document speed transition points, designers remove the aspect of time and adopt sensor activation charts. These charts purposely convey an object's station-specific movement information to control system designers. The bars found on sensor activation charts represent the length of actuators or the distance objects travel while not activating a sensor.

Many machine designs come with a sequence of operation drawing for each station. Mechanical designers use the drawings as a way to convey design information to control system designers. Other design-related drawings show the dimensional offsets of station sensors with respect to station centerlines. Most designs are missing an understanding of how control system designers use object actuators and sensor position information to create application triggers. Mechanical designers use the sequence diagrams to show the time in seconds allotted for objects to move between or into process stations. Sequence of operations drawings typically do not show an object's variable travel speed as it activates acceleration, deceleration, or any other in transit sensors.

To document the speed transition points, designers remove the aspect of time and adopt sensor activation charts. These charts purposely convey an object's station-specific movement information to control system designers. The bars found on sensor activation charts represent the length of actuators or the distance objects travel while not activating a sensor. The length of each bar does not represent the timed speed of a moving object. The combined bars also describe the sequenced activation and deactivation of applied sensors. The following definitions describe two types of bars found on a sensor activation chart:

- Sensor-activation bar is a drawing object that appears on a sensor actuation chart, representing the physical activation of a sensor.
- Sensor-deactivation bar is a drawing object that appears on a sensor actuation chart, signifying that no station sensors are active when an object's actuator is between sensors.

Figure 2 shows how mechanical designers can construct sensor actuation charts using sensor-activation bars. Notice how each of the

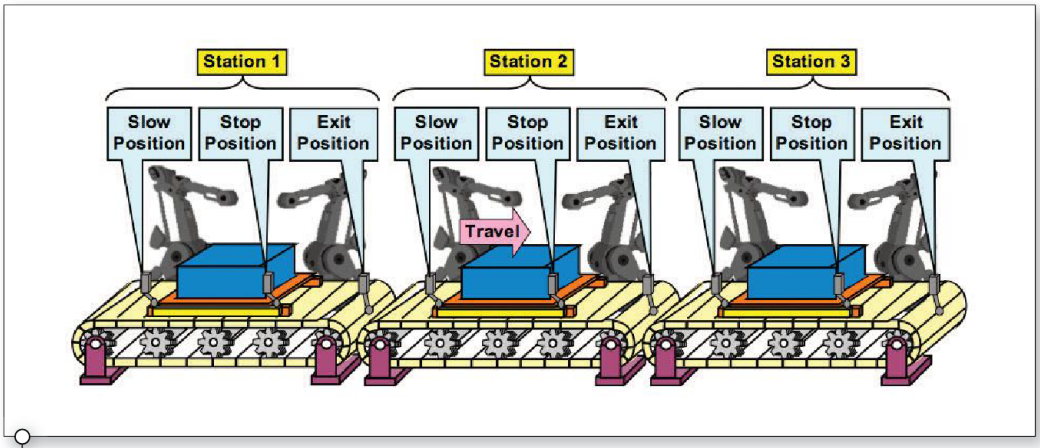

Figure 1: The diagram shows a Slow, Stop, and Exit Position sensor for each station. The Slow and Stop Position sensors detect both ends of a carrier's actuator to signify an object is in position at a station. All figures courtesy: Daniel B. Cardinal

MORE ADVICE

KEY CONCEPTS

Most designs lack understanding of how control system designers use object actuators and sensor position information to create application triggers.

To document the speed transition points, designers remove the aspect of time and adopt sensor activation charts, which convey an object's station-specific movement information to control system designers.

To improve control system designs, manufacturers must insist that machine and conveyor suppliers provide a method for documenting trigger positions.

GO ONLINE

Go to www.controleng.com for additional stories about support-focused enterprise controls by Daniel B. Cardinal as well as other stories on discrete sensors and actuators.

CONSIDER THIS

What other applications can sensor actuation charts be used for?

> Robotic operation starts after the carrier stops and both sensors detect the end of the actuator.

three independently controlled stop-stations use sensors to detect a carrier's long sensor actuator. These actuators force control applications to create large gaps between moving objects. The same drawing shows three sensors assigned to each independently controlled station. The diagram shows a slow, stop, and exit position sensor for each station. The slow and stop position sensors detect both ends of a carrier's actuator to signify an object is in position at a station.

The station's robotic operation starts after the carrier stops and both sensors detect the end of the actuator. The slow position sensor signals the control application to decelerate the carrier moving towards the stop position. The second stop position sensor at each station detects the leading edge of a carrier's actuator, and it signals the control application to stop the moving object. Each Exit Position sensor detects an object depart a station and enter the next. An object can only start to move into an empty station when the exiting carrier ahead is no longer activating that station's exit position sensor.

The sequence of operations for the three stations shown in Figure 1 are the same. Each station's sequence starts with a fast-moving object entering the station and activating a slow position sensor. The object immediately decelerates and continues moving until it activates a stop position sensor. Once stopped, a mechanical locator (not shown) extends, and two clamps (not shown) sequentially close to secure the stopped object. After the stopped object is securely located and clamped, station robots begin their operations. When the robots complete their work, the clamps open and the locator retracts. The new retracted state enables an object to move towards the downstream station. The conveyor moves the object forward when the next station is clear.

This means no object is present in the station, and the last object successfully exited.

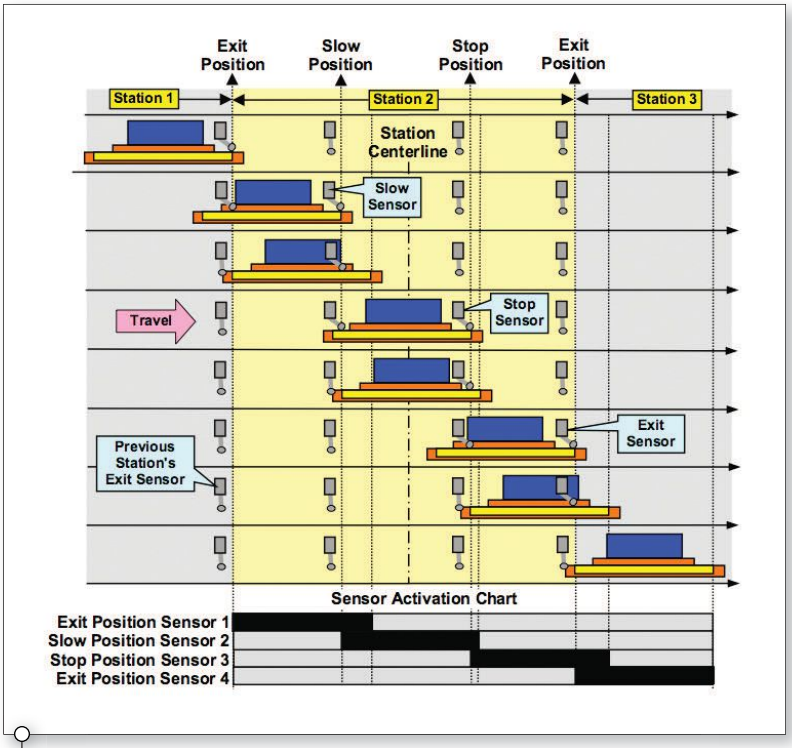

Figure 2: This example shows how mechanical designers can construct sensor actuation charts using sensor-activation bars.

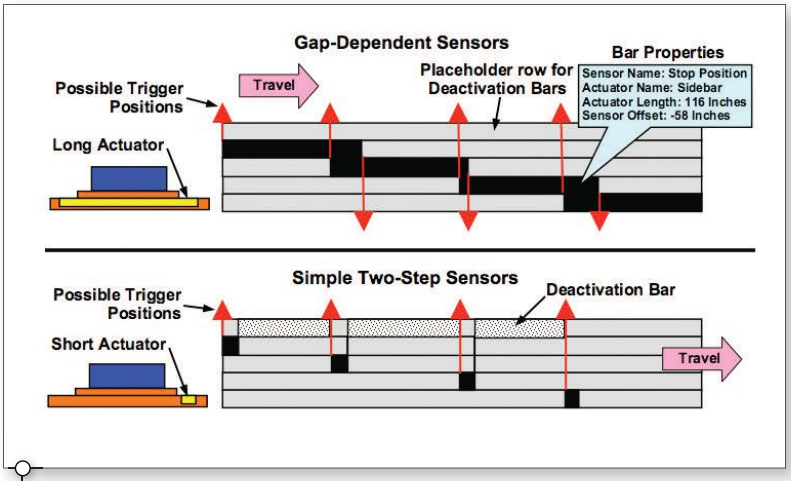

Figure 3: This example shows the sensor activation charts for two different conveyor examples. Each chart uses arrows to show the location of possible triggers.

> The station's robotic operation starts after the carrier stops and both sensors detect the end of the actuator.

> "Manufacturers must insist that machine and conveyor suppliers provide a method for documenting trigger positions."

Similarly, the next object cannot enter this station until the current completed object exits. When the object exits, a control application enables the motors for each independently operated conveyor. If the control application is not able to confirm the exit, each motor starts within a predetermined amount of time and disables forward movement. After confirming movement, the object continues to activate and deactivate the station's exit position sensor. Only after an exiting object deactivates can an exit position sensor become an upstream object that is allowed to enter the now emptied station.

Trigger-firing position information is not readily available to most system integrators. So, how do integrators know where control system applications will produce triggers for controller-based applications? Many integrators do not know the trigger positions forcing add redundant sensors or trigger circuits.

To improve control system designs while simultaneously formalizing the trigger firing positions, manufacturers must insist that machine and conveyor suppliers provide a method for documenting trigger positions. The generation of a sensor activation chart is the first step in this process.

Figure 2 shows an example of how designers produce a sensor activation chart. This specific example is for the second station pictured in Figure 1. Each bar in the sensor activation chart represents the activated state of a station sensor. Since mechanical designers know the dimensional relationships between sensors, they are able to assign descriptive property fields to each bar object. The sensor's name, actuator length, and leading edge offset dimension to an object's stop position are examples of bar-specific property fields.

Figure 3 shows the sensor activation charts for two conveyor examples and the timing for carriers that have small sensor actuators. Each chart uses arrows to show the location of possible triggers. The gap-dependent chart at the top shows the location of triggers for any of the stations pictured in Figure 1. Notice that when mechanical designs use these actuators, the sensor transitioning off has no positional value. The delta between activation and deactivation trigger positions represents a small travel distance. **ce**

Daniel B. Cardinal *works as an engineering consultant for Insyte Inc., implementing integrated scheduling and part identification applications in the automotive industry. Edited by Chris Vavra, production editor,* Control Engineering, *cvavra@cfemedia.com.*

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New Automation Technology **BECKHOFF**

Tool calibration method speeds implementation of 6-axis industrial robots

A teach-position method calibrates tools used by six-degrees-of-freedom (6DoF) robots for peak efficiency and improves industrial processes.

MORE ADVICE

KEY CONCEPTS

A teach-position method speeds tool calibrations.

Six-degrees-of-freedom robots play a key role in performing multiple industrial tasks.

A teach-position method will speed up production and is cost-effective for machine builders.

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CONSIDER THIS

Would this teach-position method speed your robotic restarts after tool changes?

As robots become more sophisticated, they are being implemented into more industrial processes. Six-degrees-of-freedom (6DoF) robots are capable of complex movements that enable them to perform well in many complicated industrial tasks such as palletizing, handling, gluing, and welding. A 6DoF robot can lift and deftly manipulate heavy payloads, precisely moving them with complex geometry.

Because of their high-performance capabilities and flexibility, 6DoF robots are assigned many industrial tasks using a wide variety of tools. However, taking advantage of the capabilities of these robots requires precise re-calibration every time a new tool is introduced. Re-calibration is often time-consuming and inaccurate, inhibiting industrial processes, and delays in production.

There is an effective teach-position method that quickly calibrates a new tool used by a 6DoF robot without relying on manufacturer measurements or external sensors. The method is easy, accurate, and useful in practical applications.

Calibration of a 6DoF robot

A 6DoF robot holds and moves a tool to perform a task. The robot must know the exact location of the tool while it works. Each time a different tool is attached, the robot must be precisely re-calibrated.

Methods for calibrating 6DoF robots include: touching reference parts, using distance sensors, and employing laser interferometry. A robot also can be calibrated using external sensors, such as camera systems, that can be attached to various robot locations to acquire the precise position of a reference object.

These methods can be time-consuming and complicated. A teach-position method was developed as an easier alternative and has already achieved excellent results.

Determining the tool center point

Kinematic calibration methods are used to determine the tool center point (TCP), the point in relation to which all robot positioning is defined. The TCP is defined relative to the world coordinate system, the Cartesian coordinate system for any point in the world, which always remains stationary with respect to the robot (see Figure 1).

The tool coordinate system defines the position and orientation of the tool and is at a zero-position at the TCP. The TCP of the robot moves to programmed positions as it executes a Cartesian

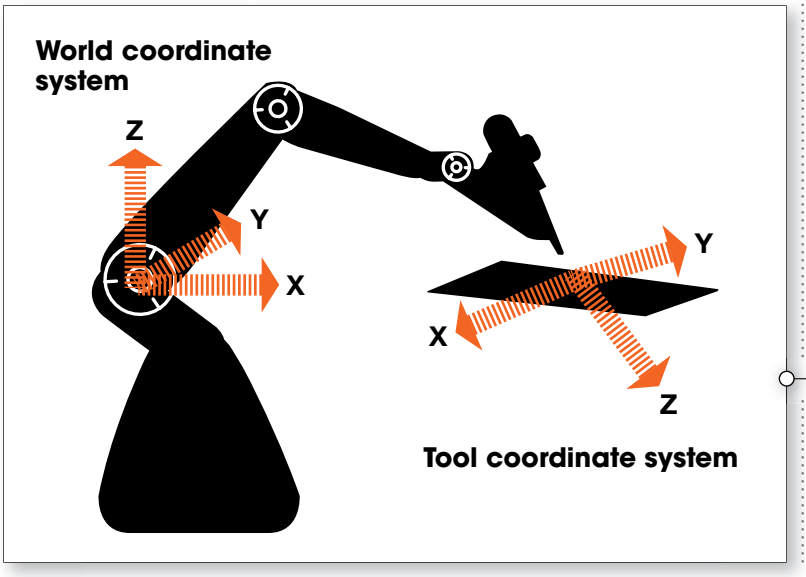

Figure 1: An illustration determines the tool center point (TCP) relative to the world coordinate system. The Servotronix teach-position method quickly calibrates a new tool used by a 6DoF robot without relying on manufacturer measurements or external sensors. All graphics courtesy: Servotronix

Wonderware Distributors Possess Powerful HMI and SCADA Capabilities for your Automation Projects

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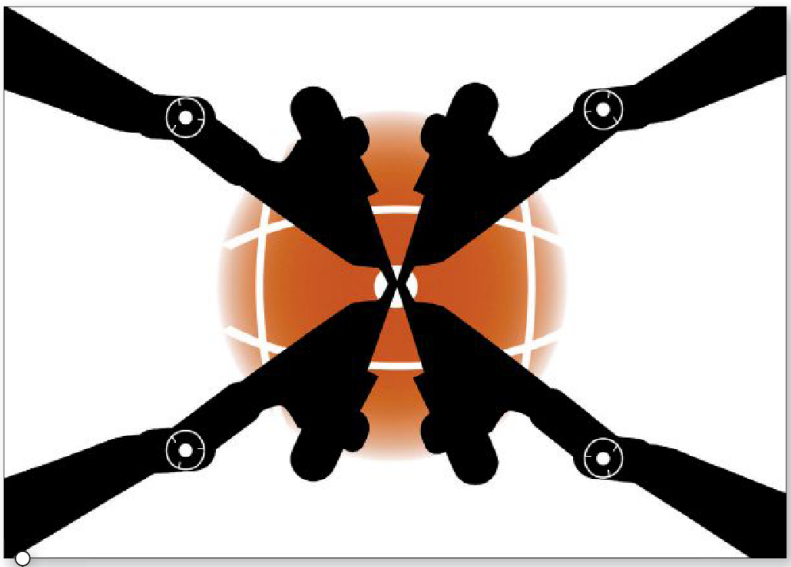

Figure 2: Robot configurations pointing to the same location will lie on a sphere with the tool tip in the center of the sphere.

motion. Changing the tool changes the tool coordinate system, requiring re-calibration to enable the new TCP and accurately reach the target.

In many robot applications, the motion trajectories of the TCP represent complex paths in the robot's working space, typically a straight-line path with some orientation change of the tool by the robot. The tool itself might need to be replaced occasionally or more frequently. Each time the tool is replaced, a new set of geometric parameters must be determined and assigned before operations can continue.

For most industrial applications, a teach-position method is the most practical means for writing robot tasks. With this method, tool parameters have to be available (usually from the manufacturer) with high accuracy. The angular offsets of the tool and its Cartesian offset are necessary for generating straight-line paths with a controlled orientation of the tool.

Quite often, the operator is expected to identify the tool geometry under certain constraints such as:

- No prior knowledge on tool dimensions from the manufacturer
- No available hardware assistance
- No knowledge about how the tool is mounted on the robot flange.

Faced with these constraints, the operator must undertake time-consuming calibration procedures every time the tool is changed.

Using a teach-position method for exact calibration

A method for quick, exact estimation of tool geometry without external sensors, vision, or other aids was developed without requiring the dismounting the tool. By using this teach-position method, the operator simply brings the 6DoF robot's TCP to several different positions/orientations, which are then automatically input to the tool-dimension estimation algorithms. The algorithms quickly determine precise calibrations of the new tool and prepare it for use.

The accuracy of this calibration method improves with more tool positions/orientations that are used as input to the algorithms. Experiments show that while using an inverted homogeneous matrix does not necessarily lead to desired results, using least-squares estimation results in values that lead to precise calibration.

Testing a teach-position method

Tests were performed using a 6DoF robot with a mounted tool, six high-performance servo drives, and a controller. A teach-position method involves an analytical calculation and does not require the dismounting of the tool. The XYZ dimensions are estimated and the tool tip is assumed to be in constant Cartesian location.

It is axiomatic that all robot configurations that point to the same location must lay on a sphere with the tool tip in the center of the sphere (see Figure 2). Taking measurements of points that lay on the sphere enables calculation of the TCP.

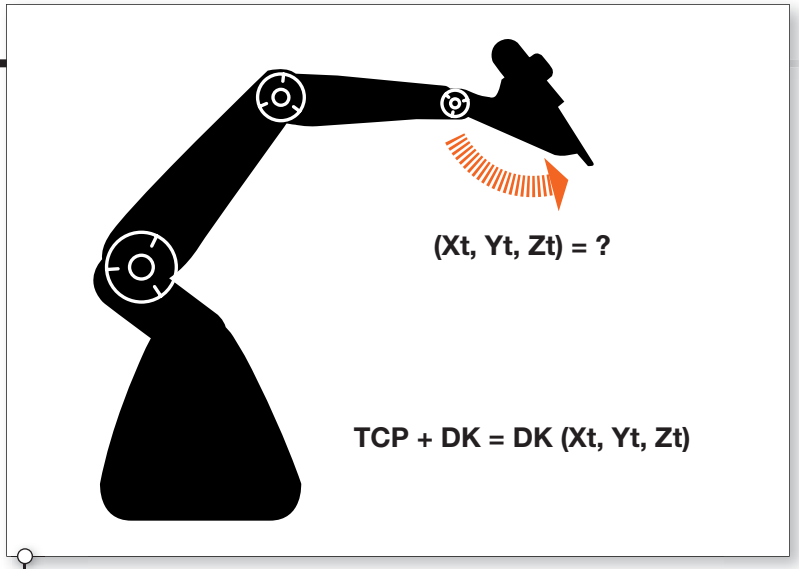

Figure 3: Taking measurements of points that lie on the sphere enables tool center point (TCP) calculation with "T" representing the center.

Equation 1:

$$R^2 = (X - X_t)^2 + (Y - Y_t)^2 + (Z - Z_t)^2$$

In equation 1, there are four unknown parameters (R, Xt, Yt, Zt), where t represents the center. The values of X, Y, and Z are calculated by direct kinematics. To reach acceptable accuracy, the method requires at least four points to define a sphere. Therefore, four such configurations include:

$$R^2 = (X_1 - X_t)^2 + (Y_1 - Y_t)^2 + (Z_1 - Z^t)^2$$
$$R^2 = (X_2 - X_t)^2 + (Y_2 - Y_t)^2 + (Z2 - Z^t)^2$$
$$R^2 = (X_3 - X_t)^2 + (Y_3 - Y_t)^2 + (Z3 - Z^t)^2$$
$$R^2 = (X_4 - X_t)^2 + (Y_4 - Y_t)^2 + (Z4 - Z^t)^2$$

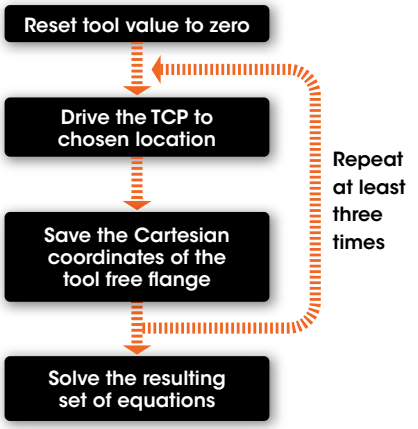

Figure 4: An illustration shows the four steps in the step-by-step Servotronix method for quick, exact estimation of tool geometry without external sensors, vision, or other aids, without dismounting the tool.

If the four points define a circle (three points with one redundant point also in the circle), the points can exist on many spheres in which case the sphere center is not calculable.

By using equation subtraction, not only is the unknown variable R eliminated, but all nonlinear components in the equations are cleared. This leaves a set of polynomial equations of degree 1 which can be solved by linear least-squares fitting. Taking more than four points results in more equations and higher accuracy.

The step-by-step method requires the consideration of at least four measurements as shown in Figure 4.

A teach-position method

A teach-position method is quick, accurate, and inexpensive, enabling tool calibration without dismounting the tool. The described method can be performed without dedicated hardware, saving time and effort whenever a new tool is mounted. Machine builders can easily implement the method and benefit from the quick, precise, and virtually cost-free re-calibration of 6DoF robot tools that will enhance and speed up production in a wide variety of applications. **ce**

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Edited by Emily Guenther, associate content manager, Control Engineering, *CFE Media, eguenther@cfemedia.com.*

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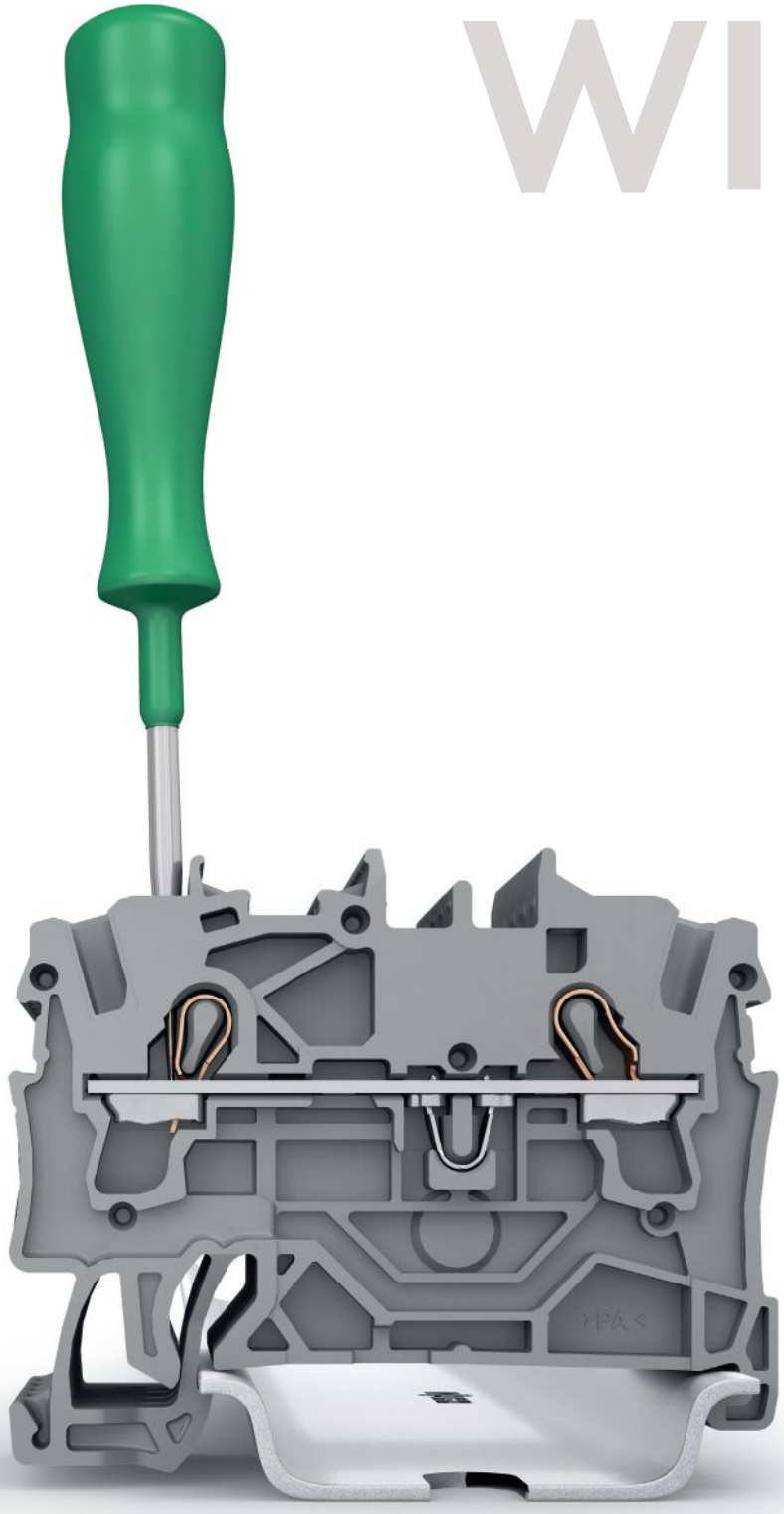

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If you're a system integrator with demonstrable industry success, *Control Engineering* and *Plant Engineering* urge you to enter the 2017 System Integrator of the Year competition. Past System Integrator of the Year winners—Class of 2016, Class of 2015 and Class of 2014—are not eligible to enter the 2017 System Integrator of the Year program.

What's in it for the winners?

The chosen System Integrator of the Year winners will receive worldwide recognition from *Control Engineering* and *Plant Engineering*. The winners also will be featured as the cover story of the Global System Integrator Report, distributed in December 2016.

How will the competition be judged?

Control Engineering and *Plant Engineering's* panel of judges will conscientiously evaluate all entries. Three general criteria will be considered for the selection of the System Integrator of the Year:

- Business skills
- Technical competence
- Customer satisfaction

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Manufacturing and the fourth revolution

Industry leaders within manufacturing have already set in motion the idea of a fourth industrial revolution, or Industrie 4.0, and the Internet of Things (IoT) will play a major role in how manufacturing changes.

REST communication and the IIoT

A popular mechanism for the Industrial Internet of Things (IIoT) is representational state transfer (REST) communication. If a system or device exposes this kind of interface, it becomes Web-compatible.

Three ways to ease succession planning

Address common challenges with ownership transition.

U.S. continues to lead in natural gas production

For the fifth year in a row, the United States leads the world in the production of natural gas, and that lead is widening.

The benefits of using a soft starter on ac motors

Switching your ac motors to include a soft starter may result in an initial payout. Because of the reduced power consumption and maintenance, they will typically pay for themselves very quickly, and the benefits will be fully experienced from that point forward.

How to find value in a KPI lifecycle

Key performance indicators (KPIs) are part of a lifecycle because KPIs are continuously defined, redefined, and are even sometimes abandoned. Explicitly defining a KPI lifecycle provides an impetus for the development of methods and tools that enhance performance.

Control and integration companies:

7 ways to qualify for the research and development tax credit

Companies with a cross-disciplined approach to design and production in controls and automation can qualify for the R&D tax credit, which brings in an estimated $10 billion annually for U.S. businesses, provided that the companies can take advantage of the break. See project examples that qualify and seven ways to fit the R&D tax credit.

For those who are in the business of improving industrial production processes, be it through controls and automation or through the integration of multiple systems, it is likely that there is an excellent opportunity to bring added value to the company through the research and development (R&D) tax credit.

The R&D tax credit brings in an estimated $10 billion annually for U.S. businesses and has become one of the largest and most generous tax credits out there. Due to the cross-disciplined and technical nature of their work, industrial controls, automation, and systems integration companies are among some of the absolute best candidates for the credit. In some cases, results can save companies money that reaches six figures.

This industry is such a premier candidate for the credit, and changes made as recently as December 2015 will be tremendously beneficial to these companies.

How the R&D tax credit works

Considering the potential total value of the credit, it is surprising that, by and large, the R&D tax credit is actually severely underclaimed by the majority of U.S. businesses. (*The Wall Street Journal* estimates that only one out of every 20 eligible businesses is claiming the credit.) There are numerous reasons for this, but in general, a misunderstanding of what the federal government defines as "research and development" tends to be the main culprit.

Despite what the name may imply, the R&D tax credit is not just for clinical trials, patents, or scientists in white lab coats any longer. Rather, in the case of industrial automation and systems integration companies, it is the everyday technical problem solving performed on the factory floor by engineers who are working to improve a product, or updates to iterative steps devised by a plant manager to enhance the efficiency of a systematic process, that can lead to eligibility.

In the case of control engineers, the long hours spent on hardware and software development, or motion control experimentation, for example, will also generally qualify businesses for high-end credit results. Any type of work performed by employees that is intended to design, develop, program, or enhance the efficiency of automated production systems fits perfectly with the kinds of activities the R&D credit rewards.

Tax credit project examples

For example, a company that designs, retrofits, and manufactures custom industrial automation machinery was contracted to conceptualize and manufacture a robotic assembly machine. During the design phase, the team used several 3-D software platforms to simulate and illustrate to the client how the machine would operate. This practice ended up reducing waste and cutting costs. Materials and parts were purchased and assembled while the complex multi-axis motion controls and software were developed simultaneously. This project,

MORE ADVICE

KEY CONCEPTS

The R&D tax credit brings in an estimated $10 billion annually for U.S. businesses.

Work that is intended to design, develop, program, or enhance the efficiency of automated production systems qualifies for the R&D credit reward.

The R&D credit is often overlooked by owners of industrial automation and systems integration companies.

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CONSIDER THIS

There may be other tax breaks and deductions out there that are designed to save companies money if they take advantage of them.

Companies with a cross-disciplined approach to design and production in controls and automation can qualify for the R&D tax credit, which brings in an estimated $10 billion annually for U.S. businesses, provided that the companies can take advantage of the break. Courtesy: Alliantgroup

in conjunction with other innovative undertakings, helped this company qualify for $242,967 in R&D credits.

In another example, a value-added reseller and systems integrator for industrial automation products discovered that it qualified for $214,106 in R&D credits thanks to the company's work helping factories engineer and integrate products and technologies. The activities that determined their eligibility for the credit included the assimilation of automation components such as sensors, alarms, motion controllers, wireless communications, and large-scale machine components.

The key takeaway from these examples is that there are many ways to qualify for the R&D tax credit, including (but not limited to) the following seven activities:

1. Everyday techniques and processes that are associated with industrial engineering, programming, and manufacturing are generally ideal fits for the R&D tax credit.
2. Performing interdisciplinary engineering, such as control design and mechatronics, for industrial purposes
3. Resolving unique automation challenges for diverse applications
4. Delivering custom solutions that utilize measurement and data-driven technologies
5. Developing software or hardware for instrumentation
6. Performing evaluations, feasibility studies, and system tests to ensure optimal functionality
7. Programming automated controllers such as industrial PCs, PLCs, and HMIs.

Companies providing a wide span of control, automation, programming functions, and services can be eligible for this opportunity, and it's not just limited to product engineers or smart manufacturers. The R&D credit reaches across the spectrum of the Industrial Internet of Things (IIoT) to include suppliers and peripheral service providers.

The PATH Act, the R&D tax credit

Working in the favor of American companies, big changes were made this past December when Congress signed the Protecting Americans from Tax Hikes (PATH) Act into law, thereby enacting key modifications that will greatly expand the number of industrial automation

> "The 2016 expansion of the tax credit removes the alternative minimum tax (AMT) bar for eligible small businesses, less than $50 million average gross revenue for three prior years."

and systems integration companies (and for that matter, U.S. businesses as a whole) eligible for the R&D Tax Credit.

The PATH Act made the R&D credit permanent, which provides business owners with a reliable resource for long-term financial planning. Additionally, the law includes a major expansion that will take effect in 2016 by removing the alternative minimum tax (AMT) bar for eligible small businesses (defined by the legislation as businesses with less than $50 million in average gross receipts for the prior 3 years).

This is a barrier that effectively prevented qualifying companies from taking advantage of the R&D credit for years, and loosening the rules governing AMT's limitations has greatly expanded the number of companies eligible for the credit.

Despite being more available than ever, the R&D credit continues to be a blind spot for business owners of industrial automation and systems integration companies. This niche industry is at the top of the list of some of the absolute best credit candidates, and it's time for business owners to claim they're fully entitled to tax savings. Ignoring the value of the R&D credit could be among the biggest mistakes a company can make-and considering both congressional changes and the new dynamic trends within the industry itself, it would be wise for these companies to look long and hard at the R&D tax credit. **ce**

Tracy Lustyan, *managing director, Alliantgroup. Edited by Chris Vavra, production editor,* Control Engineering, *CFE Media, cvavra@cfemedia.com.*

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IoT to IoAT:
Internet of Autonomous Things devices provide solutions

Future Internet of Autonomous Things (IoAT) devices will utilize knowledge-enhanced electronic logic (KEEL) technology and may consume information from other devices or the cloud and participate in solutions they were never designed for.

MORE ADVICE

KEY CONCEPTS

IoAT devices will deliver expertise and adaptive command and control, beyond just providing information.

IoAT devices can operate independently or as objects that can self-organize and operate as teams to solve problems they have never been programmed to address.

The tools and techniques that will allow these capabilities to be delivered exist today.

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CONSIDER THIS…

How will IoAT devices transform the way your control system process information?

The next generation of Internet of Things (IoT) devices will deliver expertise and adaptive command and control, beyond just providing information for higher level processing. Knowledge-enhanced electronic logic (KEEL) technology will play a role in accelerating the delivery of these advanced capabilities into small, low-cost devices. The Big Data concept is that all of the connected devices will be producing information that is consumed by some higher-level system. Potentially, there is another view.

Given that some type of controller will control these devices, many of these devices can take on new responsibilities. Gartner Inc. predicts that there will be 6.4 billion connected objects in use by 2016 and 21 billion by 2020. Rather than just producing data, these devices can perhaps take on additional roles. In the future, these devices may consume information from other devices (and the cloud) and participate in solutions they were never designed for.

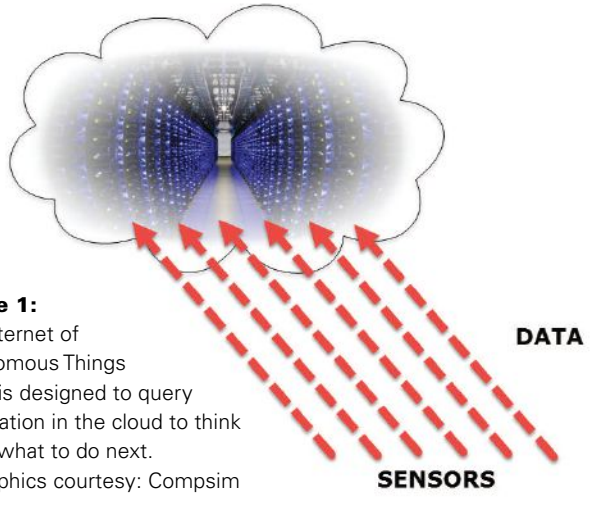


Figure 1:
The Internet of Autonomous Things (IoAT) is designed to query information in the cloud to think about what to do next.
All graphics courtesy: Compsim

Not just collecting data

The primary objective of collecting data usually is to make better decisions. Predictions using data can prepare systems for the future by detecting change, or exerting some kind of control. Using a broader description, one might suggest that data can be collected for the purpose of controlling behavior. If the organization doesn't control systems' behavior, another organization will collect that data and use it accordingly. The common perception is that as problems become more complex, large processing engines can only handle them, or that those problems require humans-in-the-loop to interpret the complex information sets.

Another common "Big Data" view is that much of the information processing will be accomplished by searching for patterns of data from large data sets that are collected over time. This view is that the data is in control, so we should let the data drive the solution. Well perhaps, or perhaps not?

Some who have been around for a while look at the IoT and see nothing that is really new. Distributed control and supervisory control and data acquisition (SCADA) products have been used in industrial automation for many years.

"Timesharing" and "cluster computing" are terms that have been associated with distributed computing. These terms are often used to define the technology-of-the-day that includes taking inputs, manipulating the data, and then distributing information to control actions or outputs.

The evolution of technology that has resulted in the IoT market has been driven by the commoditization and re-distribution of resources. Each time a shift takes place, some marketer will create a new name and claim the market.

The commoditization of processing power in microcontrollers, tied to low-cost development environments, has reduced the cost of processing information. It has also commoditized interconnectivity with consumer-based networks and protocols that have provided the infrastructure for new devices to participate in more complex applications. Additionally, microelectromechanical systems (MEMS)-based devices have reduced the cost of sensors and actuators.

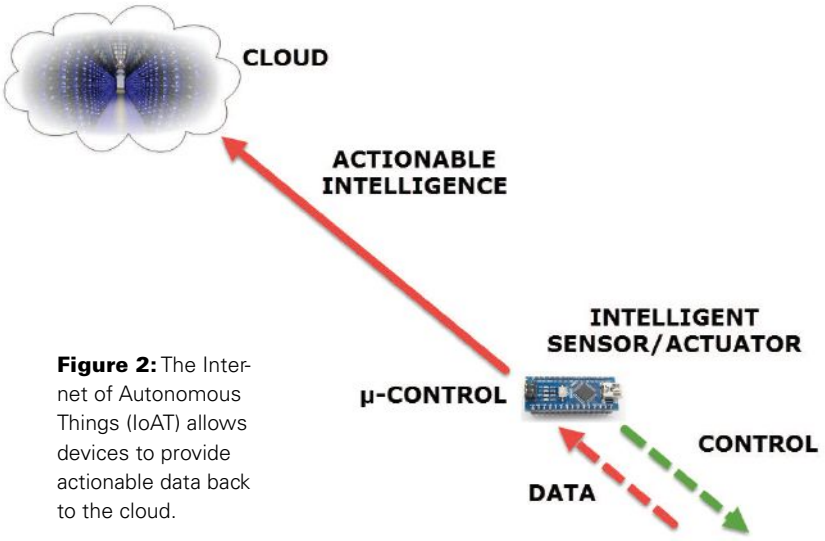


Figure 2: The Internet of Autonomous Things (IoAT) allows devices to provide actionable data back to the cloud.

Cloud-based control solutions

Cloud-based control solutions help many organizations centralize their processing deployment, which may help them manage their distributed applications.

However, there is always a "but" in this type of situation. Sometimes things go wrong. Putting all the eggs in the "cloud basket" connected by webs of open networks exposes many organizations to new risks. The new market for network security, redundant communications, and encryption has recognized the risks and offered patches to protect the user from new problems.

If a system can be hacked, it will be hacked. And given that if a system can break, it will break. And when things go wrong, they will probably go wrong at an inconvenient time.

Consider this analogy: What if there was another Earth, "Earth1," that only had one human living on it? That single human could have a billion tentacles that are connected to billions of tools. Earth1 could operate just like Earth; possibly even better, because, hypothetically, the single brain of Earth1 could manage conflicts between its tentacles and its tools (see Figure 1). However, if Earth1 had a problem and lost some of its tentacles, those functions would be completely lost. And if Earth1 forgot how to process all the information, then it would be dead in its universe.

Compare this to our Earth with its billions of humans. Each human has a brain that has its own proprietary sensors and actuators (see Figure 2). Our Earth is not dependent on any single communication link. Furthermore, it is not dependent on any single human. Our Earth benefits from groups of humans working together and it benefits from humans redistributing themselves from one collection of humans to another to address different problems. It also benefits from the ability of individual humans to continue to operate when communication links are broken.

Humans (in general) can figure out what to do if one of their tools is broken or lost. Humans can also respond to damage to other humans, as well as to bigger strategic and tactical issues. Individual humans can focus attention on specific tasks, but they know when to look beyond their assigned tasks at the "bigger picture." Humans (as a population, or groups of populations) are able to adapt (see Figure 3).

Another characteristic of humans is their ability to dispense "expertise." Expertise is more than having an ability to follow rules. Expertise is the ability to deliver judgment and reasoning. Judgment and reasoning are what allow the human to balance alternatives. They understand when to re-allocate attention when unexpected things happen. Human judgment and reasoning are used to solve more complex, inter-related problems that have conflicting objectives (solving tactical short-term goals while still considering longer term strategic objectives). It is judgment and reasoning that help humans make relative (how much) decisions, as they balance risks and rewards.

> "IoT devices will be generators of information; maybe the edge devices should also be viewed as consumers of information."

Current state of the IoT

The general concept is that IoT devices will be generators of information. However, maybe the edge devices should also be viewed as consumers of information (using our human model). There might also be an opportunity to expand more into the actuation role and do

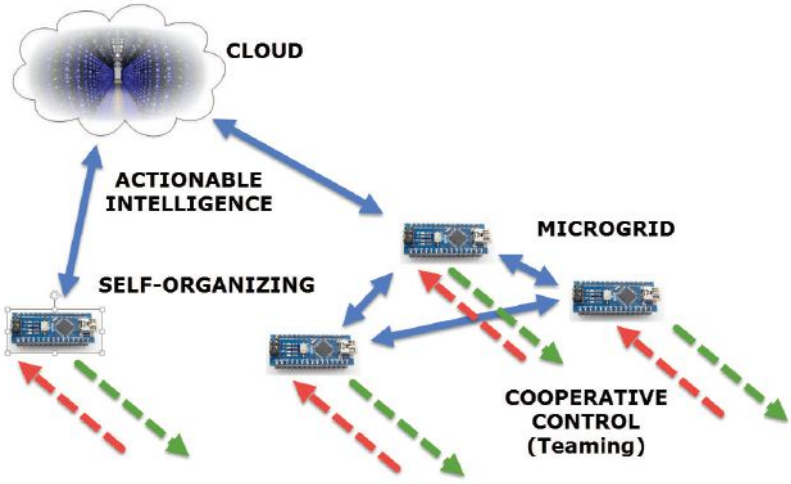
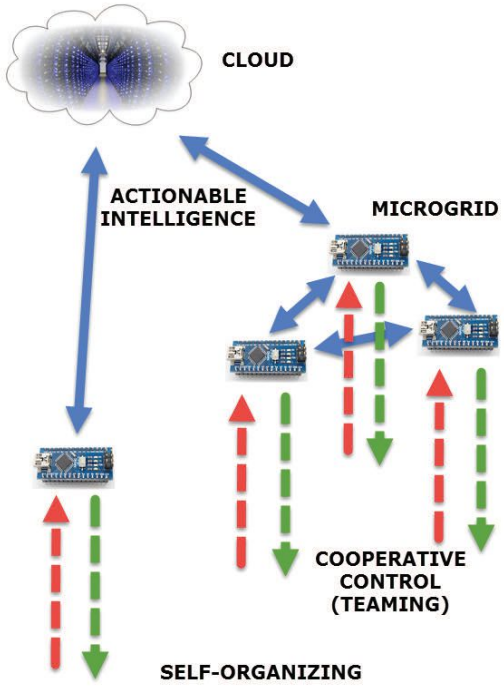


Figure 3: Distributed expertise allows devices within the microgrid to either cooperate or self-organize data (see below) based on the situation.

Figure 4: Distributed expertise allows devices within the microgrid to either cooperate (see above) or self-organize data based on needs.



some things locally without depending on the computer in the sky to process information.

In this case, users might avoid some of the risks associated with propagation delays and widely distributed computing. If we look at opportunities for IoT devices to behave as autonomous (or semi-autonomous) devices and redefine IoT as the Internet of Autonomous Things (IoAT), then what might the market look like?

IoAT: Internet of Autonomous Things

Since there are an abundance of information sources distributed across the face of the Earth, maybe there will be a growth in distributed tools. It is very likely that more intelligent actuators will be created.

Based on that, the following scenarios are likely:

- Actuators will collaborate with local information sources (just like humans do). Microgrid infrastructures are starting to appear in the market.
- Actuators will be consumers of information (as humans are).
- Actuators will identify their own information sources beyond those directly attached (just as humans gather information from nearby information sources and use their own senses to drive their own decisions and actions).
- Actuators will work together to address problems when they lose connectivity with their supervisor in the command hierarchy (just as humans operate with their peers in emergency situations).
- More intelligent autonomous/semi-autonomous devices will be able to recognize unplanned situations and respond according to human-defined guidelines (just like humans follow rules of engagement and operational policies they have been provided in advance). This will enable the devices to address problems they have never encountered before.
- When dealing with teams of devices working together, there will be devices that may encounter problems during operation. These self-organizing devices will be able to react in real time (adapt collectively) to change.

Even when these IoAT devices (operating as a local team) encounter problems they cannot address together, they may be able to transmit actionable intelligence up their information hierarchy (if they have a communication link). They will even be able to use their own embedded expertise to look for communication alternatives.

Think of these new IoAT devices as objects that can operate independently or as objects that can self-organize and operate as teams

to solve problems they have never been programmed to specifically address before.

More mobile-like devices that have multiple tools attached will be able to address more problems, all without going to the cloud for advice.

One might speculate that personal security, home automation, health care, industrial automation, transportation, agriculture, and military applications will lead the way with IoAT devices.

One might also speculate that personal, security, and financial applications will lead the way in the form of personalized software agents.

What are the roadblocks?

There are still some challenges and hurdles because it remains in its infant stage.

The hobbyist market is exploding with remotely piloted aircraft. While many of these devices are still remotely controlled, many have significant processing power. A DIY drone has GPS, roll-pitch-yaw sensors, altimeter, compass, video feed, wireless network connections, battery sensor, torque sensors, and motor feedback logic. Platforms come in various sizes and demonstrate how much performance (with connectivity) is currently available in the commercial space (i.e. commoditized). So, processing power is not a roadblock.

Connectivity is also not a roadblock since the Internet has commoditized connectivity. Wi-Fi and Bluetooth will continue to add security to their information exchange. Peer-to-peer and point-to-point microgrid networking will open new doors. It is likely that more development will be made in this area. The consumer and hobbyist market will drive this. Locally connected devices will be able to handle various point-to-point, peer-to-peer, and broadcast messaging structures.

Also, consider the IoAT actuators. This will be a new market for many new players. These will be the tools, arms, and hands (end effectors) of the IoAT devices. Their basic function will be to respond to threats and opportunities. Initially they may be remotely controlled tools, but eventually they will be able to self-organize and act collectively (team). They will become the human assistants that are always alert, always doing their job, always ready to respond to new threats and to new opportunities. Rather than calling the availability of these devices roadblocks, they will be market opportunities.

One might suggest that their availability will create new opportunities because some problems will need support from multiple IoAT devices working together (so they can collectively solve problems). Looking at the opportunities will drive changes: Why not solve the problem at the source, rather than just providing information for someone else to worry about?

There has been another significant roadblock. There will be a requirement to be able to capture and package human-like judgment and reasoning skills that will execute in the small, low-cost IoAT devices. We are talking about packaging human-like expertise that will enable these devices to solve complex problems that have historically required humans directly in the loop to address.

> "We have to give machines the ability to think in a more abstract manner to solve more problems beyond their original designs."

However, we do not have to replicate the human brain in these devices. These are machines with some limited set of capabilities. We only have to enable the machines to have the ability to consider alternatives of how they can use their capabilities in different situations. We just have to give them the ability to think in a more abstract manner. We do not want them to have free will. We do not want them to decide who their master is.

Also, we do not want to give the devices a weapon and have it used against us. Again, they will remain just machines; but they will be more capable machines that can use their abilities to solve more problems than they were originally built for. We want these devices to be able to pursue broader goals.

Business drivers

Location is everything. Users deploying packaged sensors are occupying space. A machine in place is already occupying that space. By adding new capabilities in the same space, the user is delivering a better level of service. Users and companies that are able to package human-like judgment and reasoning with the solution will create new opportunities and use that capability for a more efficient operation. It can also be used to add more safety to an enterprise on enhance security.

In a factory automation environment, the user can improve operational efficiency if the

machines can monitor and adjust their own behavior without depending on simple, statistical, preventative, maintenance procedures or dedicated operators. If machines can monitor their own stress, age, wear and tear, and upcoming jobs, they can tell their supervisors when maintenance should be performed in advance of system failures. Or they can highlight significant risks that they see coming.

Business drivers for someone interested in delivering "expertise" through IoAT devices:

> "Localized processing: Delivery of expertise that is closer to the information source will allow minor problems to be addressed before they become major issues."

- Provide new capabilities:
  - Take humans out of the control loop
  - Reduce human error by automating services
  - Insert expertise where humans cannot go (size/risk)
  - Allow humans to command their own army of devices (amplify a human's capability)
  - Provide services that historically have required humans to analyze, thus making human expertise available continuously.
- Provide the ability to package judgment and reasoning into software applications and devices and make it:
  - Easy to use
  - Easy to learn
  - Easy to test
  - Easy to explain.
- Provide a solution that can be deployed in very low-cost devices without adding significantly to base costs.
- Provide a safer environment:
  - Remove humans from risk
  - Reduce human-induced errors in judgment.
- Provide 100% explainable and auditable behavior:
  - For safety critical systems
  - Because the user wants to know why things happen
  - So the user can focus on making systems better and better.

The market for IoT solutions will continue to evolve. IoAT devices will process information closer to the source to determine:

- What does it all mean?
- What can be done and how should it be done?
- Who can help?
- Who needs to be told what to do about a situation (providing actionable intelligence; not just data)?
- What more is needed to address the situation (beyond what an individual device, can do)?

Delivery of expertise that is closer to the information source will allow minor problems to be addressed before they become major issues. This localized processing of information will isolate the user from many of the security issues that may exist with distant, centralized information processing.

Organizations will compete based on the packaged expertise and the adaptivity of the IoAT devices they offer to the market.

The tools and techniques that will allow these capabilities to be delivered exist today. All that is required is for alert organizations to move quickly to address the opportunities. **ce**

Tom Keeley *is the founder of Compsim and the inventor of knowledge enhanced electronic technology. Edited by Joy Chang, digital project manager, CFE Media, jchang@cfemedia.com.*

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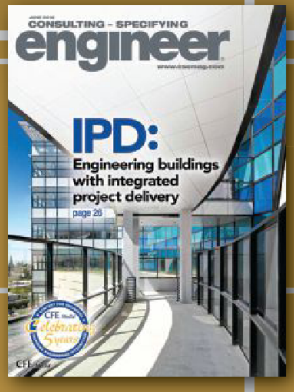

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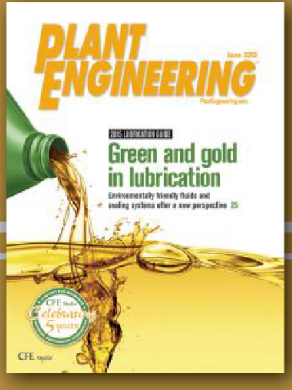

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Advantech Helps Enable Intelligent, Connected Factories

In the past, devices and equipment within most factories offered minimal connectivity to each other. This was for several reasons, the main one being a lack of compatibility between different manufacturers preventing devices from communicating with each other.

This lack of compatible standards and programming languages meant that gathering all the data in one program was an expensive challenge. However, thanks to technological advancements, manufacturers such as Advantech, are now developing hardware and software to ease the process of connecting both old and new devices to enable smart factory solutions.

WISE-4000 Wireless IoT Devices

For example, Advantech's WISE IoT modules provide an HTML5-designed configuration interface, which can be accessed from any modern device or platform.

Likewise, Advantech's **WISE-4000 IoT Wireless I/O modules,** designed specifically for use in IIoT applications, use RESTful web services and HTML 5 to dynamically adjust the display of information based on the device being used to access it.

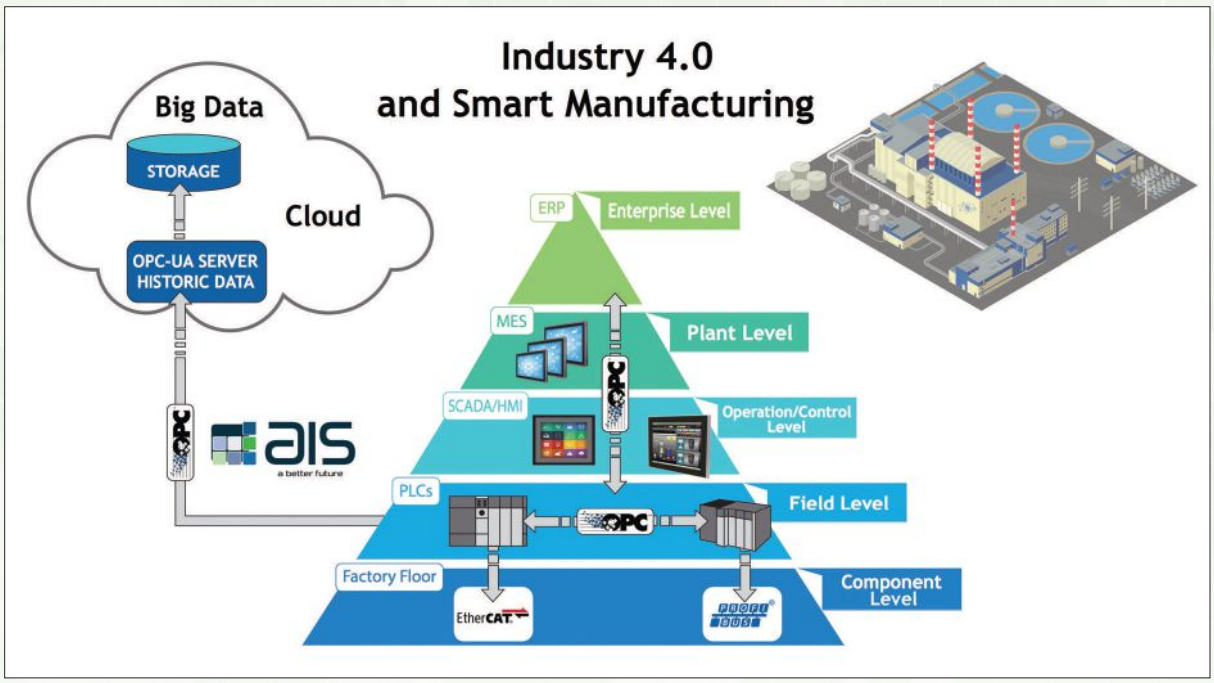
In addition to web-enabled I/O devices, Advantech also produces a range of industrial computers, such as the **UNO-1200 & UNO-2200 series,** which act as an IIoT gateway to process data coming from end devices or PLCs running divergent protocols. These IIoT gateways make it easy to extract intelligence from your plant floor machines.

UNO-1200/2200 Compact Edge Computing Gateways

Furthermore, Advantech's latest **WebAccess 8.1 browser-based HMI/SCADA software** is a complete cloud-based system that can be designed and constructed using WISE-4000 and other Advantech data acquisition devices. WebAccess provides three types of interfaces: A Web Service Interface for customers to integrate data into their own apps; a pluggable widget interface for programmers to develop their own widgets to run on the WebAccess Dashboard; and a DLL interface for developing Windows applications. These three features enable WebAccess to permit development of IIoT applications for different vertical markets.

Advantech's wide selection of smart factory solutions have been designed with Industry 4.0 technologies in mind and enable seamless connection, aggregation, and transmission helping to make your factory more intelligent.

IoT Gateway HMIs, Industrial PCs, Thin Clients and Embedded Panel IPCs for Connectivity, Data Collection and Networking



AIS's open platform HMIs deliver interoperability between systems and networks and enables fast and easy application development. It allows users to leverage new TCI/IP-based networking, PC-based Automation, Data Acquisition, Communications Gateway, M2M, Industry 4.0 and Industrial Internet applications.

AIS offers a complete family of Smart Integrated, Touch Panel PCs and HMIs, Embedded Panel IPCs, Rugged Box IPCs, "Thin-Manager Ready®" Thin Clients and DIN Rail IPCs for a sustainable and scalable platform that reduces costs and increases network security.

Industrial Box PCs - Available in three models, AIS's Industrial Box PCs and fan-less embedded computers are suitable for continuous-duty, mission-critical applications in manufacturing and process industries.

DIN Rail Industrial PCs - AIS's DIN Rail Industrial PCs (IPCs) and Embedded Automation Computers offer the benefits of PC-based control and DIN-Rail mounting design for easy installation inside control cabinets.

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> *"The use of nonmetallic engineered materials offers a multitude of competitive advantages"*

According to Glenn Saunders, Vice President of Sales and Marketing, "Systems using automation and controls are in every industry and every environment. The use of non-metallic engineered materials offers a multitude of competitive advantages, such as reduced weight and easier modification processes, over traditional metal enclosures. Allied Moulded's enclosures are a great alternative to steel, especially when applications encounter harsh environments."

Glenn Saunders
Vice President of Sales and Marketing

Allied Moulded's products are marketed in the U.S. primarily through an extensive network of professional manufacturer's reps, all specialists and experts in electrical boxes and enclosures. Allied Moulded has expanded its global reach, with the addition of Allied Moulded Enclosure Products (India) Pvt Ltd., serving India and the Middle East markets.

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A Better Coupling Choice Has Arrived

Baldor's newest addition to our coupling product offering – the Baldor•Dodge® Raptor coupling – featuring a finite-element optimized winged elastomeric element design, the Raptor provides longer driven equipment life and improved reliability. Raptor's patented WingLock technology increases surface area at the most critical regions of the element, resulting in higher bond strength, improved fatigue resistance, and longer life than competitive urethane designs.

For reduced maintenance, the Raptor offers a split element for easy installation and replacement without moving or re-aligning connected equipment. Slotted clamp ring holes offer extra clearance for mounting hardware, resulting in a noticeably easier installation. Designed for drop-in interchangeability, Raptor couplings work in existing applications without any modifications.

Longer Driven Equipment Life and Improved Reliability

Leveraging over 50 years of Dodge's natural rubber expertise, the Raptor features a natural rubber flexible element that offers a number of performance benefits when compared to competitive urethane designs.

Because the Raptor element uses a natural rubber compound, it is significantly more flexible than urethane designs. Natural rubber yields an element with approximately 50% lower torsional and bending stiffness, resulting in longer life for all types of connected driven equipment – including motors, pumps, compressors and gearboxes.

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The Baldor•Dodge Raptor has everything needed for easier installations and reduced maintenance costs.

- Split element for easy replacement without moving and re-aligning connected equipment
- Slotted clamp ring holes offer 187% extra mounting hardware clearance versus competitor's circular through holes.
- Approximately 50% lower torsional stiffness makes the element significantly easier to manipulate by hand during installation
- Maintenance free non-lubricated natural rubber element for trouble-free operation

Installation for Baldor• Dodge Raptor couplings are quick and easy. The Raptor's horizontally split element doesn't require locking shafts during installation, meaning a faster installation, requiring fewer tools and eliminating shaft damage. Simply fasten the shaft hubs, install the element, and tighten the hardware.

Suitable for a broad range of industrial applications, Baldor•Dodge Raptor couplings are third-party ATEX certified for use in hazardous environments. Raptor elements are also available with an Armored Element that exceeds ASTM 1149-07 rubber deterioration standards for use in extreme environments.

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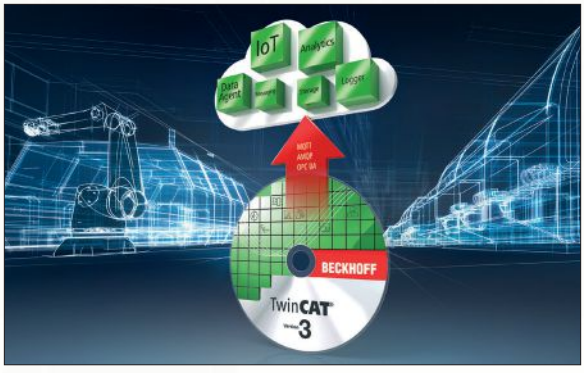
IoT hardware and software solutions from Beckhoff: Fast, Standardized Connection to the Cloud

PC-based control establishes efficient integration of data and communication services in the cloud

Recently announced hardware and software tools from Beckhoff Automation make readily-available PC-based control technology your real-world gateway to the Internet of Things (IoT), Industrie 4.0 and the cloud. With the **TwinCAT IoT** solution, for example, the TwinCAT 3 software platform from Beckhoff provides a complete solution for fast and efficient implementation of Internet of Things and Industrie 4.0 concepts. TwinCAT IoT supports standardized protocols for cloud communication and for sending push notifications to smart devices. The extension of conventional control tasks, through applications such as Big Data, pattern recognition or condition and power monitoring in the cloud, can result in exciting production efficiency increases.



Fast and easy to configure, TwinCAT IoT software combines with an Embedded PC or Industrial PC as the IoT controller, providing a seamless connection between the Internet of Things and the Internet of Services.

Filtering, further processing and interpretation of the collected data via the also recently introduced **TwinCAT Analytics** create genuine added value. Comprehensive analyses enable predictive maintenance, machine downtime reductions and control solution optimization – for example, by minimizing cycle times or energy peaks.

The upgraded software platform offers users a wide range of functions for exchanging process data via standardized communication protocols such as AMQP and MQTT, as well as accessing special data and communication services offered through cloud service providers. Corresponding services can be hosted in public cloud systems, such as Microsoft Azure™ or Amazon Web Services™, or within local networks.

On the hardware side, the newly-introduced **EK9160 IoT Bus Coupler** from Beckhoff establishes a direct connection to the cloud without any special control program between Beckhoff EtherCAT I/O and the Internet of Things. As a result, the coupler enables simple and standardized integration of I/O data with cloud-based communication and data services. Via an integrated web server, I/O data can be parameterized, such as in data processing and timing, through a simple configuration dialogue. No special engineering tools are needed with the EK9160 IoT Bus Coupler.

BECKHOFF

For more information:
www.beckhoff.com/TwinCAT-IoT

Emerson Innovations Improve Capital Project Execution

Addressing a growing industry demand to reverse trends in capital project execution, Emerson combines innovative technologies and services in its Project Certainty initiative. Capital projects are becoming larger and more complex; requiring more integration and often involving multiple stakeholders, engineering firms, and suppliers. According to industry data, over 65% of projects over $1B and 35% of projects under $500M fail, exceeding budgets by over 25% or missing schedules by more than 50%.

The good news is that the technology innovations needed to improve capital project performance exist today. So, why are capital projects still failing? The reason is that work practices have not kept pace with product innovations.

Emerson's global team of project engineers work hand-in-hand with customers to re-think these practices in order to eliminate cost, reduce complexity, and accommodate change.

Early Engagement Brings Time and Cost Savings

Project Certainty begins with early engagement during Front End Engineering and Design to define a better project approach. Despite traditionally accounting for approximately 4% of a project's investment, automation strategies can impact cost, schedule, and complexity beyond the automation scope.

For example, the right design strategy can eliminate control room space by 70% and eliminate wiring up to 80%. Additionally, loop commissioning hours, typically on the critical path, can be reduced over 70%.

Jim Nyquist
President PlantWeb™ Solutions
Emerson Process Management

Eliminate Complexity with Project Innovations

Project complexity can be tackled by decoupling process automation hardware and software development, facilitating global concurrent engineering and fabrication, and using new technologies that provide a single source of project data to reduce the impact of data and documentation changes.

Innovative Technologies Help Accommodate Late Changes

Technologies like Electronic Marshalling with CHARMs and pervasive wireless field instrumentation are helping project teams accommodate late project changes while reducing impacts on schedule and cost.

"Our industry needs a step-change in how capital projects are executed," says Jim Nyquist, president of Emerson Process Management's PlantWeb™ Solutions. "The technologies and proven methodologies are here now. It will take collaboration and commitment to eliminate outdated project approaches and drive change in our industry."

It's time for Project Certainty.

EMERSON.
Process Management

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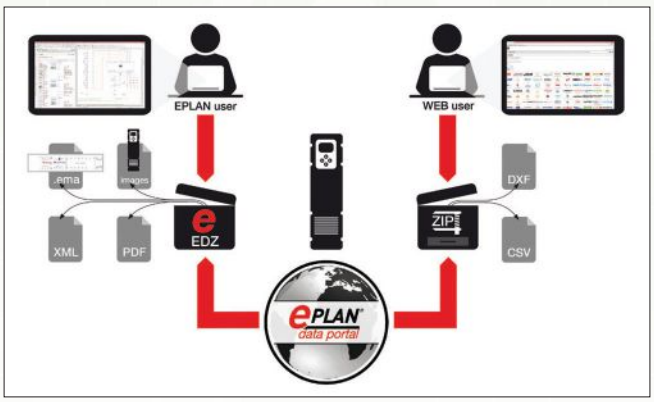
How the EPLAN Data Portal fits into a data strategy for the Smart Factory

The rise of the Industrial Internet of Things and the Smart Factory is creating a paradigm shift in machine design and the optimization of a fast-paced efficient production environment.

The Smart Factory will be a highly dynamic and responsive environment. Machines, equipped with performance measuring sensors, will have a "voice" in the process. Collecting data from every conceivable aspect of production will open up new horizons in micro and macro analysis in pursuit of continuous improvement.

Determining which data to collect and how to analyze and use it is among the essential first steps for realizing the full benefit of investing in advanced manufacturing systems. At the Enterprise IT level, the determination is made as to which data to gather and which components have to be incorporated into the machine or process design. Then, the Enterprise IT and Design Engineering leadership construct the standard component database used by the Design Engineering team to design and maintain the physical system.

Next comes the acquisition of high quality, detailed, vendor-validated electrical and fluid component data to populate that database. Consulting multiple vendor catalogues for that on an as-needed basis can be extremely time-consuming. EPLAN created the EPLAN Data Portal as a free, value-added service for EPLAN users, and now has extended free access to many non-EPLAN users. The Data Portal is a single, unbiased web-based tool where engineers can search over 610,000 vendor-validated parts from 137 manufacturers for the device data they need.



EPLAN users can source the portal's contents directly from their EPLAN CAE, importing it into their project files, avoiding having to create data sets manually.

Many EPLAN licensees use the portal strategically to build up a large digital archive of parts macros, the reliance on which can greatly accelerate workflows and assure consistent quality. Since mid-May, AutoCAD users can sign up for free at www.eplandataportal.com and download device schematics in .dxf format. ERP and PDM/PLM users can access commercial data needed for enterprise resource planning, such as item and type numbers and descriptive information.

EPLAN

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Stop Hardwiring and Start Connecting in UL 508 Applications.

An Industry First: Individual HARTING connectors eligible for UL 508-certified Control Cabinets

Want to use connectors, but worried about UL 508 approval?

HARTING has achieved a breakthrough that facilitates the use of connectors and connector-based cable assemblies in electrical control panels, switchgear and other control systems requiring UL 508 certification.

UL 508

More than two dozen **HARTING** connector configurations have passed rigorous safety testing by UL and been designated "UL-Recognized", a newly created approval in the 2237 category. This approval was put in place by UL at the request of **HARTING**.

HARTING is the only connector manufacturer with products that have earned this status and corresponding UL mark. Users gain access to all the benefits of Plug & Play connectorization in panel assembly, including massive cost and time savings during commissioning and maintenance compared to the alternative – hard-wired connections.

Fast track end product certification with UL approved HARTING connectors

Until now, an OEM could not use individual connectors in a field-assembled, UL 508-certfied control cabinet unless it subjected the end product to extensive additional UL safety testing at its own expense, a time-consuming process that often delays bringing a new machine to market. Using UL-Recognized components from **HARTING** simplifies and fast tracks end product certification, providing specific conditions in the use of the connectors are followed.

There is a UL-Recognized **HARTING** connector product for almost any control panel application. All are well-proven catalogue products, employed in a wide range of applications, including control cabinets certified to other international standards. **HARTING** will seek UL-Recognized status for many more of its connectors in the months and years to come.

- UL 2237 Recognized Components: You are now able to field assemble using individual "UL-Recognized" components. The newly launched "PVVA2" section of UL 2237 was established by UL at the request of HARTING.
- UL 2237 Listed Cable Assemblies: Choose from an extensive range of "UL-Listed", pre-assembled connector cable assemblies that fall under the PVVA category of UL 2237. This is a complementary standard to UL 508 that governs multi point connections of power cables in industrial machinery.

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Experion PKS

Honeywell's Experion PKS is all About Connecting People

Experion® PKS was the first enterprise-wide solution to merge disparate functions, systems and knowledge to integrate people with processes, business requirements, and asset management for superior performance.

The result is one unified architecture for all process control, safety systems, and advanced application software—with a consistent HMI across everything.

The Latest Experion PKS in the Orion Trilogy of Releases

The latest Experion PKS Orion is the world's most advanced, open and cyber secure control system on the market today. Our new IIoT-ready release further optimizes LEAP™ project execution with Automated Device commissioning. Auto Device Commissioning enables late binding of devices with loop configuration created in the cloud.

Open System Integration

Honeywell's advancements in open system integration have led to new capabilities such as applying Experion for electrical system control and management, multivariable APC in the controller, WirelessHART, and automated skid integration via SCADA.

- Auto Device Commissioning reduces loop commissioning time from hours to minutes.
- Experion for Electrical System Control and Management allows you to integrate your ECMS with your process control system, with one control system with one HMI.
- Experion Profit Controller in C300 and ACE moves multivariable predictive control out of the Microsoft operating system and into the Experion Control Engineering Environment.
- Automated skid integration applies our LEAP lean automation project solution to PLC integration.
- Experion PKS supports all wireless standards, including ISA 100.11a and WirelessHART.

LEAP™ and Automated Device Commissioning

Experion® PKS further optimizes LEAP™ project execution in our most advanced, open and secure control system. Auto Device Commissioning automatically binds control configuration engineered in our secure cloud with field devices connected to any Universal I/O channel. The result is a reduction in transmitter commissioning time from 2 hours to 1 minute.

Continuous Evolution with the Customer in Mind

Experion PKS improves project efficiency and production and reduces operator-related incidents and lifecycle management costs. Honeywell continues our 40-year control system evolution coordinated with customer input to defend safety, security, and intellectual investments while keeping you current with today's technology.

Honeywell

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Kyland's Smart Gateways set the trend in power utilities

DG-COM 3000

DG-A8/A16 Rack Mount Smart Gateways

DG-A2/A4 DIN Rail Smart Gateways

Kyland's **Smart Gateways** are a family of compact protocol gateways that meet IEC 61850 standards. The gateways can be deployed in various control environments to transfer data through both serial ports and Ethernet ports. Kyland's Smart Gateways allow you to import pre-specified IEC 61850 SCL (.icd/.cid) template files and map the data to an internal Virtual Machine Device (VMD) with the built in configuration tool. The devices can then be viewed as standard IEC 61850 IED's from the master control center.

The product family consists of three different families of products:

1. The DG-COM-3000
2. The DG-A2/A4 DIN Rail Smart Gateways
3. DG-A8/A16 Rack Mount Smart Gateways

The **DGCOM-3000 series** are Kyland's latest generation of Smart Gateways which combine an Ethernet switch with serial and i/o creating a versatile device designed to meet the demand of data collection and switching. DGCOM-3000 can meet the requirements of data collecting and redundant ring transmission on the same device. 2 Gigabit SFP ports redundant ring connection, 6 100Base-TX RJ45 ports, 8 RS232/422/485 serial ports along with a total of 24 Digital inputs and outputs make this product a solid "all in one" solution.

The **DG Series A2, A4, A8 and A16** are Kyland's Smart Gateways with powerful data communication and process functions, low power consumption, flexible installation advantages. These products are built around an ARM Cortex-A8 architecture for high performance allowing IEC 61850 SCL(CID/ICD) import and configuration, configurable MMS (IEC 61850-8-1) server and client applications as well as the ability to support GOOSE publish and subscribe functions.

The family supports full function NTP for time synchronization, dual mode RS232/RS485 isolated serial ports, 0/100M IEEE 802.3 Ethernet ports as well as support 3G GPRS wireless communication. These products are IEC 61850-3, IEEE 1613 compliant.

Learn more about Smart Gateway products at **www.kyland.com/index.php?optionid=976**

KYLAND

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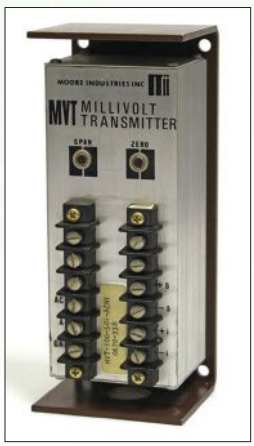
Moore Industries: A History of Innovation and Safety

Moore Industries Headquarters in North Hills, CA

Moore Industries was founded in 1968 by Leonard W. Moore, who is still chairman of the board and has daily presence at the company's North Hills, CA, headquarters. The company started out as a three-person operation in a garage in California, and now has offices worldwide in Australia, Belgium, China, The Netherlands and The United Kingdom. It is one of the last independent, privately owned instrument companies left in North America.



Moore Industries' First Signal Conditioner

Moore Industries started out making signal conditioners. "After working in the instrumentation industry for a few years, I saw a market for tough, reliable, noise-resistant signal conditioners," says Mr. Moore. At that time, reliable and rugged devices were difficult to find.

From his years in the instrumentation industry, Mr. Moore recognized the inherent need for durability and safety in products that would be housed in closed spaces around electricity, volatile gases and personnel. In 1972, the company was the first to build products with RFI protection, extruded aluminum housings and interlocking corners—before any certifications existed making these features necessary. The company was also an industry leader in building products with input-to-output isolation.

Moore Industries maintains numerous stringent certifications for many of its products ranging from CE compliance, Non-Incendive, Intrinsically-Safe and Explosion/Flameproof approvals.

The company was an early adopter of IEC 61508 and was engaged by EDF Energy to help develop guidelines for the assessment of 'Smart' devices to be used in safety related or safety critical applications within the UK nuclear industries, called **EMPHASIS**. In addition to providing EMPHASIS approved products, the company has received functional safety certifications from exida and TUV on products as well as its design, development, manufacturing and documentation process.

Moore Industries IEC 61508 Functional Safety Products

Today, Moore Industries designs, manufactures and sells alarms, HART interface devices, complete temperature sensing and transmitting products, signal conditioners and isolators and IEC 61508-certified Functional Safety devices and Explosion/Flame-proof enclosures. The company's dedication to safety ranges from hazardous area protection, as provided with Explosion/Flame-proof enclosures and intrinsically-safe devices, to internal circuitry, firmware and development process design as it moved into the Functional Safety arena.

MOORE INDUSTRIES WORLDWIDE

For the latest innovations and news from Moore Industries, visit: www.miinet.com/blog

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Enabling Connectivity for the Industrial Internet of Things

28+ Years of Experience with Industrial Communications Infrastructure

The industrial IoT (Internet of Things) is driving more field devices to be connected to the Internet every day, putting a premium on networking products that can deliver continuous connectivity without human intervention.

Since 1987, Moxa has designed and manufactured hardened networking and communication equipment for mission-critical applications. Our Ethernet switches, wireless access points, IP cameras, computers, and more are specially designed and tested to ensure highly reliable operation and connectivity for industrial users and harsh environments.

Oil & Gas Industry's Most Powerful, Reliable Panel PC

Moxa's flagship panel PC, the EXPC-1519, is an extremely powerful and reliable unit equipped with the critical features and certifications required for Class 1, Div. 2; ATEX Zone 2; and IECEx rated hazardous environments.

The combination of features and quality of engineering are industry firsts for an industrial PC and include a "glove-friendly" touch interface, wide operation temperature range (-40° to 70°C), fanless cooling system, dual core Intel® i7 processor, and flexible I/O arrangement.

Connect Devices to Databases With 4G LTE

As a system integrator or OEM, it's important to start leveraging the Industrial IoT so you can deliver the greatest value to your customers. This means getting your customers' devices connected to the cloud and to a database that can be read by advanced software platforms.

Moxa is now offering the 4G LTE Jump Start Kit to make this as easy and cost effective as possible. It includes an easily-programmed Modbus data logger with built-in 4G LTE communications, a Modbus gateway that connects to the most common types of PLCs and RTUs, and an I/O module to collect analog and digital sensor data. For a limited time, this kit is available for under $1000 to qualified system integrators and OEMs.

Features:

- Easily makes data from the most common sensors and devices available over a 4G LTE connection to a cloud-connected database or platform for dashboards, remote monitoring, and IIoT applications
- Huge savings on data plan costs through built-in data compression and programmable data processing
- Free ThingsPro software includes ready-to-use Modbus and 4G LTE configuration interface as well as RESTful APIs for C/C++/Python programming

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POSITAL and Industry 4.0: One Million Sensors at Your Fingertips

POSITAL-FRABA, a manufacturer of high-performance position and motion sensors, has responded to the challenge of an increasingly dynamic market by adopting an advanced web-based product configuration system. It allows customers to quickly and efficiently order devices, which have exactly the right mechanical and electronic characteristics for their application. Offered under the slogan of "One million sensors at your fingertips", the unique business model is backed by a data-driven manufacturing system that delivers products on a just-in-time basis. This approach serves both customers and distribution partners by making the right products available quickly and at the right prices.

Christian Leeser president and owner of FRABA

POSITAL has made a significant commitment the idea of a data-driven, network-based manufacturing and product distribution system. "A decade ago, much of our production was based on a traditional craft-based model", says Christian Leeser, president and owner of FRABA, POSITAL's parent company. "Products were built in small batches by specialist technicians who could respond to special orders by building one-off variants of existing products." Leeser continues: "We have made a very deliberate change towards a data-centered industrial model that we call mass customization. With this, we can build the customer exactly what he needs, quickly and efficiently, while keeping costs at mass production levels."

Data-centered Manufacturing

At the center of the POSITAL approach is a data-driven and cloud-based manufacturing system that controls each step of the production cycle. POSITAL's encoders and inclinometers are made up of largely interchangeable components and modular sub-assemblies so that a wide range of configurations can be built by putting together parts with the appropriate characteristics. The manufacturing support system receives orders and presents the factory worker with a complete set of assembly and testing instructions.

POSITAL's encoders and inclinometers allow a wide range of configurations

The system is largely paperless, with assembly and test instructions displayed on a computer monitor or tablet device. The instructions are presented primarily in graphical format so that the system can be easily deployed in countries with different native languages.

The front end of this system is POSITAL's web-based Product Finder posted on **www.posital.com.** The online-configurator is accessible from computers or mobile devices. Customers and distributors can 'build' sensors that meet their requirements by selecting from a menu of the features and characteristics. Fabrication and delivery can usually be accomplished within a few days.

Mobile Product Finder

POSITAL
FRABA

Contact: info@fraba.com | 609 750 8705 | **www.posital.com**

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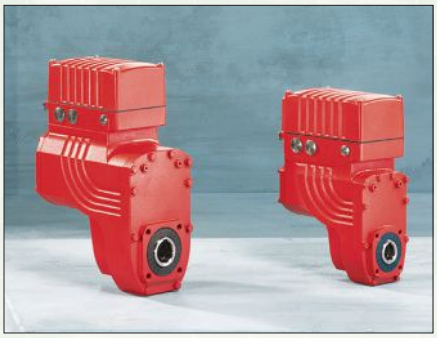
SEW-EURODRIVE … Power Transmission Innovation

MOVIGEAR®



The MOVIGEAR® Mechatronic Drive System for horizontal-materials handling from SEW-EURODRIVE sets new standards in terms of efficiency and functionality. MOVIGEAR® not only combines the gear unit, motor and drive electronics within one highly reliable, efficient, and hygienically designed unit, it also reduces total start-up cost and annual operating costs in your material handling system…by as much as 50%!

IE3 Compliant DRN.. Motor

Our new DRN.. induction motors meet the stringent IE3 super-premium energy efficiency standard. They also fit existing gear units – allowing for easy upgrades and retrofits of existing DRE (IE2) gearmotors. The weight and dimensions of the new DRN motors have only marginal changes as compared to the DRE series. Due to its outstanding system stability, tight control, and high-cycling capacity, the DRN.. electric motor can replace a servo motor in many cases. Plus, its multiple brake sizes allow a higher torque for a stopping brake or a lower torque for a VFD holding brake. And finally, its wide HP range and various connector options enable the DRN motor to be used in a wide variety of new and retro-fit applications.

DRC Electronic Motor

The DRC electronic motor provides an ultra-efficient motor and electronics package for those gear units already installed in your system. Like MOVIGEAR, the DRC electronic motor consists of a permanent-field synchronous motor with integrated drive electronics in a completely enclosed housing. The DRC electronic motor offers greater flexibility allowing it to mount to any gear unit plus, offers an optional mechanical brake.

About SEW-EURODRIVE

Engineering excellence and customer responsiveness distinguish SEW-EURODRIVE, a leading manufacturer of integrated power transmission and motion control systems. SEW-EURODRIVE solutions set the global standard for high performance and rugged reliability in the toughest operating conditions. With its global headquarters in Germany, the privately held company currently employs over 16,000 employees with a presence in 48 countries worldwide. U.S. operations include a state-of-the-art manufacturing center, five regional assembly plants, more than 63 technical sales offices and hundreds of distributors and support specialists. This enables SEW-EURODRIVE to provide local manufacturing, service and support, coast-to-coast and around the world.

SEW EURODRIVE

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Leading the sensor industry in new product innovations

From factory automation to logistics automation and process automation, SICK is one of the leading sensor manufacturers. As a technology and market leader, SICK provides sensors and application solutions that create the perfect basis for controlling processes securely and efficiently, protecting individuals from accidents, and preventing damage to the environment.

With more than 3,000 patents for its products, SICK continues to lead the industry in new product innovations. The diversity of its product line allows SICK to offer solutions at every phase of production in the automotive, packaging, electronics, food and beverage, consumer goods, logistics, parcel, material handling, oil and gas, chemical/HPI, power, and cement industries.

Industrial Sensing

SICK's wide range of industrial sensors is perfectly suited to industrial applications and requirements. SICK's sensors offer a long service life, ruggedness and precision. For its smart sensor solutions, SICK utilizes state-of-the-art sensor technologies and com-plete integration into the control level via IO-Link to intelligently and reliably solve industrial automation tasks.

Safety

Since our inception, we have led the world in opto-electronic safety solutions for hazardous machines and work areas. SICK continues to develop innovative point-of-operation devices, optical perimeter and area guards. Advanced functions of our safety control devices include fixed, floating, and multiple point floating blanking, Presence Sensing Device Initiation (PSDI) and multiple configurable muting controls.

Machine Vision and Automatic Identification

With an innovative line of vision-based reading systems, integration software, bar code line scanners, omni-scanners, and dimensioning products, SICK offers the industry's broadest range of solutions for automatic identification applications. SICK's 2D and 3D vision cameras are built for industrial environments, leveraging SICK's 60-plus years of experience with industrial sensors.

Detection and Ranging

Laser measurement technology from SICK detects both 2D and multi-dimensional contour data and can process information either externally or in the sensor itself. They are ideal for indoor and outdoor applications, including anti-collision in harbors, detection in building automation, or position evaluation in navigation.

Environmental Monitoring

Our environmental monitors division is a worldwide supplier of opacity, gas, dust and flow analyzers. SICK's equipment utilizes in-situ and extractive technologies to provide the most cost-effective installation, operation and maintenance.

SICK
Sensor Intelligence.

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www.sickusa.com

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Increase your control system's flexibility with a modular, all-in-one PLC from Unitronics

For over 25 years Unitronics has manufactured PLCs with integrated HMI panels; today, Unitronics offers a diverse line of mature automation solutions alongside innovative new products. While other manufacturers are only just introducing single-unit PLC and HMIs, Unitronics is already improving and perfecting the all-in-one concept. The new UniStream line offers a modular PLC+HMI, allowing users to design a control system unique to their application.

Creating a customized, all-in-one PLC with UniStream takes only three easy steps. The user selects an HMI panel; Unitronics offers 7", 10.4" and 15.6" color-touch-screens for easy operator interface.

The powerful, modular CPU mounts onto the back of the panel, and then the user chooses the I/O and communication modules to get the exact configuration their application requires; these Uni-IO and Uni-COM modules snap in next to the CPU. The result is a single integrated controller with PLC, HMI and onboard I/O.

This modular approach to the all-in-one concept allows for incredible flexibility. The CPU and HMI together have two USB host ports and a USB programming port, two Ethernet ports, a CANbus port and an RS485 serial port.

The UniStream supports a range of communications, including EthernetIP, and features like remote access via a VNC connection. I/O modules have options for digital and analog I/O configurations, including high-speed and temperature measurements. A single CPU can support 2000 I/O points, with both local and remote expansions, for countless possible configurations.

Furthermore, the UniStream platform is entirely programmed in one software. Ladder logic, communication configuration and HMI design are all programmed using the UniLogic software.

With features like user-defined function blocks and options for code reuse, UniLogic is intuitive and user-friendly. UniLogic also supports a full suite of utilities for remote access and monitoring, like real time video streaming, as well as data logging and back up.

UniStream with IO

Wide IO

Unitronics aims to provide the best possible experience to our users: our all-in-one PLC and HMI units are easy to set up and to use; the latest version of our single-environment programming environment is always available for download; and, should any problems arise, every user has unlimited access to our market-leading technical support for no additional cost.

UNITRONICS®

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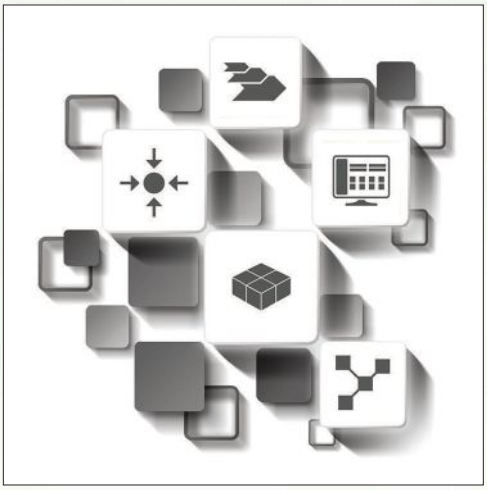
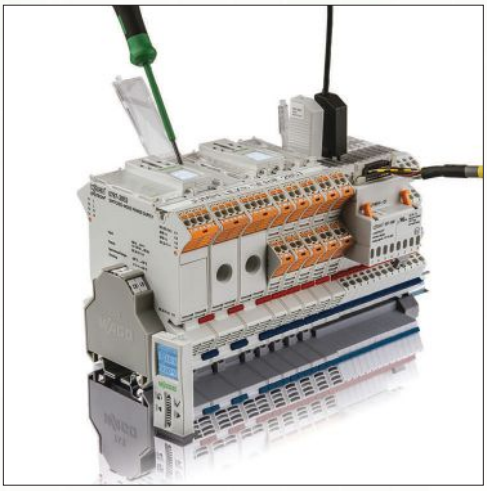
WAGO Blazes the Trail for Innovative Manufacturing Technology





WAGO Corporation provides North America with innovative Interconnect, Electronic Interface, Terminal Block and Automation solutions. Innovations include:

PFC Family: Compact High Speed Programmable Fieldbus Controllers

The PFC family of controllers offers advanced compact, computing power for PLC programming and process visualization. Programmable in accordance with IEC 61131-3, PFC controllers feature a 600 MHz ARM Cortex A8 processor that offers high speed processing and support of 64 bit variables. Controllers also feature a built-in firewall and VPN providing added security for IoT applications.

The PFC200 acts as a fieldbus gateway to communicate between MODBUS TCP/UDP/RTU, CANopen, PROFIBUS and RS-232/RS-485, eliminating the need for third-party converters. Configuration of fieldbus networks is further simplified with e!COCKPIT and WAGO-I/O-PRO programming and visualization software. The PFC family offers economical, scalable I/O technology that facilitates automation of individual machines or entire systems.

e!COCKPIT: Driving Rapid Development of Automation Projects

e!COCKPIT supports all automation tasks from hardware configuration, programming, networking and simulation to visualization – in one easy-to-use, intuitive package. ***e!***COCKPIT allows engineers to develop applications quickly and conveniently, slashing their time-to-market.

- Programming based on standard IEC 61131-3 languages
- Multi-controller programming
- Networking wizards to simplify connected devices

Interface Technology for Manufacturing Systems

Machines and equipment used in the manufacturing sector require industrial-grade power supplies capable of reliably handling power peaks, stabilizing voltage fluctuations and safely preventing dangerous conditions. To address these needs, WAGO's EPSITRON® Power Supply System offers a wide variety of high-performance power supplies, buffer modules and ECBs.

WAGO®

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INNOVATIONS FROM THE INDUSTRY

Yaskawa America, Inc.

Be Capable of More

If you're a machine builder or equipment user, you know all about high expectations, limited resources and tight deadlines. Your success depends on suppliers who respond with precisely the right products, delivered with consistency and reliability that never fails. Yaskawa has been putting this brand of customer success in motion for 100 years. It shows in today's commitment to innovative automation technology, to engineering expertise, and to the operational strength that is the proof behind our promise.

- Products that Perform: Product performance is more than just a specification. It is the confidence that your machines will work as expected …every time … in a way that consistently outperforms your competition.
- Operational Excellence: Problems with component quality, supply chain hiccups and downtime surprises are simply unacceptable. You need a partner with the operational rigor and expertise to engineer them out of existence.
- Engineering Expertise: Focus your engineers on their core competencies while still delivering effective machine automation, thanks to a team of Yaskawa engineers who can instantly add power to automation design, development and support.

Sigma-7 Servo Family

Yaskawa recently introduced Sigma-7, a new line of rotary, linear and direct drive servo motors and amplifiers, to the U.S market. System designers and automation end users will benefit from the speed, precision and efficiency improvements in Sigma-7, the most technologically advanced servo systems ever created by the world's largest manufacturer of drives, motion control, and robotics.

Sigma-7 Servo Family

- Nearly double the bandwidth of Yaskawa's industry-leading Sigma-5 servos, for quicker response to system commands
- 24-bit encoding that boosts precision to a level 16 times higher than the industry standard
- A 20% smaller footprint, plus a new amplifier design that saves control panel space
- A new package of algorithms that correct machine imperfections, including ripple compensation, anti-resonance and friction model compensation
- New dual-axis amplifiers that mount in smaller spaces, cut parts counts and regenerate power for long-term energy conservation

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1-800-YASKAWA (927-5292) or (847) 887-7318 | **www.yaskawa.com** | marcom@yaskawa.com

input #48 at www.controleng.com/information

Robots for manufacturing, automotive applications

Mitsubishi Electric's RV-F Series 6-axis robots are available in 35, 50, and 70 kg payloads. These robots are designed to address applications that require higher payloads and longer reaches such as CNC machine tending, large material handling, and assembly applications. The RV-35F, RV-50F, and RV-70F robots are designed for the automotive, food and beverage, and electronic manufacturing industries. Benefits and features include payloads that allow applications that require heavier parts and tooling to be robotically automated. They also have a long-reach arm for tasks that can be spread farther apart. They can accommodate larger parts and processes with the ability to extend up to 2050 mm.

Mitsubishi Electric Automation Inc.
www.meau.com
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Mass flow controller for OEM and process integration applications

Alicat Scientific's Basis 20SLPM is a mass flow controller designed to fit a wider range of applications including sparging into liquids, sample dilution, and many gas mixing applications. Specifically designed for original equipment manufacturers (OEMs) and process integration, Basis provides fast, accurate control of gas flow rates. It is designed for use in OEM gas analyzers, automated gas mixing on process lines, and anywhere mass, flow-only control is required. Multiple communications options—RS-485, RS-232 and Modbus Serial; and 0 to 5 Vdc analog—mean Basis can be built into a broad range of end-user products.

Alicat Scientific, *www.alicat.com*
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Ultrasonic sensor for detecting layers and splices

Sick's UD18-2 ultrasonic sensor is designed to check for double layers and splices and is able to determine whether one, two, or no material layers are present between its sender and receiver. The UD18-2 can detect objects regardless of material, including paper, cardboard, shiny metal, and transparent plastic. The UD18-2 also features the capability to teach-in up to four sensitivity levels, and the sensor can switch between sensitivity levels during operation, which allows the sensor to tackle complex applications. The UD18-2 is designed for applications in the packaging, print and paper, electronics and solar, automotive, and metal and steel industries.

Sick, *www.sickusa.com*
Input #202 at www.controleng.com/information

Photonics alignment platform for automated production environments

Aerotech's FiberMaxHP is a second-generation, 3- to 6-axes, photonics alignment platform designed for critical photonics alignment in automated production environments. FiberMaxHP noncontact direct-drive technology is designed to enable high-precision alignment without sacrificing production throughput. The FiberMaxHP is available with 3 to 6 axes of direct-drive alignment allowing the platform to be specified with the exact number of axes needed for the application. Since many applications require manual adjustment of fixtures and parts for a one-time initial alignment, the FiberMaxHP comes with 1 to 3 axes of manual angular alignment with ±2-deg of motion.

Aerotech, *www.aerotech.com*
Input #203 at www.controleng.com/information

Servo motor and amplifiers for designers and end users

The Sigma-7 rotary, linear, and direct drive servos and amplifiers from Yaskawa are designed for system designers and automation end users. Sigma-7's features include 24-bit encoding and a package of algorithms designed to correct machine imperfections, including ripple compensation, anti-resonance, and friction model compensation. It also features dual-axis amplifiers that mount in smaller spaces, cut parts counts, and regenerate power for long-term energy conservation. Eighteen Sigma-7 products cover a wide range of motion control applications, with rotary servos from 3 W to 55 kW in output. Users can choose from two direct drive servos and four linear products, including a Sigma-Trac option designed for easy bolt-on, plug-in implementation.

Yaskawa America Inc., *www.yaskawa.com*
Input #204 at www.controleng.com/information

Power distribution boxes for long cable runs

Phoenix Contact's M12 power distribution boxes are designed for field-based power supply voltages of 24 V. These distribution boxes, in combination with standard M12 power cables of 4x10 AWG conductors, are designed to eliminate voltage drop that occurs across long cable runs. The distributor has four T-coded M12 receptacles with a current load of up to 10 A per channel. Each of the eight channels is equipped with a plug-in fuse. Devices are connected directly via T-coded M12 power cables. An M12 diagnostics port, which can be connected to the controller in the control cabinet, provides further evaluation data.

Phoenix Contact, *www.phoenixcontact.com*

Input #205 at www.controleng.com/information

Stainless steel, explosion-proof junction box

United Electric Controls' 316 stainless steel, explosion-proof junction box is available assembled with the company's stainless steel product lines such as pressure and temperature switches as well as pressure transmitters. It is also available for separate purchase as a junction box kit. The junction box has IP 66 certification, representing resistance to dust and inclement weather, as well as worldwide certifications. The explosion proof stainless steel junction box is available for ordering as junction box option M432, which has ½" NPT threads or option M433, which has M20 threads. The junction box is designed for the oil and gas, petrochemical, chemical, and additional process applications.

United Electric Controls (UE), *www.ueonline.com*

Input #206 at www.controleng.com/information

Explosion-proof, linear position sensor

Balluff's Micropulse TA12 hazardous area, linear position sensor is designed for position feedback applications on hydraulically actuated valves and in hydraulic cylinders located in hazardous locations. The TA12 is ideal for level monitoring and turbine speed control applications. Features include noncontact, wear-free magnetostrictive technology, measuring ranges up to 7,620 mm, USB configuration capability for in-application customization, dual-position magnet capability that allows monitoring of two independent motions, and field-replaceable electronics module for fast, easy in-cylinder repairs. Operating temperature range is -40 to 80 C (-40 to +176 F).

Balluff, *www.balluff.com*

Input #207 at www.controleng.com/information

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Ladder logic: Data manipulation

After values from an analog card have been captured, filter the data. Microsoft Excel can simulate a filter before it is coded into a programmable logic controller (PLC).

After capturing values from an analog card using a programmable logic controller (PLC) there are methods to filter the data and methods to simulate a filter using Microsoft Excel before it is coded into a PLC. For the formulas, the same variable names were used:

N = New value calculated and substituted for the input value. In other words, the calculated filtered value.
L = The previous captured input value.
F = The previous calculated filtered value.
k = The manipulated factor for all calculations (sometimes known as Alpha).
i = The current analog input value.

Avg = A running average over x number of previous samples, (3 for x was used in this example.)

The first order filter formula is New Filtered = Last Filtered + Factor * (Input - Last Filtered). This equates to N=F+k(i-F) using variables above.

MORE ADVICE

KEY CONCEPTS

There are methods to filter data and capture data using Microsoft Excel after the data has been captured.

In ladder logic, a "calculate" type command lets the user type the formula in directly.

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CONSIDER THIS

What other methods could be used to capture and filter data?

Raw Input	Form 1	Form 2	Form 3	Form 4	Form 5	Form 6
19808						
19834						
19860						
19886						19867.8
19912	19880.8	19893.8	19886	19899	19870.4	19881.06
19936	19907.2	19919.2	19911.33	19924	19896	19897.54
19960	19931.2	19943.2	19936	19948	19921.07	19916.28
19984	19955.2	19967.2	19960	19972	19945.6	19936.6
19992	19982.4	19986.4	19978.67	19988	19966.4	19953.22
20000	19990.4	19994.4	19992	19996	19982.93	19967.25
20008	19998.4	20002.4	20000	20004	19995.2	19979.48
20024	20004.8	20012.8	20010.67	20016	20004.8	19928.83
20048	20019.2	20031.2	20026.67	20036	20018.13	20009.38
20168	20024	20084	20080	20108	20054.93	20056.97
20096	20182.4	20146.4	20104	20132	20083.2	20068.68
20120	20091.2	20103.2	20128	20108	20107.2	20084.07
20144	20115.2	20127.2	20120	20132	20131.2	20102.05
20132	20146.4	20140.4	20132	20138	20122.4	20111.04
20108	20136.8	20124.8	20128	20120	20127.2	20110.13
20084	20112.8	20100.8	20108	20096	20119.2	20102.29
20060	20088.8	20076.8	20084	20072	20098.4	20089.6
20036	20064.8	20052.8	20060	20048	20074.4	20073.52
20008	20041.6	20027.6	20034.67	20022	20049.6	20053.86
19984	20012.8	20000.8	20009.33	19996	20024.53	20032.91
19960	19988.8	19976.8	19984	19972	1999.47	20011.03

Simulation of a signal with listed some analog values in one column on a Microsoft Excel spreadsheet. These values are typical for a 13 bit signed analog signal from a PLC card; notice that they increment or decrement by a factor of eight. Tables courtesy: Frank Lamb, Automation Primer

	Algorithm	K
Formula 1	N=L+(1/k*(i-L))	1.2
Formula 2	N=k*(i-L)+L	0.3
Formula 3	N=Avg	(Avg)
Formula 4	N=(i+L)*((k-1)/k)	2
Formula 5	N=((Avg*4)+i)/5	(Avg)
Formula 6	N=F+k(i-F)	0.4

This is a key with the variables listed and the formulas. The "k" values are linked to cells used in the table, so they can be changed as needed.

To simulate a signal analog, values were listed in six columns on a Microsoft Excel spreadsheet. These values (typical for a 13-bit signed analog signal from a PLC card) have an increment or decrement by a factor of eight, so on a 0 to 10 V or 0 to 20 mA signal with a range of 0 to 32,767, there would be 4,096 possible values for the signal.

The first column has input values. The columns after the first show results after using the various filtering formulas found. The reason the input column has earlier values in it is to provide a running average of up to five values in the formulas. Formula 6 also needs to use the previous filtered value.

Formula 1 looks like it makes the signal worse. Formula 2 and Formula 4 did nearly the same things, even though they used different algorithms. Formula 3 is a straight running average, which worked well. The current and previous values were used for an average of three; using more created a delayed reaction. Formula 5 also uses a running average. Three samples were used in the average also even though the intent was to use four or five.

Formula 6 represents the formal definition of a first order filter. Sometimes this is known as a first derivative filter; if the points were equated to position, this would represent a velocity-based filter. A second order filter would then represent Accel/Decel and a third order filter would represent "jerk."

The filters would work off of the delta between the current and previous values. Simulating formulas can be done in Microsoft Excel, but the user may want to check before coding it into the PLC. **ce**

Frank Lamb is the founder of Automation Consulting Services Inc. This article originally appeared on Automation Primer. Automation Primer is a CFE Media content partner. Edited by Chris Vavra, production editor, Control Engineering, *cvavra@cfemedia.com.*

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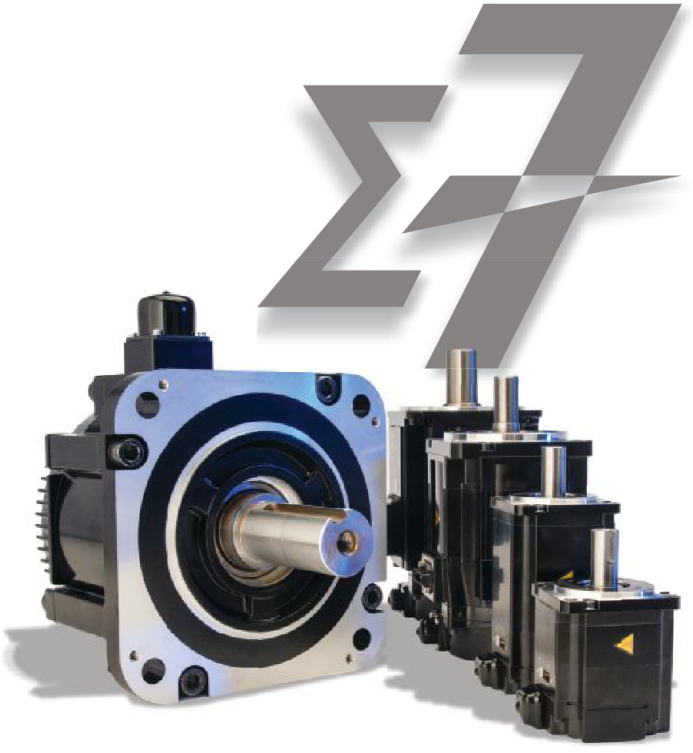

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