Food safety compliance 50 | Sensors for food processing F1

CONTROL ENGINEERING

Reed Business Information.
Vol. 56 No. 10

OCTOBER 2009 Covering control, instrumentation, and automation systems worldwide

Proximity Sensors 36

PLM: Helping eBOMs and mBOMs converge 42
Integrated safety debate 45
PRODUCT EXCLUSIVES: 10
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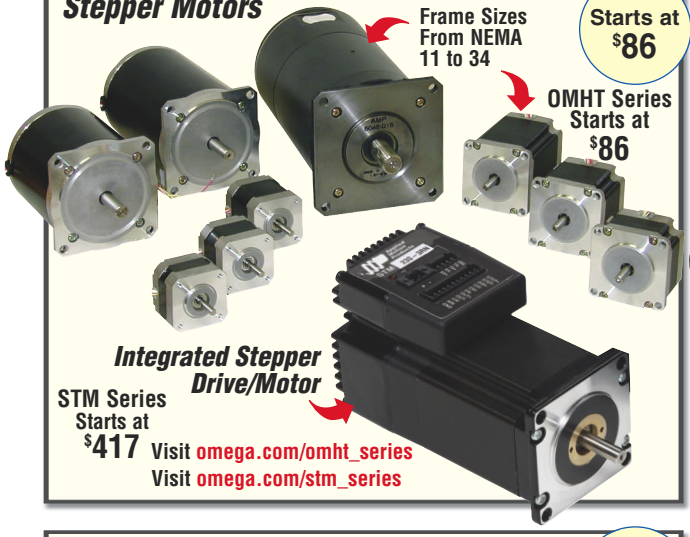

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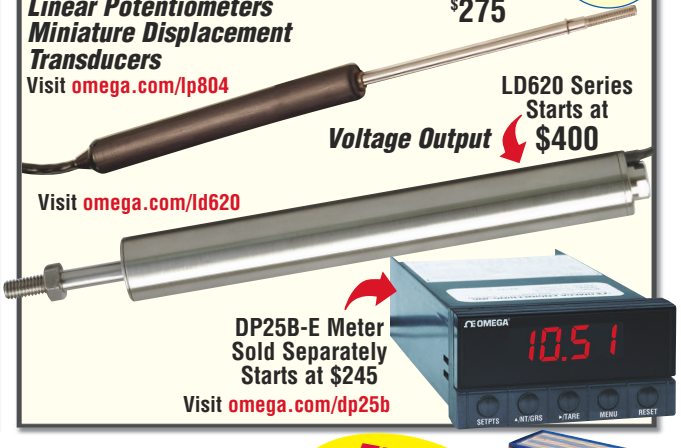

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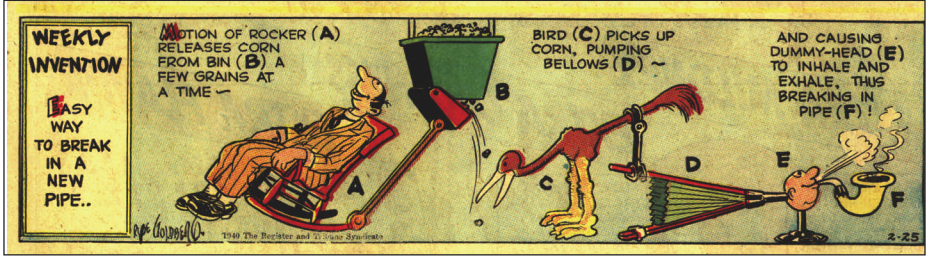

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User-generated content

Much has been made over the past few years about the value of and potential for user-generated content—content created by visitors to a Web site. Much of the benefit derived so far from this type of content has been in user reviews. Numerous research projects have shown that Internet users place more credence in user reviews than in those from other sources. And Internet visitors are, at least to some degree, relying on these reviews to help make buying decisions. For example, MediaPost reports that nearly 70% of online shoppers read at least four reviews of a product before purchasing it, while almost a quarter of people check eight reviews or more.

Beyond the value of user reviews on a particular product is the value to be derived from shared opinion and discussion. That type of conversation, enabled by the Internet, is what brings the peer-to-peer discussion so sought after at industry events to interested parties on a daily basis, regardless of where they may happen to be.

Control Engineering's groups on LinkedIn (http://budurl.com/celinkedin) and Facebook (http://budurl.com/cefacebook) are now home to more than 100 such discussions. It's been the most exciting development of our entire experiment with social media—so much so that we are now committed to developing some of these discussions into feature article content for the print publication and our Web site.

> **"Let your voice be heard and feel free to start some compelling content of your own."**

The first of these articles appears in this issue—"Integrated Safety: Has Its Time Arrived?"

Beginning as a discussion point linking to Siemens' Charlie Fialkowski's post on Safetybase.com, the conversation quickly grew to more than 20 user-generated comments (seven of which I had to save before being deleted from the news feed on LinkedIn to use as part of the article in this issue). The comments came from engineers, consultants, and industry vendor representatives, with all sides of the issue being well-represented: for it, against it, and possible under given certain circumstances.

Overall, the comments were well-mannered and insightful, though things did get heated in a few instances. Most importantly, everyone on each side of the issue had an opportunity to comment and share in the discussion and mutual learning experience.

Control Engineering will be featuring similar articles based on our social media group discussions every other month beginning in January 2010. So let your voice be heard—participate in the discussions and feel free to start some compelling content of your own.

David Greenfield, editorial director
david.greenfield@reedbusiness.com

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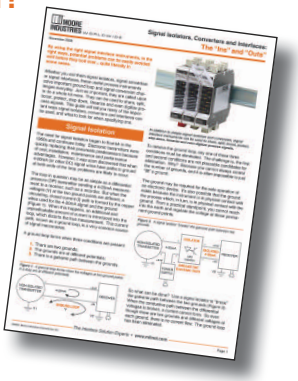

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CONTROL ENGINEERING

Vol. 56
Number 10

OCTOBER 2009 COVERING CONTROL, INSTRUMENTATION, AND AUTOMATION SYSTEMS WORLDWIDE

COVER STORY

36

FEATURE

50

features

36 Proximity sensors: How to choose and use them
Latest trends in inductive, photoelectric, and laser sensors can help your implementation. Do lower cost, less aggravation, easier setup, and longer life make sense to you?

42 PLM: Helping eBOMs and mBOMs converge
Product lifecycle management software is linking manufacturing and engineering to improve manufacturing process management.

45 Integrated safety: Has its time arrived?
Engineers, integrators, and industry representatives offer a variety of viewpoints on this hot button topic. Consensus has yet to be reached. Where do you stand? Join the discussion online.

50 Sustainability: Regulatory compliance for food safety
Different types of software can be leveraged to meet the requirements of Hazard Analysis and Critical Control Points compliance.

inside machines

Starts after p. 48. If not, see www.controleng.com/archive for October 2009.

M1 Embedded PCs keep drilling machines on budget
Kays Engineering increases flexibility and machine performance while reducing cost.

M5 Using algorithms to increase motor efficiency
Sophisticated control technuques can improve energy efficiency of older motors.

M10 Marking and vision system for NASCAR engine parts
Marking techniques produce and verify a readable 2D barcode on any part.

M12 Software virtualization environment enhances control
CNC system multitasks, running RTOS and Microsoft Windows XP simultaneously.

M15 Single point machine vision
New camera packs a complete vision system into one tiny component.

CONTENTS

Inside food & beverage

Starts after p. 54. If this is not in your edition, see www.controleng.com/archive for October 2009.

F1 **Monitoring pressure in milk processing**
Nestle's R&D center develops milk-based food products and designs manufacturing processes. Monitoring pressure in heat exchangers provided some particular challenges.

F4 **DCS migration for functional upgrades**
Yeast producer upgrades its process control system to take advantage of new networking and instrumentation capabilities.

departments

2 EDITORIAL
User generated content

10 PRODUCT EXCLUSIVE
Ethernet gateway; Power monitoring devices

12 TALKBACK
Changing instrumentation, building motorcycles

13 TECHNOLOGY UPDATE
Smart screens for industrial applications

16 TECHNOLOGY UPDATE
Leak detection: Technology catches up to theory

18 APPLICATION UPDATE
Denim manufacturer takes control upgrades into its own hands

20 GLOBAL PERSPECTIVE
Czech and Slovak Republic manufacturing growing to reclaim industry position

22 IT & ENGINEERING INSIGHT
Automation project scheduling tips

24 ADVANCING TECHNOLOGY
Rise of the PM machines

25 INDUSTRIAL ETHERNET
Device-level benefits of industrial Ethernet

33 BY THE NUMBERS
Fines for quality violations; solar power manufacturing growth

34 THINK AGAIN
DNA-level machine design

64 BACK TO BASICS
Working with multivariable sensors

news

26 800+ engineeering jobs at virtual job fair

26 ISA approves first ISA100 standard in wireless series

27 Where in the World is Control Engineering contest ends

28 Manufacturers call for strategy to transform U.S. factories

28 Siemens, Winergy expand wind turbine manufacturing

30 ABB's 800xA controls biofuel manufacturing in Finland

30 Low-cost, high-return process control improvements

31 Green Manufacturing certification

32 Embedded controls cut small engine emissions

32 New Delta V platform addresses field device connectivity, HMI

products

60 Photoelectric sensor; 10-in. HMIs; Ethernet module for analog signal conditioners; Ethernet switch; Inductive proximity sensor

61 16 point I/O modules; Trip coil, lockout relay monitor

62 Wireless for difficult terrain; Digital mass flow controller

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Go to www.controleng.com and find:

- CEtv video provides more on Mount Vernon Mills upgrade project on page 18
- See a slideshow of Where in the World is *Control Engineering* contest photos in the CEtv video section—our readers can get pretty creative
- Ideas for using Coriolis flowmeters in leak detection applications
- Part 2 of a series on saving operating costs by tightening your control strategy

David Greenfield interviews Mount Vernon Mills' denim mill electrical engineer Jonathan Payton about recent upgrades, including new motors, drives, PLCs, and HMIs – and a move from dc power to ac.

"SEEK & YE SHALL FIND"

Most popular articles this month:

- Northrop Grumman recommends Siemens CNC for F-35 supply chain
- Schneider Electric and Orange County Choppers to build hybrid motorcycle
- How to choose a controller
- AC permanent magnet motors

DAILY NEWS

- New control system platform version rethinks main concepts of field device connectivity and human interface
- Fund managers demonstrate clean energy's economic impact
- Immersive virtual reality for training
- NEMA announces completion of advanced electric metering standard

MORE LEARNING, LESS SURFING

Seven exclusive blogs

- **Ask Control Engineering**—Mixing Diesel and gasoline? How can that work?
- **Machine Safety**— EN ISO 13849-1; 2006 - U.S. bridges needed for transition
- **Pillar to Post**—Observations from a meeting in Orlando
- **Cyber Security**—CSSP offers advanced cyber security training in December
- **Make2Pack**— ISA88 Batch Control discussion: Part 1, number 9
- **Automated Vehicles**—Engine school: Unmanned van demonstration
- **System Integration**—Patience is a virtue

Downloadable podcasts

- Cyber security: You've been hacked. Now what?
- Instrumentation tutorial: Understanding and using multivariable sensors
- Fieldbus Foundation on applications in upstream oil and gas

TOPIC-SPECIFIC NEWSLETTERS

- **System Integration**, including networks, safety, I/O and system integrators
- **Information Control**, including controllers, DAQ, HMIs, MES, programming software and PLM/design software
- **Process Control**, including advanced control and instrumentation
- **Machine Control**, including motors and drives, motion control, embedded control and machine vision

Point. Click. Watch.

Webcasts

- Now on-demand: Technologies for Regulatory Compliance Regulatory compliance is an issue which is becoming increasingly critical for manufacturers of all types as federal agencies clamp down on violations of all types.

CETV videos

- Fluke demonstrates two new products: Thermal imager and rugged DMM.

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Ethernet gateway makes PLCs 'future proof'

Moxa's MGate EIP3000 series products provide 1 or 2-port DF1 to EtherNet/IP protocol conversion for users who need to connect Allen Bradley PLCs to an EtherNet/IP network. The EIP3000 series products can be used to provide the PLCs with remote maintenance capability. By supporting PCCC objects on CIP, the MGate EIP3000 can communicate seamlessly with Rockwell Ethernet devices. The gateway products support up to eight EtherNet/IP clients and eight EtherNet/IP servers simultaneously, and each client can send up to 16 requests at one time. Moxa provides a user-friendly Microsoft Windows utility with multiple language support for use with MGate products. The utility also provides traffic monitoring for EtherNet/IP and DF1 protocols. Each MGate EIP3000 gateway supports virtual serial ports. A remote PC uses a Moxa-provided Real COM or TTY driver to connect to the gateways's virtual serial port. RSLinx and SCADA systems can use the virtual COM port to communicate with a PLC through the gateway. The virtual serial port function gives RSLinx or SCADA systems the ability to connect to multiple DF1 PLCs through an EIP3000 protocol gateway as well as EtherNet/IP devices. When using termination resistors to prevent serial signal reflection, it is important to set the pull high/low resistors correctly so that the electrical signal is not corrupted. Since no set of resistor values is universally compatible with all environments, this gateway has DIP switches for setting the termination and pull high/lo resistor values. *www.moxa.com* **Moxa**

Moxa MGate EIP3000 gateways provide 1- or 2-port DF1-to-EtherNet/IP protocol conversion to connect Allen-Bradley PLCs to an EtherNet/IP network.

Economical power monitoring devices

ONLINE

Use the Zibb search atop www.controleng.com for other products, news, and tutorial articles.

Siemens Industry Inc. introduces the new line of Siemens Sentron PAC power monitoring devices. This cost-effective line of meters ranges from traditional basic monitoring to intermediate power quality monitoring capabilities. The meters have bright LCD screens and can be configured through menus on the front or using free software for remote configuration. They meet all ANSI/ UL/ IEC requirements for safety and accuracy. The PAC3100 meter is an "amp volt plus" meter. Designed to replace analog and amp meters, it also offers advanced features, such as Modbus RTU communication, a large display, and KVA/KVAR monitoring capabilities. It measures import and export energy and 25 other parameters. It is well-suited for sub-billing or cost allocation in commercial or industrial applications. When combined with supervisory systems, the meter cost effectively meets government EPAct and LEED requirements. It measures over 50 parameters and has a faster sampling rate for applications that require information about the state of the electrical system. Multiple communication protocol capability makes it a good choice for commercial and industrial systems. Optional communication modules for Modbus RTU and Profibus DP and can receive data from two independent supervisory systems—the Modbus TCP and the Modbus RTU. It enables users to set limits or alarms for voltage, current, power factor, and frequency. The PAC3200 does not require transformers when used with systems of 690 or fewer volts and offers a 22-65 V dc control power version for industrial systems with 24 V dc control power circuits.

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Siemens Industry Inc.

Siemens Industry Sentron PAC power monitoring devices range from traditional basic monitoring to intermediate power quality monitoring capabilities.

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Changing instrumentation, building motorcycles

Readers weigh in and ask questions about *Control Engineering* articles in print and online.

Re: Schneider Electric and Orange County Choppers to build hybrid motorcycle, Online news, 09/24/2009

That's cool, but…….

"As one of the premier builders of custom motorcycles, Orange County Choppers will bring an unprecedented level of expertise and creativity to showcasing our mission (of energy efficient management methodology) through their design."

Please!!! Have they ever watched the show?

Mikey will short out the super duper nickel metal halide battery pack and it will burst into flames. The old man will see the fire and start swearing and throwing stuff, knocking the bench over with the fancy schmancy electric motor on it. Then Pauly will refuse to unplug the wires before he welds crap onto the frame and smoke the "Intelligent energy management system" into oblivion.

And that's just what happens before the first commercial break.

Scott Lufkin

> "Certain customers avoid the adjustable version because of fear of field technicians and operators making unnecessary changes."

Dashboards vs. real-time data

Re: Enterprise software: Dashboards present more than just information, online tutorial, 08/27/2009

It seems so simple to state that 'dashboards can present real-time information from multiple systems'. The elephant in the room, however, is that those 'multiple systems' need to be able to accommodate, record, and transact that data in real time. So in the case of Infor's multiple ERP and supply chain products, that ability will vary wildly, with most of them unable to do most of those things in real time. Real time postings to the ledger at time of receipt? For lot controlled inventory? With the material certification detail as passed by the quality department? All in real time? Nah, with Infor those all come from different systems, if the data is even stored in a database as opposed to comment fields, document attachments, etc. Infor's dashboard is one big stick of lipstick that covers all the pig products underneath.

Jeremy Stavit
Consultant

Changing instrumentation settings

In a newsletter article entitled "Who's changing settings on your instrumentation?" (online news, 09/03/2009), Peter Welander noted that it's a relatively common practice for operators to go into the plant with a hand-held interface and tweak settings on instrumentation. One vendor sales manager weighs in:

AST has seen this when quoting two product families. The AST4300 series is our standard Class I Div 2 pressure sensor and the AST4310 is a field adjustable version. The AST4310 series has zero and span potentiometers that can change the zero or span output signal. Certain customers avoid the adjustable version because of fear of field technicians and operators making unnecessary changes: "If they see somewhere they can put in a screwdriver, they are going to change it." Some prefer to maintain control at the PLC.

Greg Montrose
AST sales manager, Mount Olive, NJ

DAQ questions

In a Soapbox editorial entitled "Factory floor visualization" (*Control Engineering* print edition, January 2009), the authors state that "with the capabilities of Flash technology, a Web browser can be embedded on a SCADA operator panel, thereby avoiding duplication of client HMI applications." A reader is wondering how to apply that advice to a data acquisition system in a laboratory environment:

I am in a research environment. I need to build a distributed data acquisition system incorporating a wide variety of communication protocols. What would be the recommended base server software package? An off the shelf SCADA package? LabVIEW? The Physics community uses EPICS? There has to be something between the sensors and instruments and the web server. What is the author using? I have considered using Flash? What is the learning curve?

Christiana Grenoble, computer scientist
Thomas Jefferson National Accelerator Facility
grenoble@jlab.org

ONLINE

View articles online to submit your own comments at www.controleng.com
Click the TalkBack tab on the homepage.

Smart screens for industrial applications

Developers of smart screen HMIs can achieve industrial-grade reliability and real-time performance by using both Flash and C/C++ components. Design of a building automation system provides an example.

Andy Gryc
QNX Software Systems

A smart screen can be defined as a human-machine interface (HMI) that uses interactive graphics displays on a touchscreen to offer users control of an underlying embedded system. Smart screens come in many shapes and sizes, and can be used for applications ranging from ticket kiosks to factory control systems.

Smart screens are becoming the preferred HMI for a variety of industrial control applications. These smart screens are essentially the same as those for consumer applications. The key differences lie in the underlying applications and the HMI design.

Where consumer applications may emphasize the "Wow!" factor—with morphing widgets and other non-essential but eye-catching features—industrial smart screens must provide clear and readily understandable interfaces. In addition, industrial HMIs must be designed to be consistent over many years and easily updatable. They must maintain a consistent look, feel, and functionality even as the systems beneath them change.

This requirement for consistency and ease of use does not imply that creating smart screens for industrial applications is less difficult than for consumer electronics. In addition to providing on-screen information and controls, smart screens may need to provide interactive access to layered diagrams, blueprints and maps, embedded videos, and other media. Above all, they must offer industrial-grade reliability.

Building smart screen HMIs with Adobe Flash Lite allows developers to take advantage of the Flash toolbox, which includes all the elements needed to build a clear, effective smart screen, and which supports the most stringent design requirements, including layout, layering, and multimedia support. Moreover, top-notch Flash designers and developers are relatively easy to find, thanks to the widespread acceptance of Flash as an Internet technology.

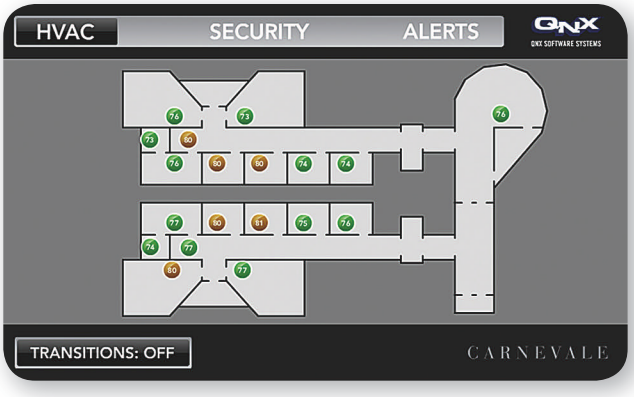
Unlike desktop Flash players, Adobe Flash Lite is designed specifically for resource-constrained embedded products. To evaluate the suitability of a Flash Lite smart screen implemented over an industrial application running in an embedded environment, we designed and implemented a building automation system and HMI. The HMI allows a user to operate a multi-zone control system, monitor system-wide alarms, and perform video surveillance. The system operator can touch the smart screen to zoom in on specific wings or rooms, adjust temperature or fan speeds, and control a variety of other functions.

The system sensors and controls are simulated,

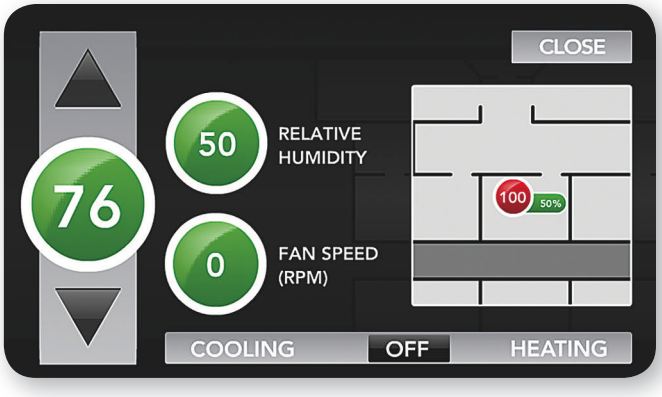
ONLINE

Whitepapers and other resources on real-time operating systems are available at

www.qnx.com/solutions/industries/automation

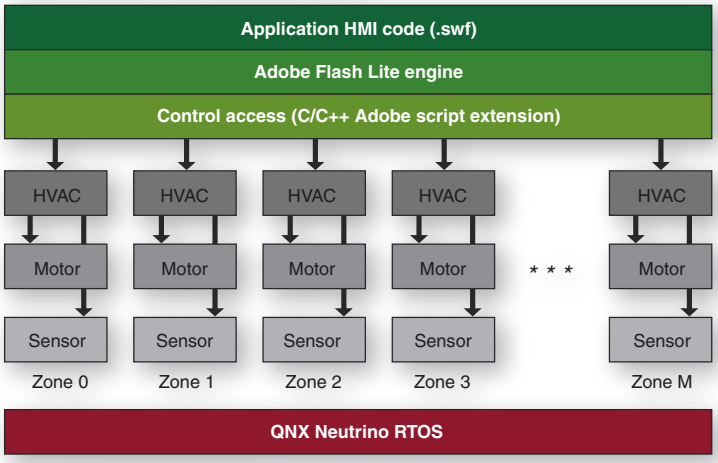


To evaluate the suitability of a Adobe Flash Lite based smart screen, QNX developers created a building automation system and HMI.



This smart screen presents information gathered through the HMI connection to the underlying system controls.

Software architecture



Source: QNX and Control Engineering

The software architecture of the building automation system shows how three processes control each zone: one for heating, ventilation, and air conditioning (HVAC), one for fan motor control, and one for the temperature and humidity sensor.

but they could be replaced by actual hardware in a real building. To more closely simulate a live environment, we designed the system to be fault tolerant. For example, if an error or a user intervention takes a building zone offline, the application detects the problem and reports it through the HMI.

A Freescale MPC8536E PowerQUICC III serves as the primary CPU, although the software stack can run on a number of different chips and architectures. The QNX Neutrino RTOS serves as the operating system, and the MPC8536E board support package provides device drivers that interface with the I2C and SPI hardware.

Three processes control each zone: one process for heating, ventilation, and air conditioning (HVAC); one for fan motor control; and one for the temperature and humidity sensor. At the top of the stack, an application using Adobe Flash Lite 3 provides the smart screen HMI.

Design challenges

A building automation system must support dynamic deployment. Physical factors often constrain module placement, and changes to building infrastructure may dictate system rearrangement.

To address the challenge, we separated the HVAC control tasks for each zone into independent processes. This separation allows the system to be distributed on multiple nodes across an Ethernet network using Transparent Distributed Processing (TDP). As a result, building engineers can arbitrarily rearrange the system's zone deployment without having to reconfigure the master HMI system. Separating each zone's tasks into different processes also provides greater fault resilience—the system can detect the problem and restart without affecting other functions.

The smart screen HMI presented another challenge. We wanted to use Adobe Flash because it simplifies the work of creating an attractive and effective user interface. However, we knew that compiled Flash binaries execute inside the Flash virtual machine, isolating the Flash HMI from the rest of the system. Flash code operating in a browser cannot manipulate the underlying PC environment, and, identically, an embedded Flash HMI does not normally have access to the embedded system's underlying hardware resources.

The solution to this problem turned out to be straighforward—use an Action Script Extension (ASE) that allows Flash code to interface directly with native C/C++ code. We used this capability to interface the HMI to the HVAC, motor, and sensor processes. This strategy allows these processes to operate like traditional embedded software, which would interface to the sensors and controllers either by directly accessing the A/D hardware and GPIO pins, or by using I2C or SPI bus drivers to communicate with the devices.

As part of this project, we attempted to address key concerns about the suitability of Flash Lite for embedded industrial applications. These include:

- **Dynamic memory consumption.** The amount of memory available to the Flash virtual machine's heap can be completely constrained so that it will not exhaust system memory.
- **Real-time performance.** Flash does not offer real-time performance. Developers can mitigate this by moving any real-time requirements into native C/C++ code and then communicating between that code and the Flash HMI.
- **The Flash single-thread model.** The HMI can stall if a portion of it is waiting on an input that fails to arrive immediately. Developers can solve the problem by moving code that can block out into a C/C++ module.

Bottom line: Developers can satisfy the twofold requirements of industrial-grade reliability and real-time performance by implementing an appropriate division of the HMI between Flash and C/C++ components.

Andy Gryc writes for QNX Software Systems, maker of middleware, development tools, realtime operating system software and services for embedded design.

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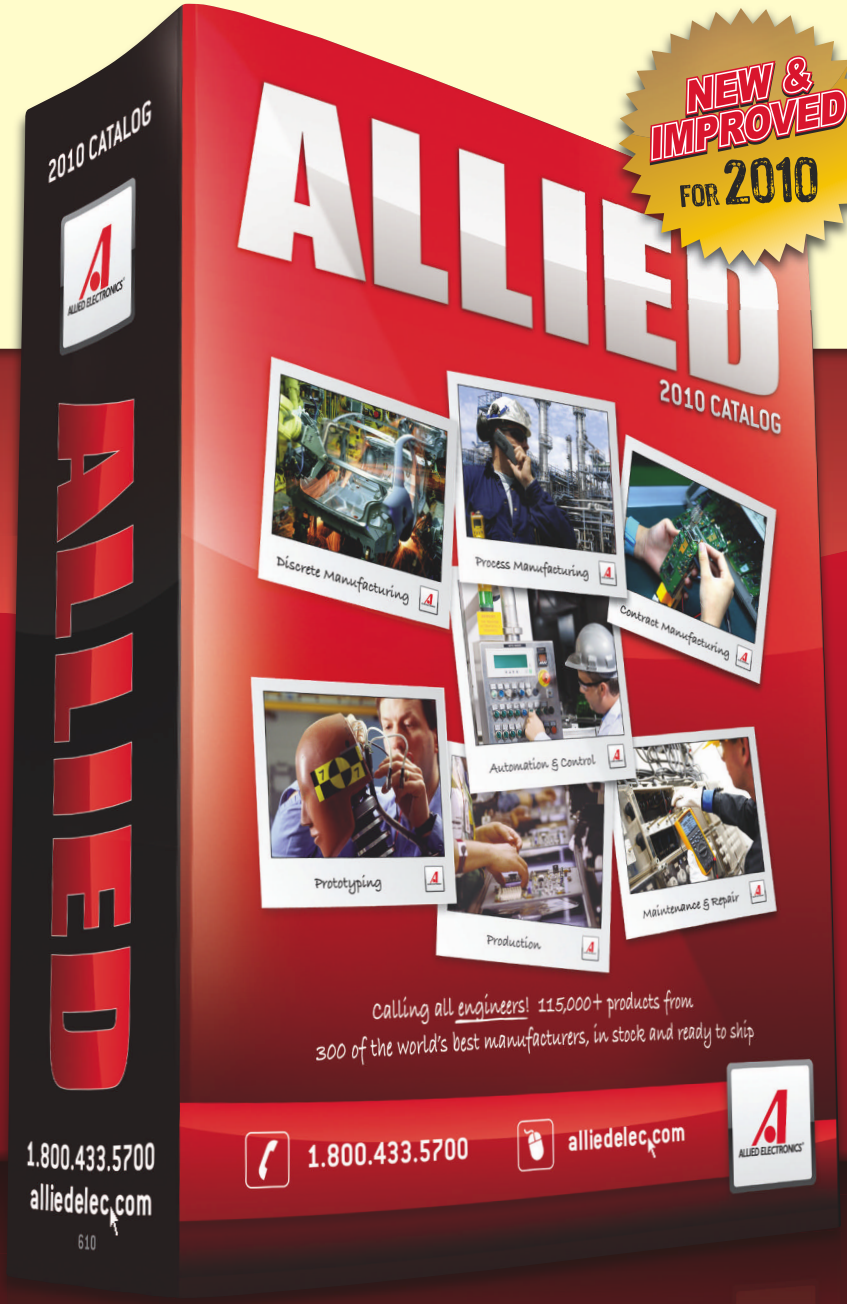

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Leak detection: Technology catches up to theory

Making sure all the oil that goes in a pipeline comes out the other end is harder than it sounds.

Marsha Yon
Micro Motion
Richard Leonard
Pro-Tech Solutions
Alvin Shoop
Expert Systems Group

One of the world's largest steam generating plants is located on an island in a major U.S. metro area. The plant distributes steam for heating and air conditioning throughout its local service area, but has to pull fuel for its oil-fired boilers from a tank farm approximately two miles away. To complicate matters, 85% of that distance is through a tunnel under a heavily traveled river. Given local environmental concerns, that fuel delivery system has to be closely monitored to make sure no oil is being lost in between.

The plant purchases No. 6 fuel oil from a tank farm across the river, so oil has to be pumped through a pressure-controlled pipeline that runs through a tunnel under the river, at a maximum flow rate of 300 gpm. Stringent requirements for the leak detection systems on the pipeline require that the system be able to detect any leak in excess of 60 gallons in 20 minutes, which effectively amounts to 1% of maximum flow.

Oil in = oil out?

The material balance method of leak detection is simple: quantity in – quantity out = size of leak. Simple, yes, but implementation is more complicated. The system must manage temperature and pressure differentials and time lag. If the system is based on volume, temperature compensation is especially challenging when different segments of the pipeline run at different temperatures. The oil temperature can change as it passes from the tank to underground to under water. Because multiple measurement devices are involved, measurement error accumulates, with negative consequences for overall accuracy.

In the early 1990s, the utility company assessed its leak-detection system and found it lacking. This prompted a 15-year effort to monitor, upgrade, and optimize the system so that it not only met but exceeded requirements.

The basic concept of the original system was straightforward and used paddlewheel sensors on each end of the pipeline. A comparator device developed in-house collected pulse data from the sensors via dedicated telephone lines, compared the inlet pulse rate to the outlet pulse rate, and calculated the difference in flow.

Unfortunately, the paddlewheels never were able to generate data with required accuracy. Variations in temperature and density made the errors worse, and the dedicated phone lines failed frequently. Although no significant leaks occurred over the 30 years the system operated, the company recognized the risk, and took steps to correct the problem.

Improved system, version 1

In the mid-1990s, the utility contracted system integrator Expert Systems Group to redesign and implement a system that would meet their specifications for sensitivity, accuracy, and reliability.

The sensing technology was changed from paddlewheels to Micro Motion D300 Coriolis mass flowmeters. Mass measurement is not affected by pressure and temperature variation, so an improvement in accuracy was realized immediately. Communications and processing were handled by two PCs connected by fiber optics. The PCs ran the Microsoft Windows 98 operating system, a custom data analysis program, and ProLink, a software tool from Emerson that retrieves process data from the sensors. As shown in the diagram, after local processing, the inlet PC sent data over TCP/IP to the outlet PC, where it performed comparison processing and leak detection analysis.

Although mass data is more stable, the leak rate is specified as a volume, so Al Shoop, proprietor of Expert Systems Group, had to make a conversion using mass and density readings measured by the D300 meters. By taking the direct density measurement from each end of the pipeline and assuming a straight-line temperature gradient from one end of the pipeline to the other, Shoop was able to generate temperature-corrected data that improved accuracy; other optimizations reduced the average system discrepancy to less than one gpm.

Even so, the enhanced system was still not ideal. The bulky D300 meters were hard to fit into the existing pipeline. Non-optimal positioning caused occasional bubbles in the line, which resulted in spikes and false alarms. The Windows operating system did not have real-time capability and its timer did not produce exact two-second data samples. Moreover, the PLCs of the time did not have sufficient computational and memory capacity to do the job. Still, the system ran flawlessly for 10 years.

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For more information, visit:

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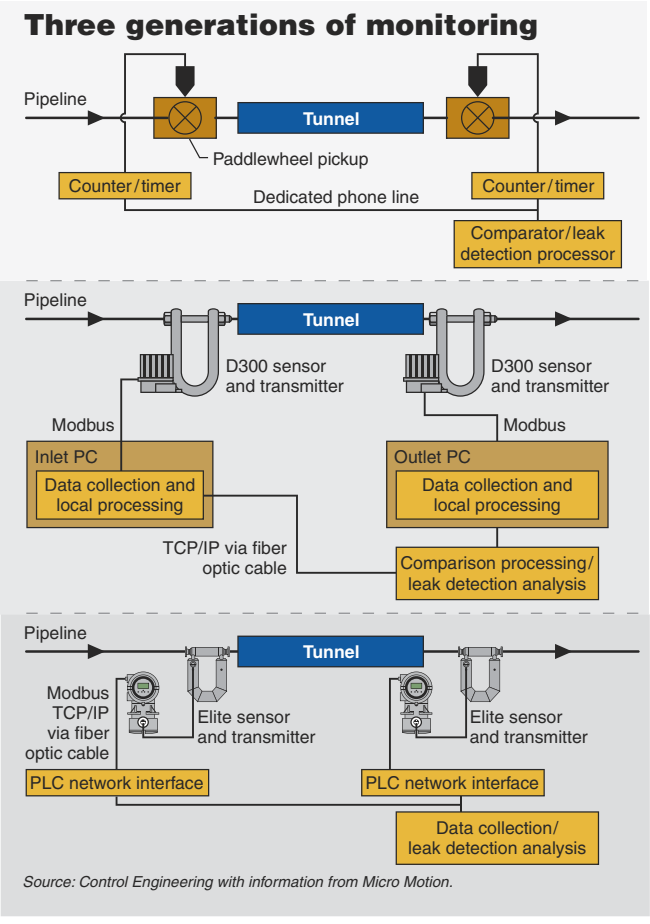
Read this story online at www.controleng.com/archive for more information on leak detection with Coriolis flowmeters.



Source: Control Engineering with information from Micro Motion.

Comparing the schematics of the three systems, it is possible to see how the technology evolved over 40+ years of operation.

Not only had PLC capabilities evolved during this time period, so too had the Coriolis sensor. The Elite Coriolis meter was five-times more accurate than the D300. Modbus-to-TCP/IP converters on each meter meant that no computers were needed because newer PLCs had no trouble processing and comparing the raw data.

The new equipment was installed beside the existing system, and immediate improvements were seen. "As a result of the increased accuracy and the preprocessing performed by the meter, for example, onboard data smoothing and noise reduction, the standard metering error dropped from 20–30 gallons in 20 minutes to less than 2 gallons in 20 minutes," says Shoop. With decreased metering error, there is no danger of false alarms caused by spikes. The previous problem with bubble formation was addressed by adding S-bends to the pipeline, thus providing space to install the sensors in their optimal orientation.

Shoop knew the system was a success when one day he noticed a slight increase in the standard metering error. It was not reported because it was below the alarm limit, but a few days later, a technician saw sheen on the ground. The glint proved to be a small puddle of oil from a pinhole leak. Although no trip was initiated, the system had successfully detected the event.

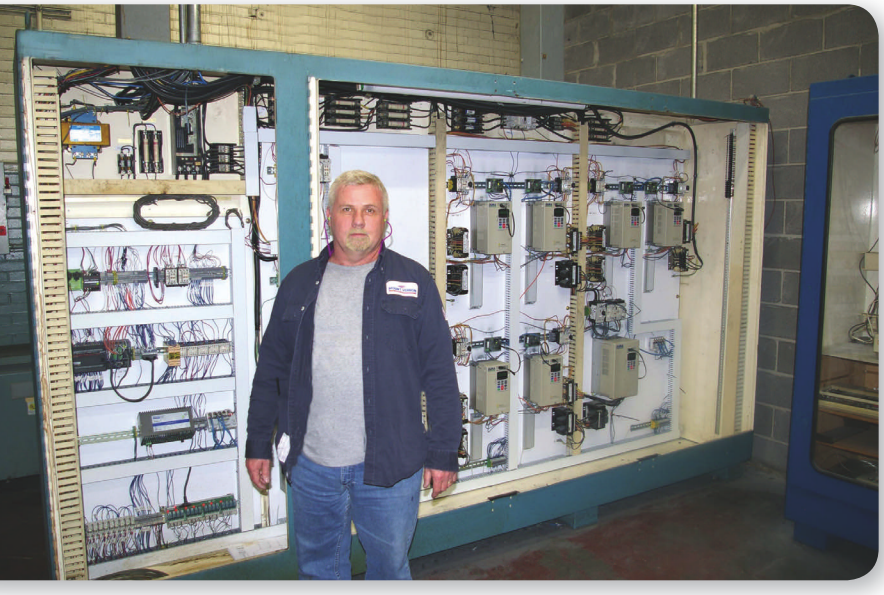
Marsha Yon is Micro Motion business development manager for liquid custody transfer. Richard Leonard is executive VP and CFO of Pro-Tech Solutions, Ltd. Alvin Shoop is president of Expert Systems Group.

Denim manufacturer takes control upgrades into its own hands

After seeking to outsource control upgrades for its refinishing lines and rebeamer operations, Mountain Vernon Mills successfully upgrades the mill's high-precision controls on its own and saves more than $40,000 in the process.

Jonathon Payton
Mount Vernon Mills

Mount Vernon Mills is one of largest textile mills in the United States. Our mill in Trion, GA, nestled along the Chatooga River also happens to be one of the oldest textile mills in the United States, with roots dating back to 1845.



Jonathan Payton stands in front of the new finishing line control cabinet, which includes a DL260 DirectLogic PLC, eight Durapulse variable frequency drives, and related control equipment. The entire design, including software, was installed during the plant's three-week shutdown. Source: Automation Direct

The initial 5,000 sq ft, two-story mill had 40 employees and started by producing 5 lb bunches of yarn to sell to local merchants from wagons. Over the next 160 plus years, the mill would survive a fire in 1875, General Sherman's march through Atlanta, bankruptcy in 1912, two world wars, the fight to get unionized, and a major flood in 1990. Through it all, the mill has continually expanded, renovated, and modified to change with the times. As a result, the mill has produced many different products over the years, including fabric used for military uniforms, crop sacks, sheeting, shirting, and even gloves.

In 1971, the decision was made to have the Trion plant produce denim. This turned out to be one of the best decisions in the mill's history. The plant installed new equipment and rode the wave of growth in the denim industry. By 1976, the facility had more than 1,100 looms producing denim. The company continued to grow, but then faced a near disaster when the "Hundred Year Flood" hit the Trion area. After the flood, the company spent the next several years modernizing its plant with state-of-the-art machines with which to produce denim.

Today, after its latest round of renovations, the mill continues to operate using advanced equipment in more than one million square feet of manufacturing space. The denim from Mount Vernon Mills is woven and finished for sale to a many major manufacturers across the country like Wrangler and Lee. Mount Vernon is now the 3rd largest producer of denim in the United States.

Updating finishing line controls

Despite regularly keeping up with changing technologies, the company found that it was getting harder to get spare parts for control systems on some of mill's finishing ranges and rebeamers. The age of the control systems also made it difficult to give operators the features and functions they wanted. Late in 2006, we decided to embark on upgrades for our rebeamers as well as one of our finishing lines.

The task of replacing the control system for the finishing line seemed daunting. It is a very large, multi-motor machine. All the motors have to work together and are self adjusting with dancer position sensors that send signals back to the PLC system. The PLC system automatically adjusts motor speeds to keep everything running together.

Because of the machine's size and complexity, we first went out for bids. When the bids came back with costs that far exceeded our budget, we decided to do the project in house and source components from AutomationDirect.

To save time, we bought new back planes to bolt on the backs of the old cabinets so they could be assembled and tested before being installed in the machine. Though we initially planned on doing this in our spare time over a period of three months, we ended up getting only three weeks and having no time for testing. Electricians were finishing mounting motors and drives before I had time to complete the software setup.

Before the upgrade project, the finishing line was powered by dc drives with field regulators. We upgraded to AutomationDirect's Durapulse ac drives and networked all the drives via Ethernet to a DL-260 DirectLogic PLC System. We selected a 15-in. C-more touch screen operator panel to replace the main operator console. We were able to procure, install, and program the entire system within the three weeks. I did all the programming of the HMI and PLC, and used AutomationDirect's telephone technical support staff to get questions answered when we encountered problems.

The project proved to be a great success very quickly. First of all, we saved nearly $40,000 compared to the other bids. And now that our control system is largely software-based, we're able to give the operator much more control of the machine, including setup parameters of the dry cans & dancers, line speeds, trimming capabilities, as well as some fault indication and maintenance screens. As a result, we are looking to add new functions or features as we continually refine the process for improved productivity.

Rebeamer retrofit

On a second project, we retrofitted our old control system for a rebeamer in order to get better performance and more flexibility. The rebeamer is a speed-controlled center winder. It winds yarn from several section beams onto a single loom beam prior to weaving.

There are dozens of these machines in our facility. The original control design for the rebeamer used manual controls (pushbuttons, pilot lights, meters) on the operator station, and a dc drive to operate the spool. As with the finishing line in the first project, it was getting difficult to procure replacement parts or make any changes to the machine, operator interface, or control system.

At first, we outsourced the PLC program in our efforts to improve its performance, but we never could get the new programs to work correctly. So we scrapped the outsourcing idea and did it ourselves.

The first rebeamer project began with a plan to retrofit one of the rebeamers with a DirectLogic DL06 micro PLC, a Durapulse ac variable frequency drive, and a C-more operator interface panel. This technology combination was selected because it enabled us to put more parameters and adjustments at the operators fingertips. With our operators continually suggesting improvements to the process or machine, we are now able to act on their inputs, and use the software-based control system to streamline the process.

A key aspect of this project involved the requirement, on the rebeamer, for the speed to be adjusted as it winds up to keep the yarn at a constant velocity. I was able to establish this level of precise control without an encoder by using the DL06 micro PLC and a single proximity sensor.

Jonathon Payton is denim mill electrical engineer, Mount Vernon Mills, Trion, GA. He can be reached at jonpay@mvmills.com.

Denim finishing lines at Mount Vernon Mills. See a Control Engineering video interview with Mount Vernon Mills' Jonathan Payton at www.controleng.com/video.

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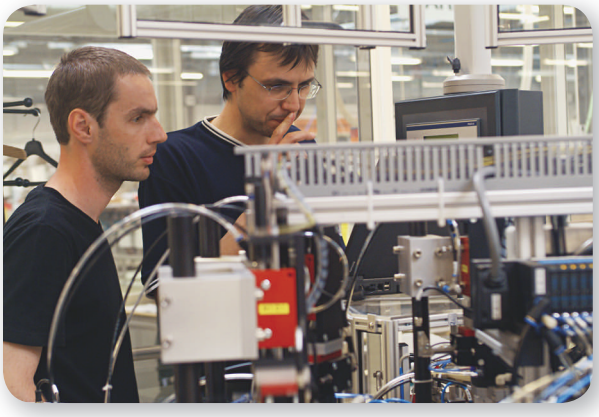
For more information on AutomationDirect products, visit www.automationdirect.com. Also, see and hear Mount Vernon Mills' Jonathan Payton discuss this application at www.controleng.com/video.

Czech & Slovak Republic manufacturing growing to reclaim industry position

Once among the world's industrial powerhouses, the Czech and Slovak Republics are working to regain their former lofty status among the world's producers with help from foreign investment and a relatively recent focus on energy efficiency.

Milan Katrušák
Control Engineering Cesko

Between the two world wars, the former Czechoslovakia built up an impressive position among the industrial countries of the world. The groundwork for the region's 20th century advance was laid during the Industrial Revolution, when the vast majority of the manufacturing plants of the multi-national Austro-Hungarian Empire originated in the areas of Bohemia and Moravia. During both world wars, the Bohemian countries were seen as a vital industrial base, first for Austria-Hungary and later for Nazi Germany.



Employees at Schneider Electric manufacturing factility in South-Bohemian Pisek actively participate in the company's energy saving program. Implementation of energy saving products has reduced consumption of energy per employee by more than 10% between 2004-2008. There are plans to decrease it another 10% between 2009–2011.

Though the Czechoslovakian manufacturing industries once represented the top of industrial production in terms of the quality and popularity of products, as well as in the modernity of its manufacturing equipment, by the end of 1980s after 40 years behind the Iron Curtain, Czech industrial enterprises lagged far behind the rest of the industrialized world. The most notable problems for the region were in technological development and work productivity.

The past 20 years, however, has been marked by the Czech industries' intense attempt to quickly match the current technology level of the Western European countries, USA, and Japan. These attempts have been equally shared across various manufacturing segments by companies such as Škoda Plzen, Budvar Ceské Budejovice, Trinecké železárny, and Vítkovické strojírny, as well as by green field plants built by foreign investors.

Some of the most notable foreign investments in the Czech and Slovak Republics have come from Japanese and Korean automotive companies—Kia Motors in the Slovakian Žilina, Hyundai in Nošovice, and a joint venture between Toyota and Peugeot in Kolín. Asia-based companies have also played a major role in the recent growth of the electro-technical industry in the Czech and Slovak Republics, as can be seen by the Panasonic plants in Plzen and Žatec, Sony in the Slovakian Nitra, and Foxconn in Pardubice.

The degree of automation of these plants is an important indicator of the maturity of industrial production as a whole. This is especially evident in the automotive industry; even though it has been slowed by the worldwide economic crisis, it remains a great consumer of the latest automation technologies. According to a recent survey in Control Engineering Cesko, automotive manufacturing plants and their subcontractors consume more than 40% of the total sales of industrial robots in the Czech region. Evidence of this can be seen at Škoda Auto Mladá Boleslav (Volkswagen Group), which has automated 60% of its welding shops. This figure reaches up to 90% in its VW-affiliated plants.

Another important factor affecting the Czech and Slovak economy is energy efficiency. From the latest data published by Eurostat (the statistical authority of the EU), both the Czech and Slovak economies are still significantly lagging behind the average of the EU 27. The Czech and Slovak regions are even considered to be lagging when compared to surrounding countries, such as Hungary or Poland. Currently, the consumption of electricity per capita in the Czech Republic is considered to be the highest

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in Central Europe, even with the unit price for kWh approximately double for both industrial enterprises and residential use, when compared to the price per kWh in the U.S.

As a result, energy management has quickly become the center of interest for the managers of manufacturing plants. The Czech branch of Schneider Electric, with its focus on production and facilities energy efficiency, is serving as an example of where the region's industry as a whole is heading with its energy-saving initiatives.

The CEO of Schneider Electric CZ, Olaf Körner, recently said: "Based on our activities, we can unambiguously state that the efficient use of energy is an important topic for our customers; a topic which is gaining increasing priority in planning measures and investments. The existing economic recession leads to a general limitation of investment and operations costs and this fact includes investments in efficiency and environmentally safe technologies. The critical aspect is the economic return of the invested means; if, in the past, the acceptable limit was five years, today the requested economic return is one to two years. This time horizon affects current decisions on investing in energy saving projects."

Another automation supplier, National Instruments, has been holding seminars in the area focused on energy savings and green applications; these topics are very popular in the central European region. The biggest players in the region—Siemens, ABB, and Rockwell Automation—have not been standing idly by. They, as well as many domestic companies, such as Papouch, ELVAC, and Elcom, have kept up with the growing interest in energy efficiency and are offering customized solutions for specific customers and applications.

Even though the former Czechoslovakia split into two successor states in 1993, the Czech and Slovakian way to mature industrial production is, in many aspects, similar. For both countries, it represents a challenge to undo the old mistakes and to return to a respected position among the most developed economies of the world.

Milan Katrušák is the editor-in-chief of Control Engineering Cesko. You can contact him at mk@controlengcesko.com.

Automation project scheduling tips

On-boarding and ramp-up time can constitute a month or more of non-productive time and be a substantial part of project cost, especially when using offshore resources. Here's how to reduce waste.

Dennis Brandl

With so many automation and manufacturing execution system (MES) projects being implemented by consultants and contractors, it is important to have good processes in place to make these projects productive as quickly as possible. In many projects, the on-boarding time—which is the time to setup all of the proper hardware, accounts and privileges—and the ramp-up time—which is the time it takes for someone to start doing useful work on the project—can be a month or more. This month of non-productive time can be a substantial part of project cost.

Most IT departments have on-boarding processes for getting PCs, user accounts, and standard tools set up. These processes work well for on-boarding administrative and clerical personnel, but workers in automation projects often need additional specialized hardware, software tools, and IT administration rights. Automation contractors also need to know your automation project processes and their roles in those processes.

It's important that this information is readily available to reduce on-boarding and ramp-up times. It is even more important to have the information easy to find if the contractors are offshore. Because of time zone differences and potential language problems with offshore contractors, simple misunderstandings of project process rules can take days to be resolved, negatively impacting the project's schedule.

Automation-specific additions

On-boarding for automation projects should augment the IT on-boarding process by adding other necessary components such as PLC or DCS programming tools, fieldbus network cards, configuration management accounts for code check-in and check-out, defect tracking accounts, test system accounts, documentation system accounts, project management tools, and physical access rights. Also, IT organizations often have separate on-boarding processes for their own staff, which usually includes additional administrative rights and software tools. Manufacturing managers should work with their IT organization to add standard on-boarding processes for automation and MES contractors. Ensuring that contractors have the right tools will eliminate problems later in the project.

Once your automation resources are fully on-boarded, they will need to understand your development processes. Fortunately, it does not take sophisticated tools to provide this information. One easily implemented method is through collaboration services or a Wiki system that provides on-boarding and ramp-up information.

The Wiki should start with a list of general questions that new personnel always ask. These would include: "What do I do first?"; "How do I see the tasks assigned to me?"; "How do I see the meeting schedule?" ; "How do I submit a problem report on (O/S-operating system, project code, tools,...)?"; "What is the project schedule?"; "What is the holiday schedule?" (this is important and often overlooked when using off-shore consultants); "What is the meeting schedule?"; "What is the project organization chart?"; "Who are the vendor contacts?"; and, most importantly, "What are those 3-letter acronyms?"

The answer to each question should include a graphical representation of the process, an identification of who to contact for questions on the process, links to the appropriate internal website for additional information, and links to internal tools used to initiate a process or take an action.

The advantage of using a Wiki is that changes can be quickly accomplished without calling on IT resources. A Wiki can also be quickly extended for project-specific information and processes.

On-boarding and ramp-up time for contractors is usually built into project schedules but is often underestimated. Spending time before any project starts to work with the IT organization to define the tools and processes your contractors need can save man-months of unproductive time, time that your project is paying for.

Dennis Brandl is president of BR&L Consulting in Cary, NC, www.brlconsulting.com. His firm focuses on manufacturing IT. Contact Dennis at dbrandl@brlconsulting.com.

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Rise of the PM machines

Permanent magnet brushless synchronous motors have moved beyond traditional applications with higher efficiency than induction machines.

Frank J. Bartos, P.E.

No relation to the Terminator 3 saga, this "rise" refers to the expanding applications and growing physical sizes for today's permanent magnet (PM) machines—motors, generators, and other devices. Times have changed the notion that PM machines comprise mainly small ac (and dc) motors.

PM brushless synchronous motors have moved well beyond machine tool, CNC, and related traditional applications. Even here sizes have grown, for example, up to 220 kW rated power from Fanuc Ltd. Newer PM machine applications include general-purpose industrial processes, electric hybrid vehicles, magnetic (variable-speed) drives, and generators for giant wind turbines. The objective is high efficiency by cutting rotor losses compared to induction machines.

One notable general-purpose product development is Baldor Electric's RPM AC line of PM synchronous motors. The design combines a laminated steel frame stator and a salient-pole, interior PM (IPM) rotor for power density and efficiency (see Online Ref. 1). Rich Schaefer, marketing manager for variable speed and specialty motors, explains that RPM AC series ratings are now available up to 700 hp (522 kW) in standard air-cooled version. Still higher ratings apply to water-cooled units, such as a gearmotor developed for the drilling industry, rated at 1,020 hp and able to produce 35,000 lb-ft (47,460 N-m) torque in a very compact space, Schaefer notes.

Indicative of further power growth ahead is a development for electrically driven gas compressors from GE Global Research. GEGR described a 6 MW, high-speed drive motor prototype at a March 2009 workshop staged by the U.S. Dept. of Energy and others (see Online Ref. 2). Efficiency and other benefits make PM machine topology the preferred choice above 15,000 rpm speeds, says GEGR.

Material issues

PM machines rely on so-called rare-earth magnet materials—typically neodymium-iron-boron (Nd-Fe-B)—for high torque production. Wider applications mean more demand for magnets whether used in small amounts for high volume products or in large quantities for fewer big machines. The latter translates to hundreds of pounds of magnets per unit, even with IPM rotor design that reduces magnet weight needed for a given torque output. IPM design generates an added *reluctance torque* component.

Synchronous PM generators for multi-megawatt wind turbines also pose large magnet demands. "In a high-speed generator, magnet weight is in the 150-200 kg (330-440 lb) range," says Anders Troedson, vice president of The Switch Controls & Converters Inc., a manufacturer of large generators. However, magnet weight skyrockets for slow-speed, direct-drive generators due to the large diameter machine and number of poles needed for torque production (see Online Ref. 3). "The lower the shaft speed the higher the torque required for the same output power," states Troedson. "Mass of magnets in a large direct-drive generator exceeds two metric tons." That's more than 4,400 lb!

> "Large generator magnets can weigh 2 metric tons."

Growth of PM machine applications has prompted initial concern that a supply-demand crisis may be coming for rare-earth magnets. Experts see a less critical scenario. "We are not running out of raw materials or production capacity," notes Troedson. He thinks increased demand will spur manufacturing competition so that magnet prices are not likely to accelerate.

"There is an abundance of rare-earth magnet raw material. The need is to ensure consistent production quality and careful supplier selection," adds Baldor's Schaefer.

Frank J. Bartos, P.E., is a Control Engineering *consulting editor. Reach him at braunbart@sbcglobal.net.*

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Device-level benefits of industrial Ethernet

Ethernet improvements, smart remote I/O and peer-to-peer technology can lead to better, more flexible control.

Peishan Juan
Advantech Corp.

An industrial enterprise can grow too big for efficient automation control using traditional technology. Advances in industrial Ethernet, however, can provide a solution. Using additional techniques such as smart remote I/O and peer-to-peer technology can result in better and more flexible control, along with a change in the way Ethernet is used.

For one quick example of the benefits possible, consider a site with widely scattered oil tanks. Monitoring the level in those tanks is best done with remote Ethernet-based smart I/O modules. Polling the tanks one by one to get their level works but the amount of time needed increases with the number of tanks. Smart remote modules with peer-to-peer capability can send a message to a control room if the level in a tank is lower or higher than a set point. The effect is a real-time update, done in a cost-effective way that scales easily with increasing site size.

> "The I/O process is simplified with peer-to-peer communications."

For end users, having Ethernet everywhere in the enterprise means the first two layers of the standard seven-layer communication model (the physical and data link layers) are the same throughout the enterprise. This eases the task of network integration and helps with network configuration and reconfiguration. It also means that one skill set can handle the entire network, reducing or eliminating the need to maintain specialized technical expertise for other networking technologies.

Smart I/O among peers

In the traditional master-client mode found in serial and proprietary networks, a controller has to read input module data. It then sends data back to the output module, completing the input-output loop. Those transactions require a controller, along with wiring to and from the I/O module. This back-and-forth sequence can take extra time if the controller is busy with another task. It also can be difficult to scale for a variety of reasons. It may involve a proprietary network, which may only be able to cover a limited distance. Likewise, there could be scaling problems if the number of connections to the controller overwhelms the device or proprietary protocol.

Peer-to-peer can decrease wiring

In contrast, peer-to-peer connections run from specific input channels on one module to specific output channels on another. Data automatically transfer from one to the other, simplifying the entire I/O process. One obvious advantage is that no controller is needed, saving system hardware costs. A less obvious benefit is that the wiring can be simplified, since it need only run from one module to the next. If connections are done using industrial Ethernet, then the wiring options become very flexible.

For an example of how peer-to-peer technology can help solve some real world problems, consider a company with three branches in separate countries. At headquarters, personnel in a control room monitor the gates leading to the other sites over an Internet connection. Given the desire to actively control the gates, one solution would be to run a separate communication network. With peer-to-peer modules, however, that control can be done over the existing intra- and Internet by placing a module at the control room and each gate. The control room module can act as a controller for each gate through the remote module.

Of course, there are different ways to implement peer-to-peer connections. One is to simply map the channel of one module to another, ensuring the security and pairing of the connection by only allowing a specific IP or MAC address control authority. The other is a more advanced case, with multiple modules mapping to one on either the input or output side. Advantech's Adam series of controllers offer such a capability. They enable flexible channel mapping while offering a response time of less than 1.2 milliseconds for wired modules and less than 30 milliseconds when in an *ad hoc* wireless mode.

Peishan Juan is a technical writer with the Industrial Automation Group of Advantech Corp.

www.advantech.com

ONLINE

To see more resources, including the full whitepaper "Benefitting from Industrial Ethernet at the Device Level with Smart Remote I/O and Peer to Peer Technology," visit www.controleng.com and search "Industrial Ethernet."

28 | Green
Wind turbines
Winergy Drive Systems

28 | Webcast
Regulations
Compliance advice

30 | Process
Low-cost gains
Simple improvements

800+ engineering jobs at virtual job fair

Fisher/Unitech has launched its second installment of No Engineer Left Behind, a virtual job fair for engineers. Fisher/Unitech, a software reseller with 10 Midwest U.S. locations, collaborated with 6Connex to make over 800 jobs available leveraging the 6Connex Virtual Experience Platform. The virtual job fair can be accessed at http://funtech.veplatform.com and will be online through Nov. 30, 2009.

The virtual job fair is a continuation of these companies' community service commitments to helping displaced designers and engineers get back on their feet, the companies say. Through 6Connex, the pioneer of virtual technology solutions, the company is offering this service at no charge to exhibitors or attendees.

Interested candidates will find over 25 exhibiting companies such as GE Lumination, Nook Industries, Utilimaster, Haworth, SolidWorks Corp. and SPX amongst the exhibitors looking to hire. An entire hall is dedicated to the Society of Manufacturing Engineers (SME), with more than 800 job listings, information on member benefits, technical communities, local events, and professional development resources as well as an area for displaced workers to apply for SME membership at a reduced rate.

Candidates can log on to the virtual job fair any time and visit company booths loaded with media-rich content such as corporate videos, audio files, PowerPoint presentations, white papers, case studies, Web links and more, in addition to viewing job openings. Fisher/Unitech is planning three live chat days where booth representatives will be online to answer questions, interact with job seekers and accept resumes online via chat sessions. Live dates are available in October and November.

ISA approves first ISA100 standard in wireless series

The ISA Standards & Practices Board (S&P) voted to approve the ISA-100.11a wireless standard "Wireless Systems for Industrial Automation: Process Control and Related Applications," thereby making it an official ISA Standard. The approval of this major new industry standard by the ISA S&P Board certifies that ISA's accredited procedures have been followed in the development of the standard.

The standard received final approval by the ISA100 committee in July of this year with 81% of the voting members approving, before being passed along to the ISA S&P Board. With the ISA S&P Board approval, the ISA-100.11a standard will now be submitted to the American National Standards Institute (ANSI) for approval as an ANSI standard, and will be submitted to the International Electrotechnical Commission (IEC) for consideration as an IEC standard. ISA100 standards committee approval came in April.

"The ISA-100.11a standard was developed by a committee consisting of over 600 end users and equipment manufacturers from around the world, and represents a truly consensus standard created in an open, unbiased forum by a global team of industry experts," said Wayne Manges, ISA100 co-chair from Oak Ridge National Laboratory. The ISA100 committee was established by ISA to address wireless manufacturing and control systems in areas including:

- **The environment in which the wireless technology is deployed;**
- **Technology and life cycle for wireless equipment and systems; and**
- **Application of wireless technology.**

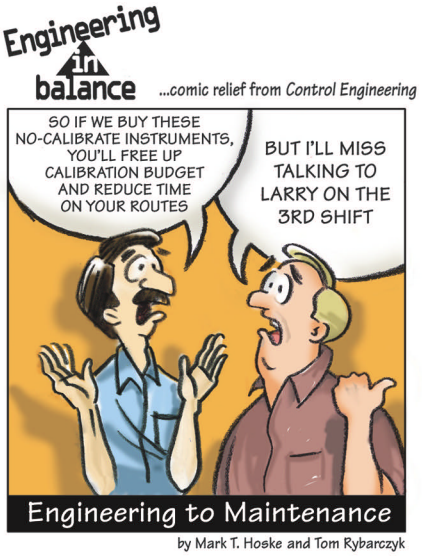
The ISA-100.11a standard is intended to provide reliable and secure wireless operation for non-critical monitoring, alerting, supervisory control, open loop control, and closed loop control applications. The standard defines the protocol suite, system management, gateway, and security specifications for low-data-rate wireless connectivity with fixed, portable, and moving devices supporting very limited power consumption requirements. The application focus addresses the performance needs of applications such as monitoring and process control where latencies on the order of 100 ms can be tolerated, with optional behavior for shorter latency.

"To meet the needs of industrial wireless users and operators, the ISA-100.11a standard provides robustness in the presence of interference found in harsh industrial environments and with legacy non-ISA-100 compliant wireless systems," said ISA100 co-chair Pat Schweitzer of ExxonMobil. The standard addresses coexistence with other wireless devices anticipated in the industrial workspace, such as cell phones and devices based on IEEE 802.11x, IEEE 802.15x, IEEE 802.16x, and other relevant standards. Further, the standard allows for interoperability of ISA-100 devices.

The standard is available at *www.isa.org/ISA100-11a.*

Motor control

Small motor 16-bit MCU



Where in the World is *Control Engineering* contest results

Control Engineering **is everywhere! Our readers responded to our "Where in the World is *Control Engineering*" contest with some real creativity and a great sense of humor. The contest asked participants to submit a photo of them reading *Control Engineering* wherever they happened to be this past summer.**

A slide show of submissions can be seen at http://tinyurl.com/witwice. The slide show video shows all the photos submitted, including those from readers competing for the coveted winners' spots on our November cover, and a few more from *Control Engineering* staffers sent in just for fun.

From the Renaissance to the Panama Canal to the barn yard, *Control Engineering* readers prove themselves to be a loyal and imaginative lot.

Watch for the winners on our November cover.

Correction

Control Engineering **North American edition, August 2009 article, "Industrial Networks: Open Source," made an unverified claim about Ethernet protocol speed. The article is correct online at www.controleng.com/archive. *Control Engineering* regrets the error.**

Manufacturers call for federal strategy to transform factories

A group of manufacturing industry representatives—including the National Association of Manufacturers (NAM), American National Electrical Manufacturers Association, the Manufacturers Alliance, and Rockwell Automation—has gone on record noting that a federal strategy and support is critical if American manufacturers are to thrive in the post-recession global economy.

This transformation to smarter, safer, and more sustainable manufacturing provides an opportunity for the federal government to help develop and make innovations in American plants to keep them competitive and to promote a sustainable U.S. manufacturing employment base, industry representatives said.

"We all are pleased that President Obama has named a manufacturing czar to coordinate federal policy and programs to help U.S. manufacturers," Keith Nosbusch, Rockwell Automation chairman and CEO said. "Until 1990, federal support for applied research, which is most critical for manufacturing, was equal to federal funding for basic science. But today it is about 30% lower, with nearly a $10 billion gap that needs to be remedied. Congress also needs to expand federal tax credits to apply to investments in smart, safe, and more sustainable manufacturing technologies."

U.S. manufacturing costs are nearly 18% higher than in America's nine largest trading partners, putting the 13.8 million U.S. manufacturing jobs at risk. The European Union allocated about $2 billion to encourage its manufacturers to invest in the next generation of technology for energy efficiency and productivity.

Industry leaders request the following federal government actions:

- **Ensure legislative priorities are in line with those of manufacturers and the general public;**
- **Double federal funding for manufacturing innovation;**
- **Establish a $2 billion public-private partnership program to research and develop a manufacturing "greenprint" for smart, safe, and sustainable manufacturing;**
- **Provide federal assistance for public-private partnerships to create demonstration projects that foster manufacturing innovation; and**
- **Expand federal tax credits to apply to investments in advanced technologies that automate and modernize factories.**

Siemens and Winergy open 'green' wind turbine manufacturing facility

Winergy Drive Systems Corp. and Siemens Drive Technologies have opened a second plant in Elgin, IL, to meet the growing demand for alternative and renewable energy sources. The new plant currently stands at 170,000 square feet, but can be expanded up to 330,000 square feet. Winergy is said to be the largest producer of wind turbine gear drives in the United States.

The company's first plant in Elgin will be maintained to manufacture the gears and components that will be assembled and tested in the new plant. It will also house the services and repairs business.

The new plant is expected to create approximately 300 new jobs in production and 55 new office jobs over the next three to four years—which is more than double the current number of employees in the original Elgin plant for mechanical drives.

Wind turbine manufacturing at new Siemens/Winergy plant in Elgin, IL.

One of the first in Illinois to receive environmental LEED certification, the new plant was built using recycled steel and designed with Siemens energy efficient lighting and heating and cooling systems, which are expected to save $500,000 annually in energy costs and reduce annual water use by 250,000 gallons. Siemens invested more than $20 million to build the infrastructure needed to equip the new plant for production.

The state of Illinois and the city of Elgin provided a number of incentives to Siemens to help secure the investment, including a Wind Energy Development Grant and Employer Training Investment Program job training funds.

BLOGS | PODCAST | WEBCAST | VIDEO

Technologies for regulatory compliance

Regulatory compliance is an issue which is becoming increasingly critical for manufacturers. To help you avoid unnecessary penalties, this Webcast will examine existing technologies and processes that can be employed to help ensure compliance, including:

- Use of wireless sensor networks to monitor process applications and environmental factors for regulatory compliance.
- Product development guidelines manufacturers must follow to stay in compliance with federal regulations.

Discussion Host: David Greenfield, editorial director, Control Engineering

Discussion Panelists: Christian Fritz, product manager for motion control and mechatronics, National Instruments; and Nick Butler, product marketing engineer for the Wireless Sensor Network Platform, National Instruments

The Webcast can be viewed at: http://tinyurl.com/cewebcast-compliance09.

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news

ABB's 800xA controls biofuel manufacturer's food waste to fuel process

St1 Biofuels Oy in Finland is a bioethanol producer making biofuel from food waste, which it claims can reduce carbon dioxide emissions by up to 80%. The fuel, RE85, for flex-fuel vehicles, is 85 parts ethanol blended with 15 parts gasoline components and additives. It is 42 cents per liter less than 95 octane gasoline. St1 uses small, centrally controlled, automated plants to produce the fuel. The plants are controlled from a central location. Ethanolix processing units devised by St1 create a dilute biofuel using a process controlled by ABB's Extended Automation System 800xA. The real-time database system for continual monitoring, reporting, and analysis controls everything: valves, activation of safety locks, and automatic cleaning.

Three Ethanolix units like this one are in operation, and two are expected to open soon. St1 Biofuels Oy plans to build up to 15 units by 2014.

Low-cost, high-return process control improvements

George Buckbee, P.E., is vice president of marketing and product development for ExperTune and he is writing a three-part series on process control improvements for *Control Engineering*. Following is an excerpt of the first installment of that article; the full version can be found online at www.controleng.com.

Your plant's control system acts as the nervous system for a process unit or maybe your whole facility. It provides sensing, analysis, and control of the physical process, and sits between the operator and the process. When it's running at peak performance, process variability is reduced, efficiency is maximized, energy costs are minimized, and production rates can be increased.

Unfortunately, most process plants are full of inefficiencies and losses. For example, a typical process plant will have as many as 30% of control loops running in manual. Many of those loops are in manual because of an underlying problem with the instruments, control valve, or controller.

The road to improvement begins when you're able to spot these issues and address them. Let's start with a simple exercise that proves the concept.

Improvement #1 - Compressed air, which is used to actuate control valves (among other things), is actually one of the most expensive utilities in your plant! You use expensive electricity to (inefficiently) compress air, and then transport it all over the plant through leaky tubes. Compressed air leaks not only cost money directly, but these losses can be large enough to require more or larger compressors.

The next time you have a shutdown, leave the compressor online. Take a spray-bottle full of soapy water and a wrench, and walk through the plant listening for the telltale hiss of leaky air lines. Spray some soapy water on the air tubing connections to see which one is leaking, then tighten with the wrench.

Does this really save money? Just how expensive is compressed air? If you know your plant's cost per kWh, you can estimate the cost per year for 1 SCFM (standard cubic foot per minute) of air: 0.25 hp/SCFM x 0.745 kW/hp x 24 hr/day x 365 day/year x cost/kWh. At a typical industrial rate of $0.06/kWh, this is roughly $98/year for each SCFM. And this figure does not include the capital, depreciation, and maintenance costs for the compressor, dryer, and distribution system.

SME and Purdue University collaborate to offer Green Manufacturing Specialist Certificate

To correct the perception that green jobs will only be found related to renewable energy—think solar panel installer or the wind turbine technician—the Society of Manufacturing Engineers (SME) and Purdue University note that there are also numerous green *manufacturing* jobs that are ideal for manufacturing workers with the proper skills.

Citing instances such as an existing manufacturing worker in the aerospace industry who has skills in composites that can almost seamlessly transfer to making wind turbines, Kris Nasiatka, certification manager at SME, said: "These types of jobs are ultimately good news for a former auto machinist, welder or fabricator with in-demand skills, but who may need additional training to meet requirements for green manufacturing jobs."

To help pave the way for those with specialized manufacturing skills looking . . . to add sustainability topics to their body of knowledge, SME is collaborating with Purdue University's Technical Assistance Program (TAP) to develop the Green Manufacturing Specialist Certificate.

The Purdue TAP curriculum focuses on such topics as sustainable manufacturing, energy efficiency, water conservation, reuse and recycling, designing for the environment, and how different pollutants affect the environment.

The program came together as part of a U.S. Department of Labor funded program in North Central Indiana. "Our goal was to provide training that would help people become more effective in their existing jobs or help them transition to jobs with new companies in emerging green industries," said Ethan Rogers, manager energy efficiency services, Purdue University TAP.

And while there are other green programs available, Rogers said, "No other program offers validation that a student has a comprehensive understanding of the many topics that comprise sustainable manufacturing."

This partnership involves SME developing an accompanying exam or outcome-based assessment, which will be tested by participants in the Purdue TAP green work force training program. Upon successful testing in Indiana, SME plans to offer the exam nationwide.

Beyond a broad course of study, the Green Certificate is said to also offer varying levels of learning intensity.

"The generalist level is intended to provide awareness, while the specialist level is intended to create project champions who have a more comprehensive body of knowledge," said Rogers. "Upon completion of the six specialist modules, they are ready to sit for the SME exam and earn an SME certificate."

Embedded controls cut small engine emissions; set motorcycle speed record

As emissions regulations increase worldwide and gas prices continue to rise, the small engine market is migrating from the use of mechanical carbureted systems to cleaner, more efficient electronic control and electronic fuel injection (EFI). To service this trend, Freescale has combined an integrated analog device with a 16-bit microcontroller unit (MCU) to provide a cost-effective platform solution for small engine control.

The platform consists of: Freescale's MCZ33812, an analog integrated circuit (IC) designed to control fuel and spark in EFI and electronic carburetion (e-carb) systems; and a Freescale S12 MCU. According to Freescale, this small engine control platform helps lower emissions in addition to reducing system complexity and engine footprint, bills of material required for motor system production, and manufacturing cost.

Target applications for Freescale's small engine control platform include small-displacement two- and four-stroke engines used in motorcycles, mopeds, and outdoor power equipment, such as lawnmowers, garden tractors, trimmers, edgers, chainsaws, snow and leaf blowers, tillers, electrical generators, and outboard motors.

The MCZ33812 analog IC impacts complexity, footprint, and costs because it combines a voltage regulator, fuel injector driver, and ignition pre-driver, as well as a relay and lamp driver, watchdog timer, and reset generator optimized for small engine control. In all, Freescale notes that this integration of IC and MCU eliminates up to a dozen discrete components and reduces the circuit board area for engine makers.

According to Freescale, the use of EFI systems on small engines can help reduce carbon monoxide emissions by up to 65%, hydrocarbons by up to 35%, and nitrogen oxide by up to 35% compared to carburetor systems. EFI-equipped small engines also increase horsepower and improve gas mileage.

Freescale field application engineer Jesse Beeker preparing for a speed trial at the Bonneville Salt Flats on a Daysun motorcycle outfitted with an ElectroJet fuel injection system using a Freescale S12X MCU.

Specific horsepower and fuel efficiencies were not be quantified by Freescale, as calculating this difference varies depending on the motor starting point particular to the OEM. However, the company notes that, as a result of changing to a closed loop electronic engine control system, the combustion process is monitored and controlled to always contain the proper ratio of fuel to air. The engine control unit (ECU) also determines the best time to fire the spark. These processes are governed by calibration tables that the manufacturer determines through engine dynamometer testing and are programmed into the ECU. These calibration tables can be optimized for maximum power, maximum fuel efficiency, or minimum pollution.

The MCZ33812 is a commercial grade device available at a suggested resale price of $1.70 in 10,000-unit quantities.

In related news, Jesse Beeker, a Freescale field application engineer, set four world land speed records during Speed Week (August 8-14, 2009) at the Bonneville Salt Flats in Utah. The records were achieved by Beeker in the 175cc pushrod motorcycle classes riding 150cc Dayun motorcycles, which feature an ElectroJet fuel injection system using a Freescale S12X MCU. His highest record speed during the Bonneville Speed Week was 63 mph. By comparison, most carbureted production motorcycles with four-stroke engines with displacements below 175cc generate approximately 6-8 horsepower and are designed to reach top speeds of up to 55 mph.

New control system platform version rethinks field device connectivity, human interface

At its Global Users Exchange in Orlando, FL, Emerson Process Management announced the new DeltaV S-series platform with two major advances: a new concept of I/O on demand through a device communication approach dubbed electronic marshalling, and changes to its interfaces and work practices based on human-centered design.

The new I/O on demand concept places small modules called CHARMS (CHARacterization ModuleS) into field cabinets near the devices. A CHARM is a single-channel analog-to-digital converter that takes the signal from one instrument and converts it for transmission on an Ethernet backplane. It handles all necessary power requirements for the device, and replaces the traditional I/O card for the DCS or PLC.

CHARMS are designed to communicate using various device protocols: analog in or out, digital in or out, HART, thermocouple, RTD, etc. Fieldbus segments and wireless gateways can also be integrated into the system.

Emerson says this approach eliminates two-thirds of the wiring and connections needed by today's conventional marshalling cabinets. Whereas traditional project engineering requires major time and cost in changing rack-room I/O wiring and terminations as process design is refined, the DeltaV S-series hardware with electronic marshalling makes changes easy and eliminates re-wiring.

Emerson also claims the new Delta V S-series launches a new approach to understanding how users apply and interface with its products. The new release includes major enhancements to all of the systems' I/O processing, operator displays, asset management, batch capability, and system security elements. These new capabilities include an entirely new set of visually focused operator displays that improve operator performance by clear and quick recognition of alerts, and rapid access to the information needed to understand the alert and act in a timely fashion. The new capabilities of the v11 software release offers a wide-ranging new solution set for process automation users, and is backward compatible with existing DeltaV installations.

15 summaries on this page are described in greater detail on the *Control Engineering* Website. Use the search box at the top of www.controleng.com and type in keywords, such as hybrid motorcycle or Cybernet, to see more on each item.

2 motives: A hybrid motorcycle, being built by Orange County Choppers and Schneider Electric, integrates an intelligent energy management system.

5 "most popular articles" at www.controleng.com in late September included a handheld infrared thermometer (and other sensors), microenergy cells, and a new control system platform.

10.4 -in. human-machine interface can give as much pixel coverage as a traditional 12-in. unit, according to Maple Systems.

11 suppliers of wind turbines larger than 1 MW and 15 component suppliers are listed in the online *Control Engineering* article: Winds of Change for Power and Control.

>12 automation, control and information events were listed on www.controleng.com/events, as of late September. Plan now for events occuring through the end of the year.

>25 MW within two years is expected to be added to the 60 MW being produced from landfill gas at Innovative Energy Systems plants in New York and Vermont, says GE Fanuc Intelligence Platforms.

$30 is the admission price to see a fully autonomous ground vehicle at an Oct. 23 Cybernet event in Michigan. RSVP by Oct. 20.

45% annual increase for U.S. solar manufacturing, 2008-2012, says GTM Research, could create create 20,000 jobs by 2012.

$31,650 was the fine assessed to a glass manufacturer in Pennsylvania for air quality violations. Also required was implementation of emissions monitoring devices, to ensure compliance. A batch wetting system was installed on the unit to control particulate matter emissions. More than $50,000 in fines also were assessed in 2006 and 2007.

60 frames per second is the refresh rate for a virtual reality stereoscopic headset used with the EyeSim simulator from Invensys Operations Management. Using the headset, a 3D projector and plant simulation software, trainees experience 3D interactions with actual process control situations.

>90 days was the pace from first meeting to completed Smart Grid standard, NEMA says. The application level standard, called SG-AMI 1-2009 Requirements for Smart Meter Upgradeability, advances interoperability for modules and meters.

2 new U.S. Department of Energy (DOE) grants went to CyboSoft for "Intelligent Industrial Furnace Control Using Model-Free Adaptive Control Technology" and "Intelligent Actuation Control Using Model-Free Adaptive Control Technology."

>100 new B&R products received UL certification, including X20 SafeIO modules.

32-bit microcontroller (MCU)-based robotics development kit from Microchip Technology is available through Digilent Inc. to address the growing interest in robotics applications in the academic and hobbyist markets. The Cerebot 32MX4 is designed to work with Digilent's Robotic Starter kit.

8.5: Opto 22 PAC Project 8.5 automation software suite supports recent additions of more Ethernet-based components: intelligent Snap I/O processors ("brains") and Snap PAC standalone and rack-mounted programmable automation controllers with wireless LAN (Wi-Fi) capabilities referred to as Wired+Wireless hardware.

got numbers?

Include info shown above, put "By the Numbers" in the subject line, and e-mail to *controleng@reedbusiness.com*. Include contact info for verification.

DNA-level machine design

ONLINE

See this at Oct.'09 www.controleng.com/archive for

- Machine design help;

- "Behavioral automation," June 2009 Think Again;

- More on DNA research.

Today's machine designers integrate engineering strategies inherent in human genetic designs. Latest theories on DNA-level adaptations in organisms align with how mechatronic designs in machinery increase productivity, agility, and the survival of manufacturing.

Symbiogenesis is a biological hypothesis that says genetic adaptations can result from a DNA-level merging of two interdependent organisms, rather than random mutations followed by survival of the fittest. For your well being, successful adaptation, and survival, here are examples of how automated machine design strategies parallel symbiogenesis.

■ Few machines are engineered from the ground up for good reason. After careful consideration of physical designs most appropriate for the machine's application, engineers incorporate commercial-off-the-shelf (COTS) technologies — such as power supplies, programmable automation controllers, and human-machine interfaces — to speed development. Internal relationships follow external environmental needs. Interdependent designs allow original equipment manufacturers (OEMs)

> "Creative engineering uses technology interdependence."

to advance machine capabilities faster than migrating self-engineered systems. In human biology, more than 1,000 symbiotic organisms reside within us, performing many functions we haven't taken time and energy to develop ourselves.

■ Board-level integration can happen when controllers may not fit into the application — a box within a box can be unnecessary. Intelligence previously available in a small enclosure can migrate onto embedded, board-level products. Similarly, DNA, the building blocks of life, once thought to reside only within a cell's nucleus, now is known to reside and function outside a cell's "control cabinet."

■ Microprocessors have broken free of controllers, migrating to other areas of the machine. Distributed intelligence, embedded in sensors, actuators, and I/O modules, brings new speed and functions. Chromosomes in humans, and other organisms, include genes from symbiotic organisms, in similar capability integration.

■ Just as machine designers widely tap expertise of automation vendors and system integrators, scientists seek help from each other's observations and research to learn, guide, and fill gaps in understanding.

Like living organisms, machines and processes built with creative engineering and interdependent technologies adapt more quickly, are more flexible, and build on each others' strengths for a more promising future.

Mark T. Hoske, *editor-in-chief*
mhoske@reedbusiness.com

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"The main advantage of ISA membership has been networking with others in the same profession. When I was an employee, I got all my past jobs in California directly or indirectly from ISA contacts. And since we started our own company, we have had jobs result from ISA contacts."

John Prince
Analyzer Products Group, Los Angeles Section

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Proximity Sensors: How to Choose,

Latest trends in inductive, photoelectric, and laser sensors can help your implementation. Do lower costs, less aggravation, easier setup, and longer life make sense to you?

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Pepperl+Fuchs Extended Range Pile Driver inductive sensors have a stainless steel face and sensing distances up to 2.5 times those of previous models.

Matching the correct sensor to the application saves a lot of cost and aggravation with easier setup, proper operation, and longer life. Recent advances in inductive, photoelectric, and laser area sensing are giving users even more choices and enabling better decisions.

Sensor manufacturers have continued to innovate during the global manufacturing economic slowdown, and following positive economic predictions, proximity sensor sales are expected to strongly rebound in 2010, according to ARC Advisory Group; year 2012 proximity sensor shipments, for example, will exceed those of 2008. Brand labeling, partnerships, and modular design are among strategies sensor manufacturers are using to hold down production costs, says Florian Güldner, analyst and principal author of ARC's "Proximity Sensors Worldwide Outlook." Modular sensor designs build on a standard set of components and interfaces within the sensor, Güldner says, creating reusable subsystems that can be produced in large volumes and used across multiple product families. This enables suppliers to buy certain modular components built by third parties, keeping end user costs stable while enabling innovation.

> "Embedded intelligence in sensors can overcome challenges."

Choosing among inductive, photoelectric, and laser sensors requires knowledge about application requirements and sensor capabilities. Marcel Ulrich, product manager for Pepperl+Fuchs, explains the strengths and weaknesses of each type:

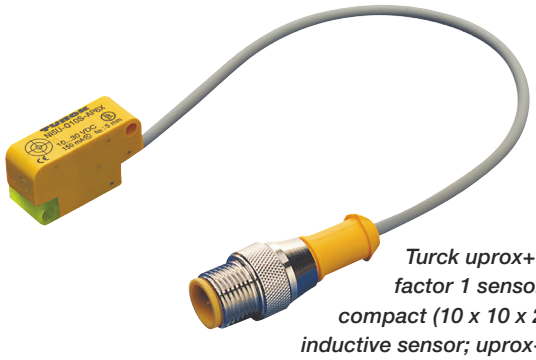
Inductive sensors detect changes in an electromagnetic field, so the target must be must be metal. Sensing ranges are short, typically within 2 in., and depending upon the physical sensor size, range often may be less than ½ in. Ulrich says inductive sensors are cost effective and robust (compared to photoelectric or mechanical types). They handle impact, mechanical shock, liquids, dirt, and dust without a sacrifice in performance. Shapes include tubular, cube, flat square and pancake.

Photoelectric sensors, as the name implies, project a beam of light and measure reflection to detect objects. Targets can be virtually any material. Distances range from thousandths of an inch for small fiber-optic models to several hundred feet for powerful through-beam types. Mechanical shock, dust, dirt, liquids and other contaminates can hinder optical performance. Variable target colors can cause difficulties for standard diffuse mode (direct detection) photoeyes. A myriad of specialty infrared and visible red photoeye options (fixed-focus, background suppression and fiber optic) can mimic laser precision at a lower price, says Ulrich.

Laser: Laser-based products, measuring time of flight, offer very precise optical detection, even at long distances. Although laser diodes have become more cost effective in recent years, laser-based photoeyes are the most expensive option of these three sensing technologies. Laser diode drawbacks, Ulrich says, include higher cost than other sensing technologies, temperature instability, limited life span, and eye safety concerns. (P+F has an "eye-safe" Class 1 infrared laser for sensing with a built-in Class 2 visible red laser for alignment.)

Selection help

To help determine the best technology for the application, sensor suppliers offer online and in-person resources, as well as printed literature. Eric Simmons, product specialist for Sick, says Sick application engineers ask questions about application details such as object detecting, ambient conditions, mounting considerations, and other



Turck uprox+ line of advanced factor 1 sensors includes the compact (10 x 10 x 28 mm) Q10S inductive sensor; uprox+ sensors detect all metals (including aluminum, copper, and steel) at the same distance without reinstallation, saving labor costs over traditional ferrite core proximity sensors.

Use Them

specifics. They may choose a sensor based on the initial description or request a target sample and drawing describing the application. "After receiving the sample and application details, the application engineer will be able to replicate the application at Sick and provide the recommended sensor type," says Simmons. Sick, and others, also offers tools such as a sensor selection guide.

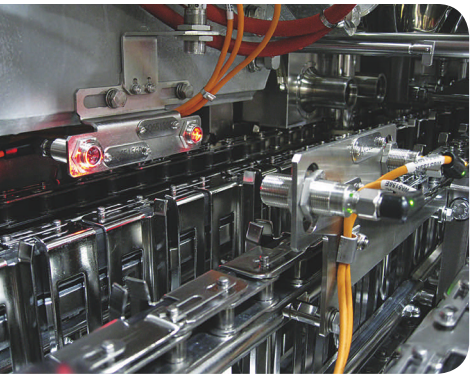
Schneider Electric Sensor Competency Center, created in 2005, incorporates sensors, technologies, and experts from the company's Hyde Park and Telemecanique business units. SCC, located in Dayton, OH, says it provides "a single, integrated resource for all its customers' sensor-related issues." The SCC website has products, tools, literature, distributors, cross-references with other manufacturers' sensors, newsletter, surveys, and videos, among other support and services. SCC's online sensor selection tool allows searching by ultrasonic, photoelectric, inductive, and capacitive sensors, and by model number or partial model number. This is useful when a part number is worn or documentation is unavailable. A "favorites" option allows comparison among various models.

Inductive sensing

For inductive sensors, technology advances have eased installation and improved durability, says Cory Nichols, sensors product manager from Eaton Corp. Recent improvements in Eaton cube and pancake style sensors include:

- *Auto-configuration*: Some sensors can detect on power-up and intelligently determine if they were wired for NPN (ground switching) or PNP (positive switching) and adjust mode automatically;
- *Embedded intelligence*: An onboard micro processor can provide potential for custom logic and allow factory customization in range and sensitivity, extending the range of sensor applications, including those with high electrical noise;
- *Rugged design*: Vibration and impact absorbing potting compound can be used inside the sensor, making it more durable in harsh environments, increasing temperature range for use in heavy-duty outdoor applications, in vehicles, construc-

Embedded intelligence has broadened sensor capabilities so fewer models of inductive, photoelectric, laser, and other sensors can be used in more applications, such as packaging. In this Elopak Pure-Pak aseptic filling machine, a rotating mandrel will grip cartons from feeder lines; ifm OG photoelectric sensors (bottom, center and p. 40) detect the carton height for proper filling.



ifm's OG washdown photoelectric thru-beam pairs, on either side of a chain conveyor, detect the leading edge and trailing edge of cartons (below) as they travel through the Elopak Pure-Pak aseptic filling machine. The sensor's visible red light source assists in alignment and can burn through water droplets on the sensor face.

tion equipment, industrial wrappers, machine tools, and automated assembly lines; and

■ *Flexibility*: Complementary outputs may be available, such as normally open or normally closed.

Nichols says complementary outputs and auto-configuration allow end-users, OEMs, or system integrators to purchase one unit that can resolve a wider array of challenging sensor applications, instead of stocking multiple sensors.

Karen Keller, strategic marketing manager for Turck, says inductive sensor designs also can help electromagnetic compatibility (EMC) and avoid electromagnetic interference (EMI). Factor 1 sensors use separate, independent sender and receiver coils, so that ferrous and nonferrous metals have the same affect and rated operating distances are equal, she says. By eliminating a ferrite core, Keller says, factor 1 sensors operate at a higher switching frequency and are immune to EMI from electric welding equipment, lifts, and electronic furnaces. Turck uprox+ products, including Q10S, are advanced factor 1 inductive sensors.

Intelligent photoelectric sensing

Embedded intelligence in sensors can overcome challenges related to changing targets and ambient lighting. The Sick W12-3 photoelectric sensor, Simmons says, uses Sick's third generation OES3 application-specific integrated circuit (ASIC) to help resolve four key challenges of background and foreground suppression.

Sick W12-3 photoelectric sensor, rated IP69K, withstands washdown environments, has rotating connections, and smart background and foreground suppression.

■ *Black/white shift*: Black on a target absorbs much more light than white. When a target changes color (either on the same package or after a recipe change), sensors may no longer detect the target, which would cause the sensor's output to turn off and then back on. This must be handled by software, or with readjustment of the sensor.

■ *Stray reflections* beyond a sensor's range may reflect back and flood its receiving elements. This could be caused by someone walking past with a reflective vest, a window being opened beyond the sensing range, a shiny object moving beyond the set point, and similar environmental changes.

■ *High frequency lighting*: New fluorescent lighting saves energy, but these high frequency lights can wreak havoc on photoelectric sensors, producing "chatter." Embedded intelligence can fix that.

■ *Another sensor's light source*: Cross talking occurs when two sensors are pointed at one another. Sensors are modulated to a unique frequency but may have instances when they are nearly in phase or a pulse is in the same modulation as its own light source. This can fool some sensors into thinking they see targets within the sensing range.

More sensor resources online

See this article online at www.controleng.com/archive for these additional resources, including a photo gallery of the Elopak-sensor application.

■ Tutorial video on sensors.

■ Applications using many sensors may benefit from using IEEE1451.4 Transducer Electronic Data Sheet (TEDS) to organize information about sensor manufacturer, model, and calibration, even with non-TEDS-enabled sensors, using a "Virtual TEDS" approach. Honeywell and National Instruments are among TEDS proponents.

■ Balluff BOS 50K photoelectric sensor has an extended range and enhanced background suppression. Learn more about this technology.

■ Carlo Gavazzi long range diffuse photoelectric sensor sees black up to 2 m, white and gray up to 2.5 m.

■ Honeywell smart position sensor can be seen in action, via a link to a Honeywell-produced video.

■ Omron Industrial Automation E2EC - 2-wire & 3-wire dc subminiature proximity sensors have inline amplifiers for greater mounting flexibility.

■ Siemens' new photoelectric proximity switches have special capabilities for handling delicate tasks.

Rockwell Automation Allen-Bradley VisiSight photoelectric sensors include a red light to help with alignment during set up. A stability indicator warns when the signal level is too close.

■ Sick laser measurement system sensors can be used for outdoor anti-collision and indoor profiling applications.

■ More sensors are on *Control Engineering*'s industrial sensor channel: www.controleng.com/sensors.

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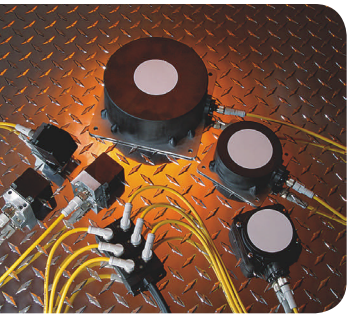

Left, top: Eaton E52Q cube and E56 pancake sensors come in industry-standard sizes, feature extended sensing ranges, and provide simplified installation and maintenance.
Left, bottom: Banner Engineering World-Beam QS30 Clear Object Sensor uses an advanced optical design that allows it to "see" translucent materials and clear targets, including PET bottles and glass containers.

Clear, reflective object detection

A fifth challenge for photoelectric sensors is clear object detection, suggested Dennis Smith, technical marketing engineer at Banner Engineering.

"Detecting clear objects is a difficult sensing challenge in many real-world situations," said Smith. The Banner Engineering World-Beam QS30 Clear Object Sensor controls how the emitted light striking the sensor reflector prevents false light signals from reaching the photodetector, Smith says. Design of the sensor allows its "microcontroller to detect small changes in the light level, so even clear objects that alter the light level only slightly will activate the sensor," he says, making it "a very sensitive and highly reliable clear object detector."

Another example is the new Allen-Bradley Visi-Sight line of general purpose photoelectric sensors from Rockwell Automation comes in a sealed, compact, cavity-free housing that minimizes the collection of dust and debris and allows easy sensor cleanup, company says. Various models target various applications: Diffuse models with an 800-millimeter sensing range provide adjustable sensitivity. Polarized retro reflective models with 3.5-meter sensing range come in adjustable or fixed sensitivity versions. Transmitted beam models provide 10-meter sensing distance, and infrared LED source models provide crosstalk immunity. A red light helps with alignment during setup and maintenance; a stability indicator flashes if the signal level is too close to the detection threshold. A patented ASIC provides linear sensitivity adjustment and noise immunity. **ce**

Mark T. Hoske, Control Engineering *editor in chief, can be reached at mhoske@reedbusiness.com.*

Washdown photoelectric sensors handle high temperatures, chemical sprays in filling machines

Packaging machines endure high pressure chemical sprays and temperatures from 20 °C to 100 °C, which can eat through traditional sensors like a kid in a candy store. Elopak, a New Hudson, MI, maker of carton-based packaging systems for non-carbonated liquid food and non-food products, endured problems associated with sensors that were not rugged enough for its aseptic filling machines. Seeking fewer sensor failures and better support, Michael Ballinger, Elopak manager of electrical engineering, and his team searched for a position sensor that better matched application requirements, including ability to withstand high temperatures.

The Elopak filling machine is central to the carton production process, completing most logistics for carton production. The filling machine forms, fills, and seals a carton before being safely packed into one of Elopak's material handling systems. A typical filling machine, the size of an overseas shipping container, can process up to 12,000 cartons per hour.

Aseptic filling machines create the toughest sensing environment. Elopak's model E-PL90HA filling machine enables customers to produce and fill cartons with acidic products that have a one-year shelf life. Cleaning cycles, which run every eight hours and last three hours, expose the machine and its control devices to temperature fluctuations from 20 °C to 100 °C, high-pressure sprays, and chemical sprays of Oxonia Active. During carton production, the machine and control devices are exposed to temperatures between 70 °C to 90 °C, and are subjected to a sterility chemical spray of 35% peroxide (H_2O_2).

While other machine parts were withstanding such exposure, position control sensors were failing under the intense cleaning. Water and chemical sprays caused condensation to build up inside the sensors, causing short circuits. In addition, water seeped inside cable connection seals and corroded the connection pins, causing failure. Large water droplets also formed on the sensor face, creating false signals or no signals.

Elopak found a solution in ifm efector's OG Series photoelectric sensors for washdown conditions. These have stainless steel construction, high temperature compatibility, and Ecolab certification. The 18 mm diameter sensors have an IP69K international protection rating, which ensures the sensor housing is dust-tight and can withstand high-pressure, high-temperature washdowns.

Ballinger says a high-intensity visible-red light source burns through water droplets on the sensor face, providing a reliable signal and assisting with installation alignment.

Sensor specifications and rugged construction also avoid "false signals or no signals that would result in bad cartons being produced," says Ballinger.

Labor is saved because machines no longer require frequent sensor replacements. Machine efficiency has increased with installation of the OG sensors, and productivity also has increased, says Ballinger. He is also pleased with service and technical support, and expects more cost savings in the long run.

See photos pages 37 and 40, with more photos and details, online.

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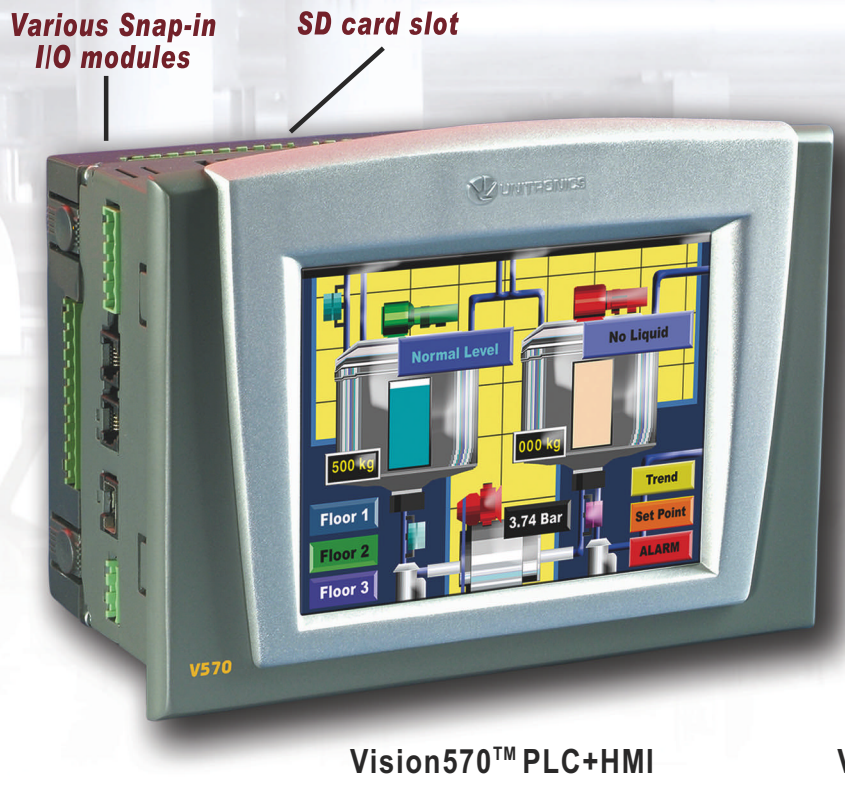

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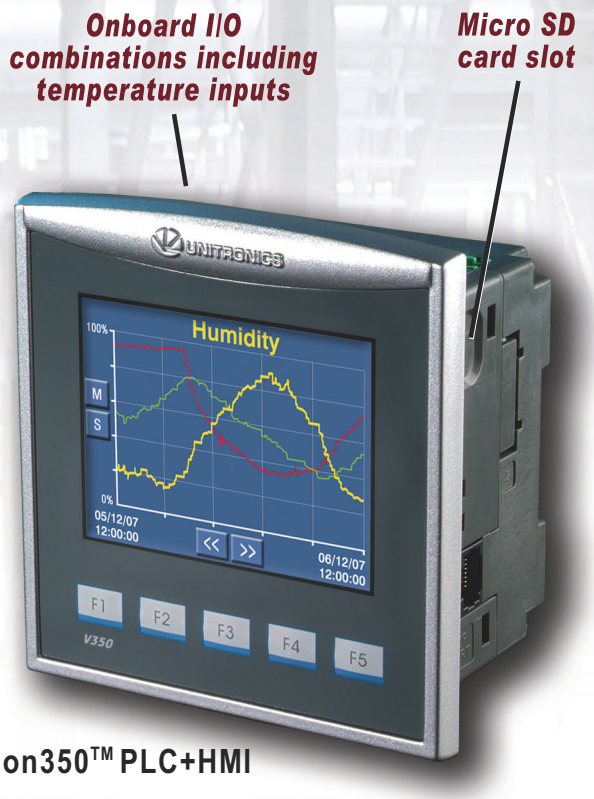

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When eBOMs and mBOMs converge

Product lifecycle management (PLM) software is linking manufacturing and engineering to improve manufacturing process management.

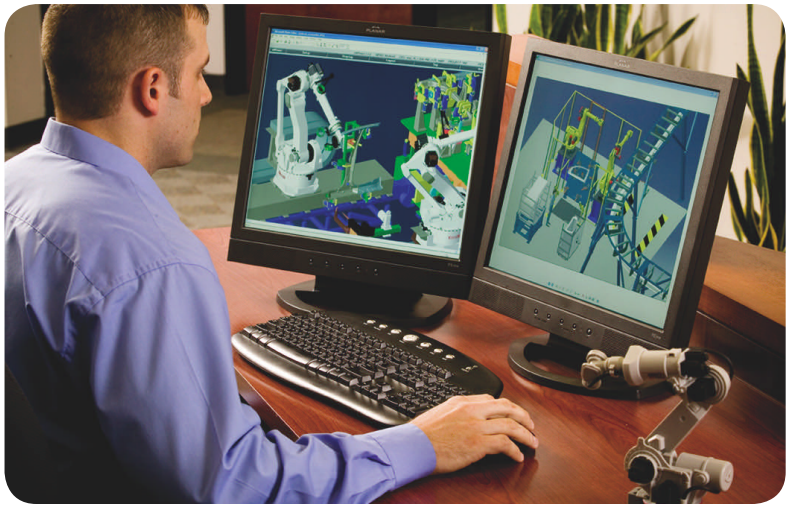
Frank O Smith
for Control Engineering

Product lifecycle management (PLM) is a business strategy that helps companies share product data, apply common processes, and leverage corporate knowledge for the development of products across the extended enterprise. As such, PLM software has gained the stature of being "the next big thing" in manufacturing enterprise information systems, assuming the mantle that ERP (enterprise resource planning) software carried in the 1990s.

PLM has attracted the interest of major software vendors eager to participate in its expanding functional footprints, and analysts who spin fetching scenarios for how PLM will transform manufacturing as we know it. The truth is, although few are fully there yet, significant steps *are* being made by system integrators and pioneering manufacturers. The focus—and progress—today seems to be where engineering and manufacturing meet: in the distinct but related bills-of-materials that each group creates.

Like ERP, PLM is not entirely new: It's built upon the legacy of its numerous component parts, including computer-aided design (CAD), computer-aided manufacturing (CAM) and product data management (PDM). PLM as a tool for manufacturers gained sizeable momentum and credibility in 2007 with Siemens' $3.5 billion acquisition of PLM software vendor UGS. "Design for manufacturability"—the banner for the evolving promise of tying design more integrally with manufacturing—became recast as "digital manufacturing." The vision is that technology will virtualize every aspect of product design and manufacturing, from concept to customer.

"Siemens' vision for connecting all the pieces is clearly where the industry needs to go," says Joe Barkai, analyst and lifecycle strategies practice director for IDC Manufacturing Insights. Nick Ballard, senior consultant for Cambashi, a U.K.-based industry analyst firm that closely tracks PLM, concurs: "Siemens' acquisition of UGS was a serious sign of intent in the marketplace."



PLM software can help engineers get things done—from concept to production—faster and cheaper. Source: Siemens PLM

PLM progress from many angles

Dassault Systemes is another major PLM vendor with an emphasis on 3D online environments dubbed "PLM 2.0." Dassault has pushed aggressively to keep pace with Siemens to reach down into the automation layer, largely through partnerships with companies like Rockwell Automation, Mitsubishi, and others. Both Siemens and Dassault fly the digital manufacturing flag, promoting comprehensive simulation of the entire process flow, from design to production and including "virtual commissioning"—the programming and testing of PLCs, robots, and the like based on CAD parameters.

PTC, a smaller, but very capable PLM vendor, puts greater emphasis on "process definition" built around its manufacturing product management (MPM) module. Autodesk, the world's largest CAD vendor, approaches the market differently, gaining entry under the moniker of "digital prototyping." Not as comprehensive, but equally committed to the market, are large ERP vendors like SAP, Oracle, Infor and others who are driving toward PLM from their enterprise system roots.

> **"Once you have the product definition and interdependencies with actual production processes captured and understood, workflow manages the change process in terms of automating the routing and approval process."**
>
> *Roy Wildeman of Forrester Research*

The potential impact on the functions of control and manufacturing process engineers is implicit in the vision of digital manufacturing. But outside the aerospace, automotive and a few isolated instances in other industries, "PLM ambition is still ahead of reality, like it was with ERP," says Tony Christian, principle consultant for Cambashi. Says Barkai of IDC: "I'm somewhat disappointed that the pace is not faster, pushing down toward the automation layer." But as yet, "it's been harder to clearly demonstrate and quantify the value." Which is not to say that the value is non-existent, experts say. Comprehensive simulation of production processes and virtual commissioning of automation lines are still more vision than reality, but there are growing examples already in play.

Time is cheaper in the virtual world

Advanced Manufacturing Technology (AMT) is a manufacturing system engineering firm based in Orion, MI. "We provide engineering solutions to everybody in the production food chain. We do hands-on programming and commissioning of robots, control programs, line start up, commissioning support, and system documentation," says Andy Jones, account manager for AMT. "With the economic challenges today, people want to get things done—from concept to production—faster and cheaper than anyone else."

To help its customers, AMT uses a variety of tools it's developed, as well as commercial PLM tools from various vendors, including Siemens. AMT is engaged currently with a large automotive OEM to do pioneering work in virtual commissioning of automation lines. That customer uses Siemens PLM Teamcenter, a central repository for all product and process data, as its engineering backbone.

"Working in the virtual world gives you the ability to evaluate product changes and how they impact production before they hit the plant," says Jones. "From a control engineering perspective, it enables you to take PLC or HMI systems and program and debug them virtually, verifying all faults before moving to the floor."

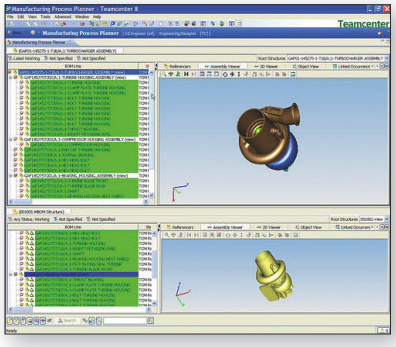
Commissioning a system on the floor is costly and time consuming, Jones says, and even if PLM software "doesn't save you time, it changes where you spend it. Time is a lot cheaper in the virtual world, and there's a lot less risk. When [a new machine] hits the floor, everything is in steel, and process changes are tremendously more expensive."

AMT is piloting the virtual commissioning work with the automotive OEM, but looks to leverage that expertise across a variety of customers in other industries. "Though everyone wants to go faster, you can't speed up things without first ensuring that the process is reliable," Jones says.

Production code from 3D drawings

A.T. Ferrell Company of Bluffton, IN, has been making equipment for cereal and grain processors for more than 140 years. It does its machinery design in Autodesk Inventor, a 3D CAD tool. "It gives us the opportunity to test different ideas while creating designs, to test functionality of the designs before we make prototypes or put them into production," says Allen Gager, design engineer and CAD manager.

Once the design is final, A.T. Ferrell uses Edgecam, a third-party CAM tool, to open the design stored in the Autodesk Vault repository to create all production machining code directly from the 3D drawing. Edgecam "programs all the machine code necessary to produce that part. You can apply various functions to select types of tools you'll need, the feed rates and RPMs," Gager says. "Before, you'd have had to do it all manually. It's a huge time savings, and you eliminate all translation errors previously caused by part geometry complexity."



Teamcenter Manufacturing software lets users validate the completeness of parts in an mBOM. New, changed or deleted parts are shown in a graphical way to easily identify the items which require an action of the manufacturing engineer.
Source: Siemens PLM

Increasingly, product design is becoming less an isolated, siloed process. "If you look at where innovation is coming from, it's no longer simply a technical invention process done in the lab," says Roy Wildeman, senior analyst for Cam-

ONLINE

For more on PLM's expanding influence on the plant floor, search www.controleng.com for the following articles:

PLM software advances announced by Dassault, Siemens, Autodesk, Oracle

PLM: 3D Process Simulation Delivers

Siemens PLM adopts S1000D to tackle sharing of technical information

Product data management systems ready for small, medium companies

Digital manufacturing: Autodesk Inventor shows component interactions

"(PLM) enables you to take PLC or HMI systems and program and debug them virtually, verifying all faults before moving to the floor."

Andy Jones of system engineering firm Advanced Manufacturing Technology

bridge, MA.-based Forrester Research. "It's more the result of the intersection with other cross-functional areas like marketing and sales who more clearly understand customer requirements and the need for quality."

Similarly, leading manufacturers are wanting downstream areas responsible for translating design into production processes—including manufacturing and process engineering—to become more seamlessly integrated into the process. "Desire to streamline the process has necessitated a link between product design itself and planning the manufacturing process needed to produce it," says Marc Halpern, research director at Gartner. "When you design a product and create an engineering bills-of-material (eBOM), you want to give manufacturing sufficient lead time to create the production infrastructure to ramp to capacity as quickly as possible. Manufacturing process management (MPM) is the umbrella for this linkage. "

MPM is a key component of PLM, the digital pivot point between design engineering and manufacturing process engineering. (The "P" in the acronym alternately designates both manufacturing "product" and "process" management.)

"Manufacturing engineering is always interested in how things are going to be done," says Francois Lamy, vice president of manufacturing product management for PTC. "Its function is to take engineering design data and create manufacturing information in terms of part structures for subassemblies, and for the design of workstations and lines required to produce them."

The mBOM is where manufacturing process management comes alive. "The eBOM might clearly show that one part needs to be glued to another, but it might not specify the glue or the applicator," says Halpern. Getting into the details of how and when in the process is at the heart of the mBOM.

MPM tools facilitate the ease and speed with which manufacturing engineers can take the eBOM and convert it into an mBOM, often using cut-and-paste functions that aid translation of product design into manufacturing processes. eBOMs and mBOMs basically have the same component elements and materials, but they're organized differently toward achieving different ends.

With a tight, bi-directional link, manufacturing engineering might readily determine, for example, that screws would be a better fastening medium than glue. It then can digitally transmit this engineering change request back to design quickly, prompting a tweaking of the originating eBOM. A tight linkage also enables timely updating and notification of engineering change orders back into manufacturing, so production is always working to the latest version of design, improving efficiency and eliminating scrap.

Workflow synchronization

Workflow is an elemental technology in this bi-directional communication. "Workflows have expanded overtime to reach outside of engineering design into manufacturing, so manufacturing can see what changes are occurring. Once you have the product definition and interdependencies with actual production processes captured and understood, workflow manages the change process in terms of automating the routing and approval process," says Wildeman.

"Manufacturers have always struggled with keeping the manufacturing BOM in synch with the engineering BOM," says Dave Shuey, director of marketing for Siemens PLM Tecnomatix product. "This is a non-trivial issue. People don't always appreciate the delays that changes in the engineering bills-of-material can cause in the production process."

The non-trivial nature of synchronization includes not only the eBOM/mBOM issue, but also the full scope of the PLM vision for digital manufacturing. Challenges are many when it comes to the accurate translation of data from 3D geometry to parts lists, physical production processes, work instructions, and ultimately automation equipment control code.

"The key take away in talking about digital manufacturing is the vision for an end-to-end process. When you start to design a product, you have to look at a number of things, including how it will be manufactured," says Dick Slansky, senior analyst/research director for PLM at ARC Advisory Group. "Digital manufacturing takes it all the way from design to production simulation, on down to automated execution on the line. This is the vision for PLM today."

PLM's integrated software modules, bi-directional data communications, and three-dimensional virtual environments are moving that vision closer to reality for manufacturers and system integrators in all industries. **ce**

Frank O Smith is a contributing editor to Control Engineering.

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Integrated Safety: Has its Time Arrived?

Engineers, integrators, and industry representatives offer a variety of viewpoints on this hot button topic. Through all the discussion, one thing is clear: Consensus has yet to be reached. Where do you stand on this issue?

David Greenfield
Control Engineering

The first discussion topic from our social media groups that we have chosen to feature in the pages of *Control Engineering* is a heated one—integrated safety. For years now this has been an ongoing discussion among the engineering community as more and more automation functionality is integrated into control devices and control devices are integrated into automation (e.g., mechatronics). While most such integrations clearly improved functionality and have been largely welcomed by the industry, the issue of safety integration on a controller has received a different reception.

Very quickly, separate camps evolved around this issue—and they formed nearly along the same lines as such camps tend to around a political issue or party. One camp is clearly for the idea of integration, while another camp is clearly against it. The third camp—we'll call them the moderates—think the idea of safety integration has potential, but often seeks to clarify the term "integration" or defers to standards to guide their safety implementations.

The discussion that frames this article began on *Control Engineering*'s social media groups after a link was posted to a blog posting by Charlie Fialkowski of Siemens on Safetybase.com. Here's what Charlie said in his blog:

"I believe that one day it will only take one control system to automate your critical process. That's right, there will be a day where it is commonly accepted that a single platform can and will provide both control and safety shutdown operations. The system themselves will be able to provide the logical separation necessary to comply.

"However, before this comes to fruition, it will take much work on system manufactures to provide a hardened platform that is both capable and reliable to take on this responsibility, and even more importantly plant owner/operators to have the diligence to instill complete safety lifecycle procedures at their facilities. Some manufactures may argue they're already there."

Very quickly, comments were posted to our groups clearly in favor of the integration idea.

"I agree with Charlie's basic premise. Smart safety is where things are going," said Ed Diehl, co-founder and executive director of Concept Systems Inc. Clarifying his position, Diehl noted that "smart safety" refers to "high integrity, programmable safety systems that also minimize downtime and production losses. Integrated platforms are a great way to provide this capability."

Mark Sutton, president at Stamping Support Inc., mentioned that the ANSI B11.1-2001 standard addresses the topic of what is needed in a single control in "Annex D-Design considerations for power press controls, and in Annex E-Design considerations for micoprocessor based clutch/brake controls."

"I would love to see them integrated some day," said Sanoj James, senior technical manager, SBG Applied Materials India. "It's hard to design a line with the safety PLC handling safety functions and the

Control Engineering's social media forums on LinkedIn and Facebook were the source of information for this article. For links to these groups and our Twitter feeds, see the boxes on page 46.

Editor's note on user-generated content

Control Engineering has experienced an unexpected success in attracting industry professionals to its social media groups on Facebook and LinkedIn. Nearly 6,000 members have joined the groups in just their first several months of existence. The high level of interactivity by the groups' members has led to a continuous stream of spirited discussions across the sites.

While regularly reviewing the discussions taking place on the group sites, we found that the keen insights and opinions shared in the course of topic discussions were not only informative, but often entertaining. That's why we are extending the discussions from our social media groups to _Control Engineering_'s printed page and our Website—so that all members of our audience can view these discussions and weigh in on them.

Starting in January 2010, we will feature selected discussions from our social media groups every other month in the print issue and online at www.controleng.com.

If you have not visited our online social media groups before and would like to see what they're all about, follow these links:

- **Automation & Control group on Facebook http://budurl.com/CEFacebook**
- **Automation & Control Engineering group on LinkedIn http://budurl.com/CELinkedIn**

regular PLCs handling the rest. Though many manufacturers provide safety components that can sit on the rack with the regular PLC components, the biggest issue I have come across is the safety field bus. It does not allow you to write to a safety component over the safety bus because it allows only a read action. For example, if I were to use a safety-rated ASi bus along with a safety PLC and power supplies, the inputs can be read over the bus but we cannot write to the outputs over the same bus."

S. Hamza Habeeb, an engineer on the Facebook group added, "One of the refineries I'm working on in Pakistan as a system integrator has chosen to integrate safety and control on a Honeywell distributed control system. Habeeb notes that while he initially had reservations on keeping emergency shutdown and control in one system "since this was not the traditional approach," he says that the client thinks otherwise and they are deploying the system in an integrated fashion. Though he is onboard with the decision, he remains a bit cautious. "Let's see how it goes, but for my part, I'm not convinced until I see an actual system running with this configuration," he added.

Against the concept

Though some members of the social media groups clearly see integration of safety and control as a feasible, if not inevitable goal, others were just as decidedly against the concept.

James Loar, application support and business process management at Ciba Specialty Chemicals, said, "While functionally it [safety and control integration] is technically feasible, I thought the idea was to avoid a situation for a single/common point of failure. This should not only include the hardware, but also the software development as well."

By keeping them separate, "you are not dependent upon one programmer's style (logic process methodology in a system) that may be flawed in a way that causes a failure (for example, program branching methods)," Loar noted. "The same concept is applied to redundant instruments; you don't put in two of the same kind of level sensors for tank overflow; so both are not affected equally by an external influence (like cold weather)."

Craig Dickson operations manager at AGR Automation Ltd., concurs with Loar's concern about programming. "You cannot rely on programmers' logic to ensure safety," he said. Based on his experience in the industry, Dickson says that "safety PLCs, like all programmable logic, can be circumvented."

"In real terms, safety of machinery and EN directives used to require the safety system to be separate and autonomous from the main control system," added Dickson, who noted that this separation was required because it simply is safer. "Smart, programmable safety monitoring does have many benefits as an addition to a separate autonomous safety system, but not as a replacement," he said.

Vendor influence?

Most of _Control Engineering_'s social media group members who disagreed with the idea of integrated safety did so on a general technology and/or safety basis. Some members, however, weighed in with their opinion that this issue is being driven by vendors pushing new technologies, rather than arising from a genuine industry need.

"What is the advantage to single platform [for safety and control]?" asks Victoria Woosley, senior project engineer at Patheon. "A purpose-built device or controller, specially designed for safety protection, can be more functional and less costly than integrating that same functionality into the general purpose automation controller. Interoperability, intercommunication, and lots of redundancy is more functional, safer, and cheaper for those of us who are customers."

Woosley contends that the arguments in

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favor of safety and control integration are "no more than an extension of the arguments that all the big automation vendors have made for the last 15-20 years in order to lock customers into their platforms and lock the competition out."

Ashok Johnson, P.Eng., TÜV FS Eng., and consulting automation and control engineer, agrees that this is a vendor-led discussion. "This discussion is strictly of vendor interest," he said. "If a customer wants to go with a 'proven in use' system for their safety system, we cannot blame them. The common platform also increases the possibility of common cause failures."

Two questions users should ask themselves when it comes to integrated safety, according to Woosley, are: "Do you really want every new feature you need for high-speed control held up for months or years while proper testing ensures that it won't compromise the safety features? Or do you want to give up needed new features because you can't be sure the new software/hardware won't harm the safety functions?"

Who's right?

Though arguments over the concept of integrated safety have been raging for years, has any sort of consensus been reached that would helpful to end users? Unfortunately no—not at least from an apparently unbiased source.

Thus the debate rages on. Despite this tension, several nuggets of wisdom from the moderate side of the discussion appeared frequently on the social media groups to help users better develop their own opinion on the issue.

According to Koen Verschueren, owner of integrator firm 2B@SiX, "EN directives don't allow you to integrate safety in a control system. You can use a safety PLC from Siemens or other supplier where you can mix standard I/O and safety I/O, but a separate program still controls the safety functions."

In essence, since the hardware platform is the same, Vershueren says that the ability to use signals from the safety program in your control system makes for easier monitoring and alarming. He also points out that using a separate safety system, but housing it in the same hardware as the controllers, requires dedicated data communication. "Beckhoff has safety blocks that can be integrated with their control I/O," he says. "But those I/O blocks are controlled by a separate safety program

Safety networks provide integrated industrial connectivity

Information about intelligent safety networks follow. Also, search "safety networks" atop www.controleng.com for related articles.

AS-Interface Safety at Work (ASIsafe)	http://as-interface.net/System/Safety
CIP Safety	www.odva.com
Interbus Safety	www.interbusclub.com
PROFIsafe	www.profibus.com/technology/functional-safety
SafetyBUS p Pilz	www.safetybus.com

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with functions tested and approved for safety applications."

Other group members suggests a close review of IEC 61511 volume 1, chapters 10 and 11, for instances where integrated safety can work up to SIL 1 or 2 levels, if the control system is specifically designed for safety functions. In this area of discussion around IEC 61511, it was pointed out that total safety integration is not possible if you also take into consideration security requirements.

"Introducing the PLC as a means of safety monitoring and control should be treated with caution," said Simon Gibons, president at SGA. "The logic blocks and the hardware also have to be proven and approved. My approach is to use the PLC to monitor the safety circuit to provide information for control purposes. But the safety circuit should be implemented with a proven safety relay system. Each emergency stop actuator can provide an additional signal to the PLC. I keep the safety circuit schematics on a separate page so trouble shooting is easier; especially when many safety points are being monitored. Furthermore, integration into neighboring systems should be carefully considered and using proven, readily available safety control relays makes this task much easier at installation stages."

Two vendor representatives also weighed in on the moderate side of the debate. After first noting that being the DeltaV SIS product manager at Emerson Process Management makes him feel as if he's "jumping into a hot pot of oil" by joining this discussion, Mike Boudreaux proceeded to offer the following helpful advice:

"An integrated control and safety (ICSS) platform that uses common hardware and software components is very different from an ICSS that has components that provide physical separation, diverse components, and independent SIS logic solver hardware," Boudreaux said. "Most of the [integrated safety] debate has focused on the extreme case of commonality, without proper attention to the concept of an integrated platform that also provides separation. An integrated platform (per the ARC definition delivered in its 'Business Issues Driving Safety System Integration' whitepaper (http://is.gd/1rbXU)) is somewhere between the stand-alone and common platforms, providing the best of both worlds."

Boudreaux explained how this is handled in Emerson's Delta V controller. "DeltaV SIS has an entirely different hardware design from the DeltaV hardware used for control. DeltaV SIS logic solvers use the Green Hills Integrity operating system, which is different from the DeltaV controller operating system. Therefore, the DeltaV SIS function blocks are different from those used by DeltaV for control. SIS communications are on a physically separate bus. The integration of DeltaV and DeltaV SIS is at the operation, engineering, and maintenance layer. Physical separation, diversity, independence, and common cause concerns are addressed with the integrated yet separate architecture of DeltaV SIS."

Agreeing that an integrated approach could achieve project goals designed after a risk analysis, David Arens, an applications engineering at Bosch Rexroth, adds that he has heard of so many companies coming out with their own ideas of a safety fieldbus that, as a person responsible for integrating safety into automation projects, he's more than a little concerned.

"To sleep at night, I have to know that all the components of my safety system will work together to achieve SIL 3 safety," Arens said. "[Ultimately,] the solution must provide the ease of integration and validation of the risk assessment and safety to everyone that may come in contact with the machine."

Arens added, "A PLC will not stop shrapnel from going through a light curtain, and the PLC is not the actuator to the gate, but it may monitor the safety condition and respond. The motion actuation devices themselves need the intelligence to handle unsafe conditions and be designed in such a way that, regardless of fieldbus, PLC or manufacturer, they all function in a safe manner." **ce**

David Greenfield is editorial director of Control Engineering. *Reach him at david.greenfield@reedbusiness.com, or via Facebook or LinkedIn.*

Embedded PCs Keep Drilling Machines on Budget

Kays Engineering gains maximum flexibility and increases machine performance while reducing controls cost.

The need to drill straight and precisely shaped holes has been with manufacturers since the very beginnings of industry. Ever since the introduction of hand guns and rifles, the precision benchmark has been set high for deep hole drilling. Even today, these drilling systems are often referred to as "gun drills" because gun and rifle manufacturing was one of the first applications to require ultra high drill precision.

Gun drill technology has moved into many other industries, such as the automotive, aerospace, and medical industries – basically any application that requires precision holes. Kays Engineering, located in Marshall, MO, is a major provider of high precision deep hole drilling systems and leads by providing the best new technology solutions for the modernized version of an age-old manufacturing challenge. With end users located in North America and around the world, Kays Engineering must remain at the forefront of automation technology to meet the extremely high precision requirements and diverse drilling needs of its increasingly international customer base.

The DeHoff gun drill from Kays Engineering now features a Beckhoff control system with the CX1010 embedded PC. The controls cost well over 50% less than the machine's previous PLC-based system. Source: Beckhoff Engineering

Kays Engineering has two well-established deep hole drilling systems in its Eldorado and DeHoff machine families. The main difference between the DeHoff and Eldorado lines is drill size. The Eldorado line is the smaller of the two with drill diameters up to ¾-inch. The DeHoff drill sizes have a much larger range. In contrast to the Eldorado line of machines, the DeHoff line tightly incorporates control of the coolant system, fixturing system, automation system and many other optional components in to the machine control according to the

INSIDE MACHINES

In this ISSUE

This month we focus on embedded system aspects of machine design and use:

M1—Embedded PC based control enables better performance and growth.

M5—FPGA-based devices enable field-oriented control of older motors.

M10—Vision system adds verification to parts marking of race car components.

M12—Virtualization helps a CNC machine multitask.

M15—Tiny cube holds entire machine vision system in one sophisticated device.

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In the latest issue of Machine and Motion Control Monthly:

- Machine safety standard update and advice from Rockwell Automation.
- Siemens H-compact Plus series offers higher horsepower, smaller footprint.
- Discrete sensor sales predicted to rebound sharply in 2010.
- Slim profile light curtain protects small machines without sacrificing safety.
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specifications required by the customer.

When compared with competitive offerings, a major differentiator with the DeHoff machines is the use of flat ground ways rather than using linear guide ways. This provides peerless stability and helps minimize vibration in the drilling process, which could otherwise cause numerous quality problems in the finished product. DeHoff machines also offer a vast range of spindle speeds to provide maximum drilling flexibility.

Constant customization

The primary customer requirement for Kays Engineering is to be highly adaptable and flexible to every unique application. "While Kays offers a job shop-oriented and standardized machine with the Eldorado line, the DeHoff line of drills is often subject to requests for rather high levels of customization," explained controls engineer Brandon Snell said. "Usually our customers have already finished the design and dimensions of their parts that are to be drilled. Kays Engineering must be totally flexible to adapt our machines to faultlessly drill these parts that have nearly limitless variance in shape and size."

The DeHoff gun drill line has some standard elements such as the servos drives, motors and other standard motion components, but the machine is very application-specific.

In the past, Kays Engineering utilized a traditional PLC to control both a servo drive and variable frequency drive (VFD) via an analog interface. A grayscale, low-resolution display panel served as the operator interface.

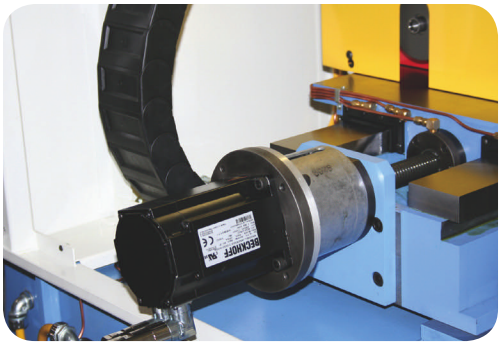
In early 2006, Kays first started looking for new controls packages and considered six different vendor options. Snell sought a highly flexible controls platform that could efficiently accommodate a wide range of customizations and provide a hardware platform that could scale in processing power.

"Many motion control alternatives we evaluated were typically priced quite a bit more than the PC-based approaches. Simple economics was a major deciding factor in favor of PC-based control," Snell said. "We encountered some controls from Beckhoff Automation during our search and thought that a DIN rail-mounted PC-based controller could be exactly what we were looking for. Once we decided to more closely evaluate Beckhoff and contacted them, we immediately received high quality support from their regional sales and application engineers to get our new system into development."

Scalable, stable embedded PCs

In late 2006, Kays Engineering went full speed into programming and controls design toward Beckhoff PC-based control. Utilizing the scalable CX Family of embedded PCs, Kays Engineering selected the CX9010 Ethernet controller with Intel IXP420 CPU and XScale technology for the Eldorado series drills. The higher performance DeHoff machines now feature the CX1010 with a 500 MHz Pentium MMX-compatible processor. The CX controllers utilize EtherCAT — the high speed Industrial Ethernet system from Beckhoff. "Another major benefit to the embedded PCs is that they utilize Compact Flash for boot and memory instead of a hard drive," Snell noted.

The 6.5-in. CP7829 control panel has a custom DeHoff logo integrated into the laminate front.



Energy use has been reduced using efficient AX2006 servo drives from Beckhoff. A compact Beckhoff AM3052 servo motor, which controls the gun drill's axis slide, can generate the same level of torque as the larger motor in the previous system.

The previous grayscale, low resolution displays from another vendor were replaced with full color 6.5 in. Beckhoff CP7829 control panels with custom DeHoff and Eldorado logos integrated into the laminate front. The CP7829 also features numerous function keys and a numeric keypad, adding to the flexibility of the new display.

The panels connect to the CX embedded PCs via DVI/USB. The CP7829 is an IP65 rated display that does not require a control panel enclosure. It can be mounted directly to machines via a pedestal or swing arm mounting configuration with all peripheral cables concealed and routed through the mounting tubes. The CP7829 can help reduce cost and required space when compared to a standard IP20 rated touch screen.

The CX9010 and CX1010 run TwinCAT NC PTP software giving Kays Engineering integrated motion control functionality. "The ease of use and configuration of the CX embedded PCs and TwinCAT reduce our troubleshooting time. TwinCAT also has built-in motion control libraries, which saves a tremendous amount of programming time — we're able to simply drop in the standard blocks of code we need," Snell said.

"We also have the flexibility to create our own HMI using TwinCAT visualization software — this is all tightly integrated with the control software so there's no worry about having the different software elements function perfectly together," Snell added.

The ability to choose Structured Text "has greatly streamlined our programming," Snell added. "While we can still use it, we are not restricted to Ladder logic and can program in all the languages established in IEC 61131-3. The fact that one line of code can handle an entire complex equation has really helped out. In the past there were occasions when I had to code averaging calculations in Ladder Logic: addition in one rung, then division in the next, and storing it in another rung isn't as easy as just typing out the formula that I know."

The system Kays Engineering created includes a "drilling parameters calculator" that allows end users to simply enter data on the material to be drilled, the required hole diameter, and the system automatically generates the appropriate feed rate and spindle speed for the materials to be drilled. Part program storage and saving files in the DeHoff and Eldorado machines has become extremely simple with the Windows-enabled embedded PCs as well, Snell said.

Using EtherCAT and standard Ethernet cabling, Kays Engineering was able to cut two entire work days from the required wiring time of their Eldorado and DeHoff control cabinets.

Simplified troubleshooting

In addition to EtherCAT-enabled embedded PCs, Kays Engineering uses the Industrial Ethernet system as the motion fieldbus. Beckhoff AX2003 EtherCAT servo drives are paired with AM3042 servo motors to tackle the motion control of the Eldorado gun drill. The DeHoff line of gun drills use a wide variety of servo drive and motor combinations including, but not limited to the previously mentioned AX2003 setup as well as an AX2006 drive paired with AM3052 or AM3044 servo motors. The EtherCAT-based motion system provides speed and position control of the axis slide.

"One of the biggest factors that led to selecting EtherCAT was the almost 'plug and play' functionality it brings to our machine design," Snell said. Previously, the servo drives and VFDs on the Eldorado and DeHoff machines required an analog 4 – 20 mA loop and excessive cabling to communicate the machine load. That method was not as reliable as Kays Engineering wanted, especially considering the long cable runs that were required.

"EtherCAT constitutes a major improvement because it offers deterministic performance and provides much higher speed and reliability. Troubleshooting cabling that consists of basic Cat 5e Ethernet cables is also inherently simple and cost effective. It's just one type of cable to manage rather than having to worry about six different types," Snell said.

Beckhoff's TwinCAT Modbus TCP library helps facilitate communication to the DeHoff and Eldorado VFDs. "With high performance EtherCAT equipped on all the Beckhoff devices and the ability to simply connect to other kinds of devices via Modbus using TwinCAT software, we're able to reduce cabling efforts in even more places using standard, inexpensive Ethernet cables," Snell noted.

Cost savings

"Overall, the new Eldorado and DeHoff control systems have become more economical than the previous systems. In addition to the higher performance, energy usage has been reduced by using more efficient Beckhoff servo drives. Today, there's a more compact Beckhoff motor controlling the gun drill's axis slide that can generate the same level of torque as the larger motor in our previous system."

This improved flexibility and efficiency did not come at an increased cost for Kays Engineering. "We saw a dramatic controls cost optimization with the DeHoff machine — the Beckhoff control system with the CX1010 costs well more than 50% less than the previous traditional PLC-based system," Snell said.

There were additional cost savings from the Beckhoff system on the improved entry level Eldorado machines using the CX9010. "This system permits slightly scaled down PC-based hardware, but utilizes the same TwinCAT NC PTP control environment. The Eldorado system with CX9010 costs more than 10% less than the lower performing system it replaced," Snell said.

The savings Kays Engineering experienced did not stop at hardware cost. "Using EtherCAT and standard Ethernet cabling, we were able to cut two work days from the required wiring time of our Eldorado and DeHoff control cabinets," Snell said.

End-user future focus

Customer reception for the new Eldorado and DeHoff machines has been equally positive and highly encouraging to Kays Engineering. "As a result of the strong feedback for these redesigned machines, at least 90% of the Eldorado and DeHoff machines will be equipped with Beckhoff PC-based control systems and EtherCAT going forward," Snell said.

Kays Engineering has by no means reached the end of its PC-based control evolution. The CX1020 and CX1030 embedded PCs from Beckhoff provide even higher performance options and provide room to grow when Kays Engineering decides to add more axes of motion and further enhance the system features of their deep hole drilling systems. "We have the ability to simply scale up to the next controller in the CX Family. Most of the existing programming and controls design will remain the same for each new machine variant. We've optimized our machine design flexibility today and well into the future," Snell concluded. **ce**

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Using Algorithms to Increase Motor Efficiency

When you can't just replace lower-efficiency motors, you can use sophisticated control techniques built on FPGA-based devices to improve energy efficiency.

Christian Fritz
National Instruments

In the face of economic uncertainties and increasing environmental concerns, many businesses are trying to make their operations more lean, efficient, and environmentally friendly. Examining your electricity bill is a good place to start. The top consumers of electricity are HVAC systems, water heating, lighting, office equipment, and machinery. More specifically, the motors within these machines are responsible for approximately two-thirds of the total electrical energy consumption in a typical industrial facility. To improve the efficiency and lower operating costs of motors in your enterprise, consider the following factors.

High efficiency motors

A motor running at 50% efficiency is converting only half of the electrical power into useful mechanical work. The rest is wasted. This makes the extra investment in efficient motors prudent since electricity costs make up 96% of the total life cycle costs of a motor. According to the U.S. Department of Energy (DOE), switching to a motor with a 4-6% higher efficiency rating can pay for itself in two years if the motor runs more than 4,000 hours a year.

Unfortunately, simply replacing existing equipment is a luxury. Many facilities host motors that are very large and costly to replace. Hence, users are always looking for ways to squeeze more efficiency out of existing assets. The key to reaping savings could lay in the drive control algorithms and implementation of commercial-off-the-shelf (COTS) hardware. Essentially, when you cannot replace the motor, replace the algorithm and controller to achieve better efficiency. With high computational power silicon devices, such as the Virtex or Spartan FPGAs from Xilinx, along with available commercial off the shelf (COTS) hardware like National Instruments' CompactRIO, one can rapidly prototype and realize precise custom control systems to increase motor efficiency significantly.

Right size motors

A second fundamental component is proper motor sizing. The DOE estimates that 80% of all motors are oversized, causing businesses to pay a high price in wasted energy. As shown in the graph, efficiency drops dramatically when the load is below approximately 40% of the full-rated load. A number of sizing tools are available online to assist you in the process, such as MotorMaster+ for AC induction motors and VisualSizer for DC servo motors. When sizing, a good rule of thumb is to choose a motor with a peak and RMS torque rating approximately 25% higher than the application requires. Similar to advances in FPGA technologies which reduce complexities in design, new virtual prototyping tools are just around the corner to help provide more accurate torque and velocity data by linking motion control programming software, such as NI LabView, with 3D mechanical CAD environments for simulation and rapid design prototyping.

Appropriate motor technology

The type of motor you choose for an application has a big impact on energy efficiency. Induction motors, also known as asynchro-

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For more information, visit:

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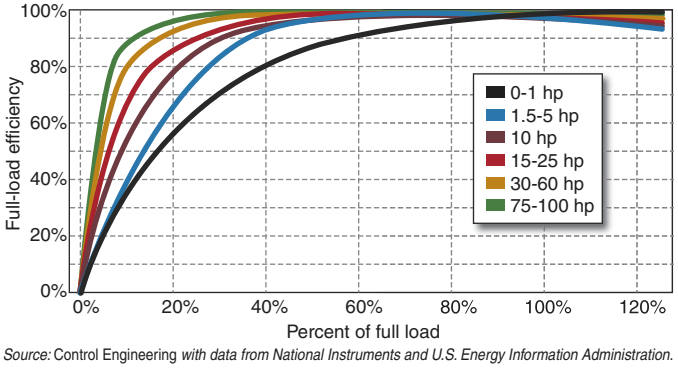
DOE whitepaper, Buying an Energy Efficient Motor at http://www1.eere.energy.gov/industry/bestpractices/pdfs/mc-0382.pdf

DOE MotorMaster+ sizing tool for AC induction motors at http://www1.eere.energy.gov/industry/bestpractices/software.html#mm

Copperhill Media VisualSizer for DC motors http://www.copperhillmedia.com/VisualSizer/

nous ac motors, are one of the oldest and most well established types of motor. With their low cost and ability to operate without sophisticated controls, ac induction motors are the workhorse for most household goods. They are usually operated in constant speed applications but can also be augmented with more sophisticated controls for use in applications requiring variable speed and torque.

Motor efficiency vs. loading



Source: Control Engineering *with data from National Instruments and U.S. Energy Information Administration.*

Motors running at less than full load can lose much of their efficiency, this is particularly true of smaller size motors.

For low-power applications, inexpensive stepper motors and brushed dc motors are popular due to the simple control circuitry necessary. However, they provide somewhat lower energy efficiency and therefore higher operating costs. Stepper motors are particularly inefficient, because they draw power even when stopped and they must be significantly oversized due to poor torque output at high speeds.

Brushless dc motors and permanent magnet synchronous ac motors (PMSM) are both commonly referred to as brushless dc (BLDC) motors but they do differ in the way their stator is wound. When rotated, the stator of the BLDC is wound in such a way as to produce a trapezoidally shaped back emf voltage, while the PMSM produces a sinusoidally shaped voltage. Brushless dc motors are more costly but provide better energy efficiency and performance when controlled using advanced algorithms compared to the ac induction motors explained above, and they can scale up to serve very high power and high speed applications.

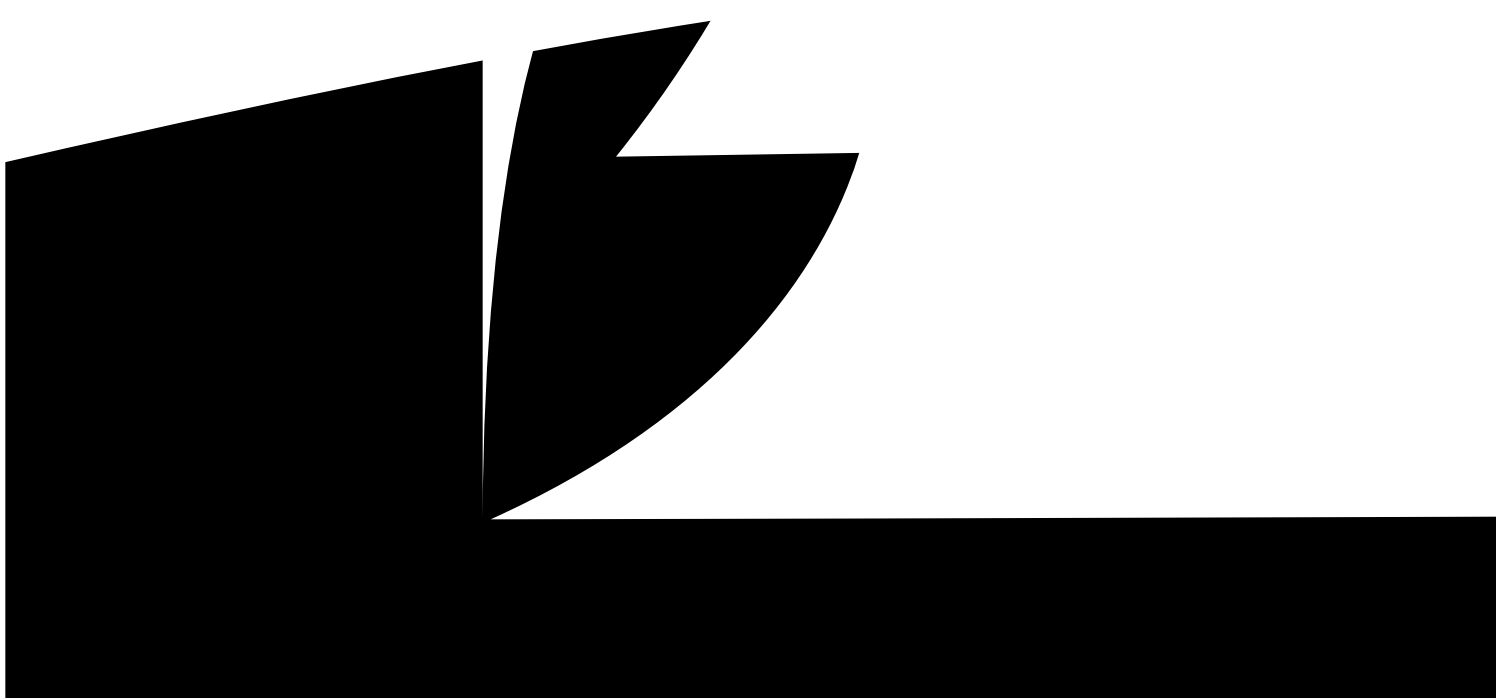
BLDC motors are a type of synchronous motor. This means the magnetic field generated by the stator and the magnetic field off the rotor rotate at the same frequency. Usually BLDCs are equipped with three phases. Most BLDC motors have three stator windings connected in star fashion. The internal structure is like an induction motor containing pairs of permanent magnets on the rotor rather than windings. Since there are no brushes, commutation must now be provided electronically. To rotate the BLDC motor, the stator windings are energized in a sequence. To calculate which winding to energize at a time it is necessary to know the rotor position typically measured by three Hall Effect sensors embedded into the stator of the motor. Based on the triple combination of these sensor signals, the exact sequence of commutation can be determined by the control electronics. Because brushless motors use permanent magnets in their rotor rather than passive windings, they natively provide higher power for their size and weight compared to induction motors. The key to high efficiency operation, however, lies in the control system.

Control algorithms for motors

The use of microprocessing technologies in motor control has increased in recent years. Their purpose is to control algorithm execution in order to deliver better efficiency. For example, when using brushless motors, a wide range of control system algorithms is available, including trapezoidal, sinusoidal, and field-oriented control.

Trapezoidal control: Also known as six-step control, trapezoidal control is the simplest but lowest performance method. For each of the six commutation steps, the motor drive provides a current path between two windings while leaving the third motor phase disconnected. This method has significant performance limitations in the form of torque ripple which causes vibration, noise, mechanical wear, and greatly reduced servo performance.

Sinusoidal control: Also known as voltage-over-frequency commutation, sinusoidal control addresses many of these issues. A sinusoidal controller drives the three motor windings with currents that vary smoothly. This eliminates



the torque ripple issues and offers smooth rotation. The fundamental weakness of sinusoidal commutation is that it attempts to control time-varying motor currents using a basic proportional-integral (PI) control algorithm and doesn't account for interactions between the phases. As a result, performance suffers at high speeds.

Field-oriented control (FOC): Also known as vector control, FOC improves upon sinusoidal control by providing high efficiency at faster motor speeds. It delivers the highest torque-per-watt of power input compared to other control techniques, and allows precise and responsive speed control when the load changes. FOC also guarantees optimized efficiency even during transient operation by perfectly maintaining the stator and rotor fluxes.

Understanding FOC

One way to understand how FOC works is to form an image of the coordinate reference transformation process. If you picture an ac motor operation from the perspective of the stator, you see a sinusoidal input current applied to the stator. This time variant signal generates a rotating magnetic flux. The speed of the rotor is a function of the rotating flux vector. From a stationary perspective, the stator currents and the rotating flux vector look like ac quantities.

Now, imagine being inside the motor and running alongside the spinning rotor at the same speed as the rotating flux vector generated by the stator currents. Looking at the motor from this perspective during steady state conditions, the stator currents look like constant values, and the rotating flux vector is stationary. Ultimately, you want to control the stator currents to obtain the desired rotor currents. Using coordinate reference transformation, the stator currents can be controlled like dc values using simple PI-control loops. Under the hood, the FOC algorithm works by removing time and speed dependencies and enabling direct and independent control of both magnetic flux and torque. This is done by mathematically transforming the electrical state of the motor into a two-coordinate time-invariant rotating frame using mathematical formulas known as Clarke and Park transformations.

An efficient method to control the power electronics is called space vector pulse width modulation (PWM). It simultaneously maximizes usage of motor supply voltage and minimizes harmonic losses. Harmonics can significantly reduce motor efficiency by inducing energy-sucking eddy currents in the iron core of the motor. Best of all, field-oriented control can be utilized for both ac induction and brushless dc machines to improve efficiency and performance, and FOC can be applied to existing motors by upgrading the control system. In fact, vector control techniques such as FOC, can be employed with ac induction motors to enable servo-motor-like performance.

FOC with FPGAs

To implement FOC, powerful computation devices are needed which makes FPGA advancements in lower cost-to-performance a natural fit for motor control. The vector control algorithm must be continuously recomputed, at a rate of 10 to 100 kHz. In parallel to the control algorithm, additional IP (intellectual property) blocks such as the high speed

PWM outputs need to execute without affecting control algorithm timing. Capable to perform control algorithms with loop rates up to hundreds of KHz, combined with its inherent parallel execution and hardware reliability can make an FPGA perfect solution for this application. This approach leaves additional room to perform communication and provide data for user interface applications, and the reconfigurability of FPGAs allows users to adjust the control algorithm whenever necessary.

The NI LabView FPGA module delivers graphical development for FPGAs on Reconfigurable I/O (RIO) COTS hardware targets allowing users to create custom applications using built-in functions or existing HDL IP. LabView is well suited for FPGA programming because it clearly represents parallelism and data flow. IPNet (ni.com/ipnet) is a companion site for LabView FPGA to search, download, and exchange additional IP algorithms. Field-oriented control algorithms for LabView FPGA can be downloaded free of charge through the NI intellectual property network (IPNet).

To connect the algorithm embedded in the FPGA to real world signals, the compact RIO and single board RIO offer a wide range of I/O connectivity and validated I/O drivers to read the Hall Effect sensors and control the power electronics driving the motor. NI Single-Board RIO is a low-cost OEM board-level embedded platform capable of executing the same code developed for the compact RIO modular platform. This combined solution allows design teams to prototype embedded systems rapidly with modular, flexible compact RIO then quickly deploy to low-cost single-board embedded hardware with 100% code reuse. Other key benefits of such a solution include shortened time to market and increased machine reliability with validated middleware.

One of the biggest challenges in embedded design is the effort required to create, debug, and validate driver-level software stacks to integrate all of the hardware components of the embedded system. Traditionally, this integration process is left to the user, which complicates and lengthens the embedded system design process. The RIO platform middleware drivers go beyond the basic drivers that traditional single-board computer and other embedded system providers offer to deliver increased productivity and performance and short time to market.

Driver software and additional configuration services software are included with every RIO-supported device. The built-in middleware driver tools contain built-in functions for interfacing between analog, digital, motion, and communication I/O and the FPGA, transfer functions for data communication between the FPGA and processor, methods for interfacing the FPGA/processor to memory, functions for interfacing the processor to peripherals (RS232 serial, Ethernet), and multi-threaded drivers for high performance.

Improving motor operating efficiency can produce significant energy and dollar savings, and provide a rapid return on investment. For example, a 5% efficiency increase on just one 500 horsepower motor operated 8,000 hours/year could save over $12,000 and 170 kWh of electricity each year. When evaluating control system upgrades, keep in mind that energy costs are typically orders of magnitude higher than hardware costs over the lifecycle of the motor. **ce**

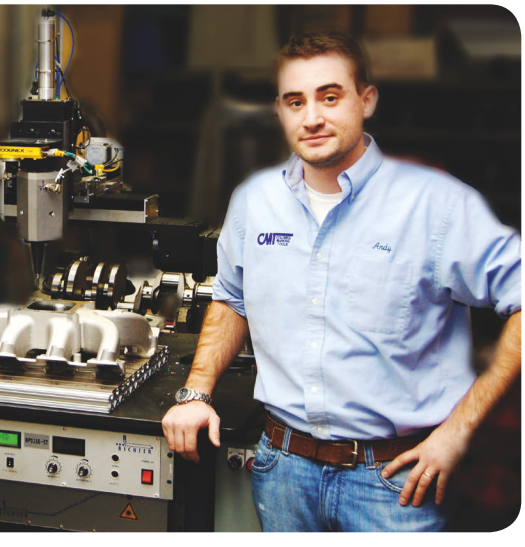
Christian Fritz is product manager for motion control and mechatronics for National Instruments. Reach him at christian.fritz@ni.com.

www.ni.com

Marking and Vision System Tracks NASCAR Spec Engine Components

Three marking options make it possible to produce a readable 2D barcode on any part, and integrated vision verifies readability before the part is shipped.

The North American Stock Car Racing (NASCAR) has adopted a new spec engine for its Camping World East and West series that uses many off-the-shelf parts to provide performance and durability at only about one-half the cost of custom-built engines. Each of the major parts in the new motor has a 2D barcode that can be read in seconds by a handheld scanner, greatly reducing the inspection time at the track. The marks need to be positioned in very specific, often difficult-to-mark locations on the parts so they can be inspected easily before and after the race (to prevent the use of illegal parts that would increase the power of the engine).



Columbia Marking Tools engineer Andy Habedank says switching among the 2D marking methods can be done quickly. This flexibility is needed because engine component materials include cast iron and hardened 4140 steel with a range of surface treatments. Source for all photos: Cognex

Wegner Motorsports, which provides spec kits and assembled engines, overcame this application challenge with the Columbia Marking Tools 3 in 1 Marking System, which produces two-dimensional (2D) barcodes using dot peen, scribe and laser marking methods so it can mark virtually any surface. A key to the success of the marking system is its integration of a Cognex In-Sight 5100 vision camera. The camera instantly grades the mark to verify that it can be read during the track-side inspection process—which happens to use Cognex DataMan ID readers.

Spec engine development

NASCAR's new engine is based on General Motor's Gen-three small-block V-8, commonly referred to as the LS2. The engine costs only a fraction of a custom-built motor because it uses stock components, including block and cylinder heads with the original bore and stroke dimensions. Race-specific components include JE-forged aluminum pistons, a Comp Cams cam and pushrods, a Holley 830-cfm four-barrel carburetor, Lunati crankshaft and rods, Edelbrock intake, a custom Stewart Components water pump, and Del West titanium valves.

The engine produces 520 ft-lbs of torque and 625 hp at a maximum of 8,000 rpm. Wegner adopted a unique tagging system that provides positive identification for each component on the engine to prevent cheating. The 2D barcode has a series of dots arranged in a square that is very difficult to reproduce or counterfeit. Its information includes the type of component, manufacturer, date of sale, and serial number.

Wegner faced a difficult challenge in producing the 2D barcodes on certain engine components. Parts such as the crankshafts, connecting rods, pistons, blocks, cylinder heads, intake and exhaust manifolds and fuel pumps are made from a range of different materials, including cast iron and hardened 4140 steel, with a wide range of surface treatments such as nitriding and anodizing. What makes these parts particularly difficult to mark is that the location of the mark is often determined by the need to make it accessible for these inspections. NASCAR inspectors use a Cognex wireless handheld DataMan 7000 series scanner to inspect the engines both before and after the race to ensure that only legal parts are used.

Multi-choice marking

While at a racing show, Wegner managers saw Columbia's Marking Tools 3 in 1 Marking System, which can perform all three of the major marking methods: dot peen, scribe, and laser marking. The peen/scribe marking unit uses an impact stylus for peen marking or a diamond tip for the quiet scribe marking of text or graphics into hard or soft surfaces. The marking force can be actuated either electrically or by air. Switching from dot peen to scribe marking is performed by flip-

ping a switch and changing the stylus. The system also has available a multi-faceted diamond tool for extended tool life.

The laser-marking unit of the system uses a compact, low-cost adjustable diode laser with variable power, from 0 to 50 watts. The laser module takes less than five minutes to retrofit to the main unit. The various marking units are mounted to an x-y slide that is driven by precision linear ballscrews.

When scribing or laser marking the parts, Columbia's machine displaces material in a way that leaves specifically recessed areas formed of grooves and surrounded by ridges of displaced material that look like round indentations. These grooves and ridges form a very reflective multi-faceted data cell, with very high contrast between the grooves and the unscribed or laser marked surface. A vision system can easily distinguish the grooves, evening the presence of extraneous marks or deposits.

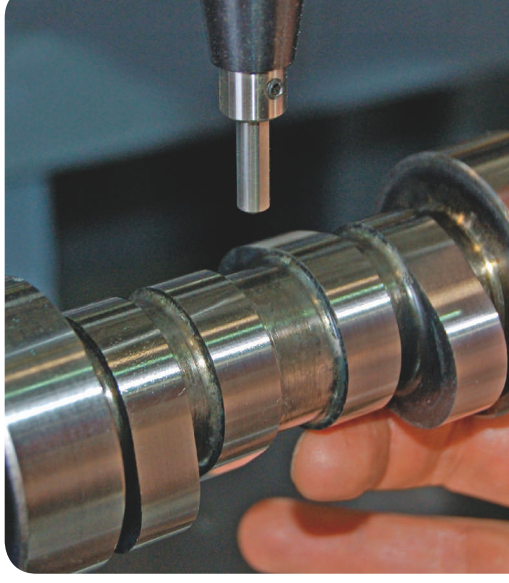
Columbia calls the marks produced by this method Square Dots. They can be produced at very high speeds with grade A readability, which is equivalent to 1,200 reads per second with no variations. The Columbia model DPS-LR-150 machine used by Wegner has a 4-in. x 6-in. marking window. A rotator attachment provides the ability to mark the periphery of round parts.

Verifying barcodes

A readable 2D barcode is critical to the integrity of these engines. If the barcode cannot be read during the pre-race inspection, there is a chance that the car will not be allowed to race. If it cannot be read in the post-race inspection, the results of the race will be in doubt.

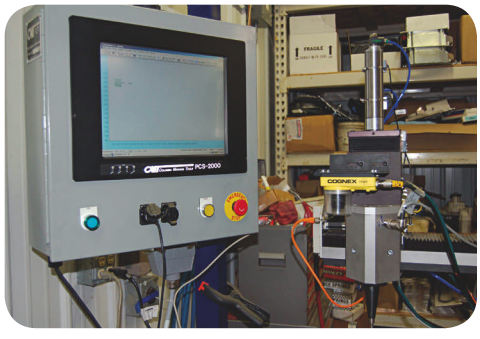
To verify the readability of each part, every 2D barcode is scanned while being generated. To meet this requirement Columbia integrated a Cognex In-Sight 5100 vision sensor into its marking machine. Andy Ruzzin, vice president of sales for Columbia Marking Tools, said, "There are a number of vision companies, but we recommend Cognex vision sensors because of their 2D barcode reading technology. NASCAR made the same decision by selecting Cognex handheld scanners for reading spec engine barcodes. Cognex's In-Sight Explorer software also provides more options for reading a 2D barcode, and makes it easier to develop a vision application."

The In-Sight 5100 vision sensor acquires up to 60 full frames per second with 8 bit images. Its die-cast aluminum housing and sealed industrial M12 connectors eliminate the need for additional enclosure hardware, and it is rated for shock and vibration to IEC specifications. When used with the included lens cover, the sensor achieves an IP67 (NEMA 6) rating for dust and washdown protection on the factory floor.



NASCAR engine components from Wegner Motorsports are marked by a Columbia model DPS-LR-150 parts marking and verification system.

Columbia Marking Tools used the In-Sight Software Development Kit to develop a user interface with a point-and-click setup. The kit let developers integrate In-Sight images, graphics, and data into custom programs, exposing only the functionality required for end users to configure In-Sight and monitor its operation, while preserving Columbia's custom interface.



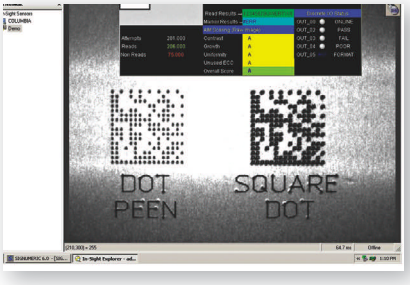
The parts marking machine creates 2D barcodes that are scanned by a Cognex In-Sight 5100 vision sensor after being generated, to verify readability.

Ease of configuration helped Wegner Motorsports get the new marking system up quickly. Wegner general manager Dan Timm said, "We got the marking machine up and running within four hours of unloading it off the truck."

Having three marking options makes it possible to produce a readable mark on the most difficult applications, said Timm. "We find that we use the scribe method on the majority of our parts, the dot peen method on very hard parts, and laser marking on a few specialized applications such as marking valves."

The integrated Cognex In-Sight vision sensors reliably grade the 2D barcode mark, added Timm.

"I was amazed that the vision system could read the mark with only simple LED lighting and without special shrouding," said Timm. "Later, when we are putting the parts together into kits, we scan the parts again using the Cognex DataMan wireless handheld scanner, which is the same model used by the NASCAR inspectors. This tells us exactly which part has gone into which kit, making it possible later to trace its history, if necessary." **ce**



Close-up of the difference between peen and square dot marking methods.

For more information, visit:

www.cognex.com/applicationsIndustries/applicationsOverview

www.columbiamt.com

www.wegnerautomotive2.com

Software Virtualization Environment Enhances Control

CNC system simultaneously runs a real-time operating system and MS Windows XP to gain multitasking capability and real-time determinism.

Kim Hartman
TenAsys

Industrial control systems can be divided into two categories, those that are designed for general-purpose control functions and are fully programmable by the end user, and those designed for a special purpose, such as controlling a milling machine or an injection molding system.

In the first category, one typically finds PLCs and general-purpose industrial computers. The second category uses dedicated controllers with built-in support for special functions, such as closed-loop motion control. Both systems benefit from multitasking—the ability to perform more than one function at the same time—but dedicated controllers place special requirements on the operating system's coordination of concurrent tasks.

Where time-critical functions are involved, such as the control and coordination of multiple axes of motion, the operating system must guarantee that time critical signals from motion tracking sensors are not missed by the control application's critical threads. An operating system like Microsoft Windows cannot provide sufficient response guarantees to host such an application, because it is optimized to provide services to a variety of general-purpose tasks, such as interaction with human operators, network interfaces, database engines, etc.

This general-purpose aim does not bode well for the timing requirements of an industrial control application, which requires a real-time operating system to guarantee the coordination of time-critical functions. But the highly specialized nature of a real-time operating system is also a severe limitation.

A general-purpose operating system like Microsoft Windows has many third-party tools available to shorten the time required to implement operator interface screens, access databases, and communicate with network protocols. In fact, the most popular computing platform for the development of industrial automation software is the PC, and PC-compatible processors running Microsoft Windows have become the de-facto standard human-machine interface (HMI) in use today. There is also a growing base of soft-

Cleveland Motion Controls' Burny XL comes in two versions: an integrated version, and a version with a remote operator panel.

ware-based PLC applications. These software-based PLC applications deliver the control functionality of a PLC and familiar PLC programming models in a Windows environment.

What can a control system developer do when he/she wants to combine real-time and general-purpose operating environments? Run multiple operating systems at the same time on a single hardware platform.

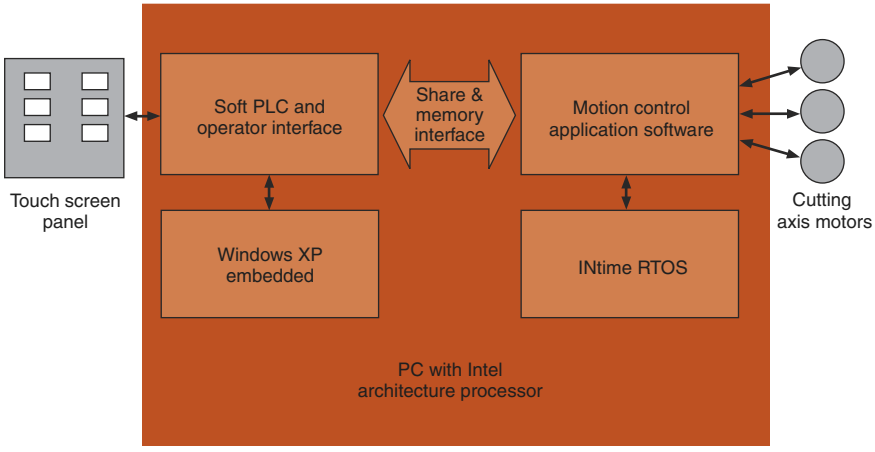
Configurable CNC controller

This is the solution that was selected by Cleveland Motion Controls (CMC) of Cleveland, OH, a subsidiary of ITT Corp. CMC focusing on providing easy to use shape-cutting motion control solutions for oxy-fuel, plasma, laser and water jet cutting machines, and routing, engraving and dispensing equipment. The company's newest PC-based computer numerical control (CNC) controller is the Burny XL, which incorporates an Intel Mobile processor. The system delivers precise and repeatable real-time control of metal-cutting axes, with an HMI that makes the machine's operators highly productive. It is designed to be a configurable platform around which CNC machine builders can customize their own products. It operates in harsh environments and comes in two versions: an integrated control platform and HMI panel, and a remote panel version.

Using a unique software virtualization environment supplied by TenAsys Corp. of Beaverton, OR, the Burny XL can simultaneously run Microsoft Windows XP Embedded and the TenAsys INtime real-time operating system (RTOS) on one embedded PC. This gives the Burny XL multitasking capability that enables future jobs to be loaded, stored, and nested by a task manager while a current job is being processed.

Such multitasking gives the Burny XL an advantage over other CNC controllers by shortening the downtime between jobs. In addition to enabling multiple tasks to perform simultaneously, the INtime RTOS supports deterministic real-time responsiveness that guarantees that the CNC's motion steps are performed on time regardless of the method (oxyfuel, plasma, laser, etc.) the machine is using to make cuts.

When CNC machine builders customize the Burny XL to their own products, they use a built-in software-based PLC and touchscreen interface designed by Cleveland Motion Control. This IEC 61131-compatible Microsoft Windows application can be programmed using ladder logic and can interpret standard "M" and "G" coded CNC programs. The software-based PLC provides target position set points to the real-time motion software, and manages all non-real-time



Source: Control Engineering

Software architecture of the Burny XL shows how Microsoft Windows XP and the INtime RTOS from TenAsys Corp. co-reside on the industrial PC that runs the machine. A virtual machine architecture, implemented by the TenAsys software, enables both OSs to execute independently.

operations directly. A shared memory interface common to the Windows and INtime virtual machines is used to pass information and commands between the software-based PLC and the time-critical motion control software that runs concurrently on the INtime RTOS (see software architecture graphic, above).

Use of shared memory is only one implementation detail of the OS virtualization support provided by the TenAsys INtime environment. INtime also directs hardware interrupt functions of connected I/O devices to ensure that less-time-critical events, such as key presses on the operator touchscreen, do not interrupt real-time tasks such as controlling CMC's cutting motors. Because of the way that the TenAsys virtualization software is implemented, Windows and Windows-application software run on the system without modification.

Depending on the motion hardware employed by the CNC system, the INtime real-time system hosts one of two motion control loops. It can host a one-millisecond loop for conventional analog drives (where velocity is deduced from position feedback) or a two-millisecond loop that controls SERCOS drives (a high-level digital motion control interface). Auxiliary I/O, such as limit switches and general-purpose I/O points, is also managed by INtime real-time applications.

Using this virtualization approach, both INtime and Windows applications run in protection ring three (user mode) on the Intel architecture processor, rather than running in ring zero (supervisor mode), as do applications in many other real-time operating systems. If a process should fail, it can be safely halted or aborted without stopping the entire system. This provides a high degree of safety to INtime-based systems, and simplifies identifying faulty applications.

Another advantage for CMC to using the INtime RTOS is the fact that real-time applications are developed and debugged directly from within the Microsoft Visual Studio development environment, just as they already do for their Windows applications.

One environment saves time

Using a single development environment, including source code debugger, for real-time and non-real-time portions of the system greatly shortens the time required to port code from an old system to INtime. It also significantly reduces the time required to get both real-time and non real-time portions of a machine working together smoothly.

By having the real-time OS and Windows tightly linked, CMC has a path on which to add new features in future iterations of their CNC products. Currently, the Burny XL uses a single-core Intel processor, but the company is planning to move its system to a multi-core platform. This would add further performance enhancements by taking advantage of TenAsys' support for running the INtime RTOS and Microsoft Windows on separate processor cores. **ce**

Kim Hartman is vice president of sales and marketing at TenAsys, which has served the embedded market with hardware analysis tools and RTOS products for 25 years. Hartman has recently been a featured speaker for Intel and Microsoft on the topic of embedded virtualization. Cleveland Motion Controls (CMC) offers a broad line of Motion Controllers and automation components, including software-based PLCs.

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Single Point Machine Vision

Dalsa Corp.'s new BOA Vision System is a highly integrated smart camera that combines all of the elements of a machine vision system in a tiny industrially hardened cube. The new technology is aimed at automated quality inspection and factory automation applications.

Michael Babb
Control Engineering Europe

Multi-camera vision appliances are embedded solutions designed primarily to satisfy inspection needs, and in today's market they have become rather sophisticated. They generally provide ease-of-use, performance, and flexibility required to meet the diverse requirements of industrial applications, while accommodating the needs and limited experience of end users.

Dalsa IPD (the IPD stands for Industrial Products of Dalsa) has been supplying machine vision for 25 years, and claims to be the only company to own all of the technology ingredients—including cameras, frame grabbers, software, vision appliances, and even the semiconductor fabrication of the CCD vision sensor chips. While the company has built its reputation on multi-camera solutions, its new BOA product follows the latest trends in electronic control devices: packing everything into a single, simple box. Steve Geraghty, director of Dalsa's Industrial Products group, walked us through the technology.

Geraghty is not unaware that several competitors have supplied diminutive machine vision packages for at least the past 10 years. But, he claims, his company has done its homework and come up with a substantially different product. Everything this new camera has to offer is inside the 44 mm metal cube: the CCD sensor, light control, all the processing (with three different processing chips), I/O and Ethernet connections, and developer and operator application interfaces. All of this is packaged inside an IP67-compliant box that is so small, a golf ball would barely squeeze inside. The IP67-rated housing means that the camera can be deployed directly in harsh, wash-down environments without the need for a separate protective enclosure.

"There are manufacturers today who have a variety of options available that offer a range of machine vision capability at various price points," says Geraghty. "Each of them, in my opinion, provide only a part of the solution; [for example,] most still have to connect to a PC where the software is running."

The BOA stands by itself, Gerahgty says, and all the software is embedded inside the box. It can do everything a machine vision inspection system is required to do: capture an image, process it, analyze it, and communicate immediately with an automation system if the part needs to be rejected. No external controller, PC, or server is required.

Technology inside

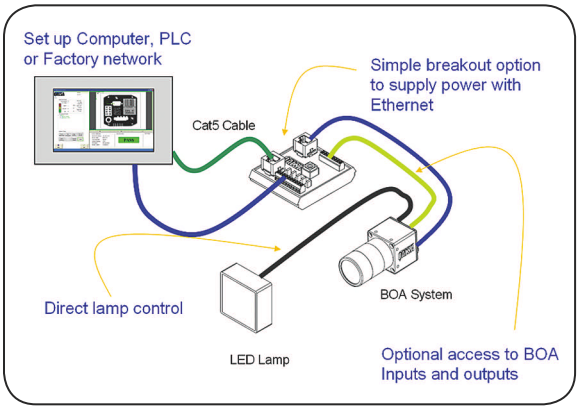
Geraghty adds another interesting claim to the one of supreme integration. He says Dalsa is the first to implement multiple processing engines. There are, in fact, three processing chips inside each BOA: a DSP, CPU, and an FPGA.

The DSP is for algorithm development and optimization; the CPU is for interfacing with operators to configure or monitor the inspection and for communicating the results with the factory environment. The FPGA is used to get the image into the camera and manipulate its quality.

The back side of the camera is the business end as far as external connections are concerned. Despite there being three M12 connectors, only one of them need be used for many typical applications: the 100 MB Ethernet connection. A second connector gives access to BOA inputs and output. It can be used, for example, to trigger the camera, or send output pulses to control the direction of automation equipment. At the top is a dedicated connector for power and strobe control of an external lamp. The remaining space on the back is filled with a set of LEDs for status indication.

Dalsa engineers have come up with a clever way to power their little box, too. In the M12 cordset to the Ethernet port, there are eight conductors: four for Ethernet signals, and four unused. Two of the four unused wires can be accessed for power supply. The camera works on 12 to 30 volts dc. Geraghty

The 44 mm metal cube of the BOA camera includes the CCD sensor, light control, three different processing chips, and I/O, Ethernet and application interfaces.



Dalsa supports all standard communications options, but sees 100 MB Ethernet as the emerging factory automation standard throughout the world.

hastens to add that this is not Power over Ethernet (PoE), but simply a matter of taking advantage of the unused cable capacity. And, for many customers, it's a big advantage because it means they have to run only one cable to the camera.

Why 100 MB Ethernet, and not Gigabit Ethernet? Or Firewire? Or USB? In its multi-camera vision appliances, Dalsa supports all the standard communications options, right up through the multi-gigabit CameraLink, but the company sees 100 MB Ethernet as the emerging factory automation standard throughout the world. So it figures this is the bandwagon to jump on.

But why not GigE, gigabit Ethernet? Why not go for high speed? This is machine vision, after all. "We're not providing images real-time as we connect," says Geraghty. "We're just providing the results of the inspection, and 100 MB is fine for that purpose.

"We can send pictures over the Ethernet wire and the performance is, actually, not too bad. We can send 10 to 15 images per second, but this is usually done during the set up period. During normal production runs, this is not normally done."

Rather than looking at thousands of photos, users can take another approach. "The camera has pretty good memory on board that allows customers to store results and failures, and look at them at any time. They can dial into the camera at any point and monitor what is happening."

Where's the light source?

Critics may be forgiven for noting, almost immediately, that unlike many other small machine vision appliances, BOA has no lighting system. There's no bank of LEDs circling the lens or sticking out of the camera. "We elected not to do that for two reasons," Geraghty says. "First, we wanted to keep the size of the camera small. And, secondly, our research has shown that in most applications, you can't used the integrated lamp and you have to purchase and use an external lamp [anyway]. So, we've found that the integrated lamp, in many applications, is wasted."

Another key technological point for the BOA is having the application software embedded in the camera, which means it doesn't depend on an external computer for support. If the operator wants to interface with the internal workings — for example, to configure the software for an inspection application — he or she only needs to connect via a Web browser. "This eliminates all problems of [software] revision control," says Geraghty.

The embedded software application is iNspect, which IPD also sells as a PC-based package for its multi-camera systems. Developed for both first-time users and machine vision experts, it accounts for about half the company's software revenues. The other half comes from a more advanced software package called Sherlock, which will be ported to run on the BOA in the future, says Geraghty.

iNspect software is for end user manufacturers in any industry who either use or want to use vision to improve quality inspection or increase productivity, but who don't want to become deeply involved in programming languages.

"A lot of times with automation applications, we find that customers don't think about machine vision upfront," says Geraghty. "They end up wanting to shoe horn it in after the line is up and running, because they've discovered they have quality problems, or something like that." The small form factor of the camera allows it to be easily integrated to existing lines — attached to the end of a robot arm, for example.

The BOA also targets machine builders looking for vision platforms that can be customized to meet their needs, and small equipment manufacturers who want a private-brand platform to accelerate their time to market. For both of these customer segments, Dalsa provides support for combining proprietary algorithms with iNspect and running both on the BOA platform. Alternatively, customers may only want to purchase the hardware platform and BOA-specific software libraries to create their own exclusive package.

Another feature worthy of note is a PC-based software emulator that works exactly the same way as the embedded iNspect software. This is a tool primarily intended for vision system installers: They can run the camera at a new installation, capture some images on a Flash memory drive, then transfer them to the PC to develop the application with the emulator. Once finished, the application can be sent back to the camera.

Dalsa will initially offer a 640 x 480 pixel monochrome BOA camera for US$1,995, which includes the full complement of tools. A color version will be ready later this year. Although Dalsa makes its own machine vision sensor chips at semiconductor fabrication facilities in Canada and The Netherlands, these are mostly large format, high-end products: sensors with at least 1000 x 1000 pixels. To keep the price of the camera under US$2,000, the company is bringing in its 640 x 480 CCD sensor chips from an outside source. Higher resolution models, says Geraghty, are in development. **ce**

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Regulatory Compliance for Food Safety

Different types of software, used separately or in an integrated fashion, can be leveraged to meet the requirements of Hazard Analysis and Critical Control Points (HACCP) compliance.

Rory Granros
Infor

Product recalls have dominated food headlines recently. It only takes one contaminated product slipping past inspectors for the consequences to be devastating. In one case from 2008, Peanut Corporation of America was forced into bankruptcy after it was determined to be mainly responsible for a salmonella outbreak that killed nine people and sickened more than 600. In another example, Topps Meat closed its doors in 2007 after recalling 21.7 million pounds of frozen meat (an entire year's production) contaminated with E. coli.

These kinds of nightmare scenarios are exactly why the Hazard Analysis and Critical Control Points (HACCP) process was created. HACCP emphasizes prevention over finished product inspection as a means of ensuring food safety. A

Automated control of all food manufacturing processes should adhere to HACCP principals.

Hybrid mobility

Schneider Electric and Orange County Choppers collaborate on project to build hybrid motorcycle designed to shocase intelligent energy management system for multiple energy source options. http://tinyurl.com/yb5d3gf

Solar mfg. up 50%

GTM Research indicates U.S. solar panel manufacturing to rise nearly 50% annually—from 875 megawatts in 2008 to 3,880 megawatts in 2012, creating 20,000 jobs by 2012. Michigan, Ohio, and Pennsylvania among states to benefit. http://tinyurl.com/lrndxb

Green Caterpillar

Caterpillar named to Dow Jones Sustainability Index for ninth consecutive year. Company also retains Gold Class recognition in Industrial Engineering Sector for ninth consecutive year. http://tinyurl.com/pqm9xt

Effective preventive maintenance of food production controls can elimiate "out of tolerance" conditions, which improves product safety.

well-designed and enforced HACCP policy can prevent physical, chemical, and biological toxins from infiltrating food products during the manufacturing process, making the products safer and reducing the number of recalls.

HACCP is based on seven principles and requires coordination of technologies from enterprise software down to the instrumentation level:

- Conduct a hazard analysis. Hazards are conditions that may pose an unacceptable health risk to consumers. To conduct a hazard analysis, identify the significant hazards associated with each step of the manufacturing process, as well as the measures (such as temperature, pH, and moisture level) that can prevent them.
- Determine the critical control points (CCPs). CCPs are steps at which to apply control to prevent, eliminate, or reduce a food safety hazard to acceptable levels (such as cooking, acidification, and drying steps).
- Establish critical limits. Critical limits are the operational boundaries of CCPs that control food safety hazards. If critical limit criteria go unmet, HACCP is not preventing, eliminating or reducing food safety hazards.
- Establish monitoring procedures. Ensuring that critical limits are being met allows food manufacturers to assess trends before a loss of control occurs, and to make adjustments while continuing the process.
- Establish corrective actions. Should loss of control occur, manufacturers must have written plans in place for disposition of the product and correction of the process.
- Establish record-keeping and documentation procedures. The HACCP system requires the preparation and maintenance of a written HACCP plan together with other documentation. This must include all records generated during the monitoring of each CCP and notations of corrective actions taken.
- Establish verification procedures. Document the scientific or technical validity of the hazard analysis and the adequacy of the CCPs. The system should also be subject to periodic revalidation using independent audits or other verification procedures.

Despite most process manufacturers having some degree of HACCP guidelines in place, the number of product recalls for the industry increased in 2008. Part of this challenge is ensuring compliance with HACCP principles across all manufacturing operations. In addition, public concern over several recent high-profile recalls mean process manufacturers may face stricter government oversight—including regulations requiring companies to report possible contamination within 24 hours to state agricultural authorities.

Different approaches to compliance

Expansive supply chains and complex products only complicate the issue of product safety. As food manufacturers create more and fresher products, outsourcing increases and supply chains are stretched to meet consumer demands. This intensifies the chances of product safety issues from cross-contamination or a safety breach as well as the risk of more complex product claims.

After taking these variables into account, reliance on manual inspection processes and human intervention is a risk most companies cannot afford to take. However, manufacturers can leverage existing technology to automate

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and ensure the effectiveness of their HACCP programs. By integrating automated HACCP throughout the supply chain, companies can prevent food contamination and avoid costly recalls.

Product lifecycle management (PLM) software is one step that can be taken toward a fully automated HACCP. The best PLM software will support five of the seven HACCP principles (hazard analysis, identification of CCPs, establishing critical limits, record-keeping, and verification) and provide design and simulation from sub-raw materials to finished goods. Any PLM solution being considered should also support definition and verification, and manage the definition and setup of HACCP in downstream data and processes.

A PLM solution should also be capable of instantly alerting plant operators of any HACCP or claim substantiation risks, allowing them to mitigate issues and ensure that proper HACCP controls are developed and integrated into all appropriate downstream processes and systems.

Enterprise asset management

Another piece of the HACCP enforcement puzzle often employed is enterprise asset management (EAM). EAM solutions track maintenance requirements for plant assets. Many of these technologies also comply with the HACCP principles of hazard analysis and record-keeping.

Maintenance capabilities offered by EAM solutions not only reduce safety risks and improve product quality, but also increase asset availability and extend asset lifecycles. Effective preventive maintenance puts an end to "out of tolerance" conditions, which improves product safety, supports audits, minimizes write-offs, and improves customer service. Since some recent recalls began with leaky pipes, leaky roofs, inadequate sanitation procedures, and improperly maintained filling equipment. Integrating HACCP practices into preventive maintenance programs protects brand equity of products, and reduces record-keeping costs.

Event management software can be used to help manufacturers respond to food safety concerns by providing proactive, real-time exception management to detect conditional change anywhere in the supply chain and communicate it instantly to those who need to take action—both inside and outside the organization. Comprehensive event

management can monitor CCPs as well as establish corrective actions across departments, plants, and even into the executive level. Some event management solutions even support HACCP's record-keeping and verification principles.

Enterprise resource planning (ERP) with integrated quality control is one of the more common software components of an HACCP program. Starting with full lot control to the sublot level from tracking of container temperature and conditions through delivery at the customer, ERP systems can be used to manage inverted, convergent, and package bills of material and process conditions with integrated HACCP data. With every movement of materials and production step, processing conditions and lot quality data is captured. Integrated quality control manages testing, quarantine, disposal or release of lot and sublots. Any failed tests or tests that are trending negatively can allow active management of lot and sublots. Timely issue identification can minimize the time to mitigate an issue and limit a company's exposure.

What's it worth?

Although an effective recall process reduces costs and disruptions, just one product recall can ruin a hard-won reputation, and force companies to close their doors forever. Even the most effective recall only slightly reduces the negative impact on businesses and brand. Proactively developing and certifying products and materials, preventing equipment safety risks and planning with compliance restraints can help the process manufacturing industry improve product safety and reduce non-value-added costs, as well as increase consumer confidence, create more competitive products and expand profitability.

All of the above-mentioned types of software — PLM, EAM, and event management — can be integrated into an existing ERP system, allowing process manufacturers to form a holistic and proactive food safety strategy. Such a strategy can be used to identify contamination at its earliest stages, contain it, and protect manufacturers from the risk of meeting a similar fate as Peanut Corporation or Topps Meat. **ce**

Rory Granros is the director of process industry solution marketing for Infor, a global provider of enterprise software. For more information, contact inforinfo@infor.com.

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Monitoring Pressure in Milk Processing

Nestlé's R&D center in Konolfingen, Switzerland, develops milk-based food products and designs manufacturing processes. Monitoring pressure in heat exchangers provided some particular challenges.

Andrew Sim
Baumer

In Konolfingen, Nestlé operates its Product Technology Center (PTC), one of 24 such research facilities worldwide. For more than 30 years, the company has been developing milk-based products and production processes there, with the main focus lying on infant food, special-diet nutrition, and health-care related products. Konolfingen developers research appropriate recipes and test processes for all operational Nestlé companies worldwide that require new products for these markets. Recently the company expanded the plant, which included adding a group of new heat exchangers.

Outfitting new heat exchangers

Following applicable European sanitary protocols, all measuring devices that contact product in the new testing facility had to be equipped with an aseptic screw connection according to DIN 11864-1. At various places around the plant, Baumer pressure transmitters of the ED701 series were already being used in other applications such as homogenizers, mills, and filling

New Nestlé products come from 24 research facilities worldwide.

INSIDE FOOD & BEVERAGE

In this ISSUE

Food and beverage processors have specific requirements outlined in two articles:

F1—Working with dairy products calls for special sanitary considerations.

F4—When temperature measurement is critical to your process, your system has to provide the right support.

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equipment. Since Nestlé had been satisfied with those devices, they were also chosen for pressure measurement for the new heat exchangers. Depending on the processes being tested, up to six new heat exchangers are used for heating or cooling the products, with temperatures reaching 150 °C (302 °F).

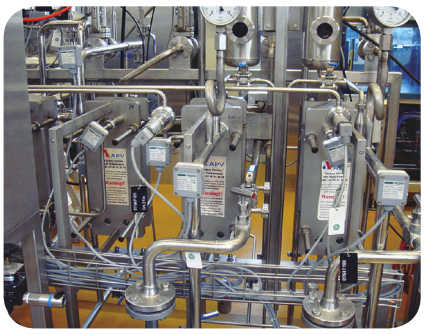
At high temperatures the products precipitate protein which then deposits on the heat exchanger's metal plates. If there is too much sediment on the surfaces, exchange efficiency falls and the differential pressure between the inlet and outlet rises. Eventually the heat exchangers have to be cleaned. Given the nature of new product development, these exchangers see a wide variety of ingredients and process temperatures as developers test recipes and manufacturing techniques with different kinds of liquid products, ranging from milk to dessert crème. Among other results, the tests show the possible range of process temperatures that might be required during production, as well as the amount of time and product throughput the unit can run before the heat exchanger needs cleaning.

ED701 for differential pressure

The ED701 measures differential pressure using a piezo-resistive pressure transducer with a flush stainless steel diaphragm suited to industrial and sanitary applications. It is based on a silicon sensor designed for high precision over a wide temperature range with downstream digital compensation to reduce signal drift. The piezo-resistive element is anodically bonded to a glass and stainless steel base for stability and thermal isolation. A stainless steel diaphragm and a specially processed fill liquid separate the sensor and process fluid.

The electronics are located within a hermetically-sealed transmitter housing, making the unit resistant to humidity, shock, and vibration. Depending on the choice of electrical connection, the protection class varies from IP 65 to IP 67. The signal processing electronics core piece is a micro-controller that compensates for drift effects on the sensor signal due to temperature changes while still maintaining a response time below 5 ms.

The ED 701 family includes a selec-



Sensors in crowded places are a challenge, particularly where impulse line length must be kept at a minimum for cleaning. Source: Baumer

tion of pressure ranges and electrical connections. Most units use a 4-20 mA current loop, along with various voltage output signals. The hygienic design makes the ED 701 series most suitable for applications in food and beverage processing, as well as in pharmaceuticals and biotechnology. Any parts that contact process fluids are 316L stainless steel (1.4435) and all materials, including the white oil used as fill liquid, comply with U.S. FDA standards.

For the use with the heat exchangers, Nestlé specified pressure transmitters with an accuracy of ±0.4% full scale and a compensated temperature range of -10 to 125 °C on the cooling water side and a maximum temperature of 300 °C on the heating side. The measuring range of gage pressure covers 0 to 20 bar (0 to 290 psi).

Nestlé's engineers wanted a new process connection for the milk tube, which they developed in cooperation with Baumer. As a result Baumer delivered the units with only a connection for the pressure-receiving side, and Nestlé made the connector for the product side.

"For the milk tube fitting, Baumer offered us the CombiConnect adapter, which we found most suitable thanks to its flush-mounted o-ring", says Ernst Strahm, Nestlé measurement technologist at Konolfingen. The CombiConnect system provides a series of replaceable sanitary process connections made of stainless steel. Nestlé has used the same connection with FlexBar and ED701 pressure transmitters as well as CombiTemp temperature measuring devices. The connections were developed to fulfill dairy and food industry sanitary requirements, including FDA and EHEDG criteria.

Duplicating successes

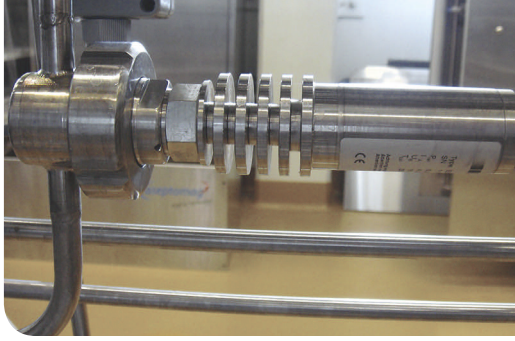
Nestlé's product developers had enough experience in other applications to know what worked well and what didn't. Based on positive results with similar pressure transmitters elsewhere in the plant, the selection process was not difficult. When selecting specialized units for use with the new heat exchangers, Nestlé returned to the CombiConnect with its own purpose-built adapter. Strahm adds, "For a hygienic pressure measurement, the quality of the measuring devices is the decisive criterion. With the ED701, we have had consistently good experiences." **ce**

Andrew Sim is managing director of Baumer Swindon, U.K.

For more information, visit:

www.baumerprocess.com

www.nestle.com



The custom fitting, designed in cooperation with Nestlé, satisfied all the sanitary retuirements. Source: Baumer

DCS Migration for Functional

Yeast producer upgrades its process control system to take advantage of new networking and instrumentation capabilities. Using smarter transmitters with better diagnostics requires improved control and networking infrastructure.

Joe Paradiso
Honeywell Process Solutions

USA Yeast produces yeast products for bakery, ethanol, and other food production markets. It was organized in 2003 by Mike Lavallee and a group of investors to compete in an industry dominated by producers based outside the U.S. The company's only production facility is located in Hattiesburg, MS, in a 37,000 square foot plant that was built from the ground up with modern and fully automated production.

Given the critical role that yeast plays in the production of bread and other baked goods, producers insist on dependable and consistent performance from batch to batch. With that in mind, Lavallee and his associates designed the manufacturing strategy to provide designed-in product consistency achieved through sophisticated process control systems combined with aggressive quality assurance.

Early retirement for DCS

The plant was originally built using a Rockwell ProcessLogix control system running on Allen-Bradley hardware. Unfortunately, the plant wasn't in operation for very many years before the system began to show its age. The company wanted to take advantage of some of the growing capabilities of smart instrumentation and improved transmitters, particularly recent advances in condition monitoring and diagnostics of temperature sensors possible with fieldbus communication. However, the control system could not support the changes, and those involved said that Rockwell had not indicated that system upgrades would support those capabilities.

"We felt that we were at a dead end and needed a system that could grow with us and provide a clear migration path," says Stacey Miller, applications engineer for USA Yeast. The company approached Honeywell Process Solutions to analyze the configuration of the existing system in light of the specific needs of the process and business drivers involved. After formulating a solution that would require a minimum of equipment change-over, Honeywell presented a proposal detailing the hardware, software, and processes that would be required to perform the migration successfully. One element of the proposal that made it easier for USA Yeast to embrace was that there was no need for new graphics, rewriting any control code, or removing any wiring or I/O connections. In addition, the most critical elements were identified clearly to mitigate risk.

USA Yeast operates 24 hours a day, seven days a week so the cutover had to be completed quickly to minimize any possibility of production disruption. The plan included doing the actual change-over during a weekend when shutting down the system was least critical to production.

Implementation logistics

To perform the migration, Honeywell supplied redundant servers, controller expansion hardware, Experion software, and engineering services. During the actual migration, several critical issues had to be resolved:

- Moving the CL5555 processors and DeviceNet cards that were paired with a C200 processor in three racks to their own racks;
- Editing all exchange blocks for the new ASA (automation system architecture) path as a result of moving the processors and cards;
- Editing the CL5555 programming for the

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For more information, visit:
www.fieldbus.org
www.honeywell.com/ps
www.usayeast.com

Upgrades

USA Yeast supplies bakery, ethanol, and other food production.

new ASA path for the messaging to the field PLCs; and

■ Flashing all the cards in the system with the Honeywell firmware.

As planned, the final migration cutover was performed over a weekend to limit process downtime. This required a very detailed strategy, careful scheduling, and long workdays to squeeze four days worth of work into two. USA Yeast worked a continuous 24 hours performing the long process of reloading all the Fieldbus points and reactivating the 350 SCMs (sequence control modules). This allowed testing to begin on the second day and the company resumed truck loading operations.

Minding the details

The success of this project can be attributed to detailed planning, careful execution and building the right team. Identifying all the project requirements, risks, and customer expectations early in the discovery phase is also vital to positive performance.

"With the support of Honeywell, we have successfully migrated our Rockwell ProcessLogix control system to Experion," says Miller. "We now have greater access to real-time information and analysis tools to make faster and more effective decisions."

With the migration, USA Yeast cited a number of specific improvements, including:

■ Improved access to plant information;

■ Improved operator effectiveness;

■ Fieldbus issues resolved;

■ Full integration of transmitter capability improvements;

■ Detailed migration path to allow for business growth; and

■ Clear channels for technical support going forward.

Miller concludes, "We are very happy with the overall migration and unbeatable performance we see with the Experion system. We see a clear growth path for our business and now have a product that will enable us to do so in a seamless way."**ce**

Joe Paradiso is project manager is project manager for Honeywell Process Solutions. Reach him at joseph.paradiso@honeywell.com.

Advances in temperature sensor diagnostics

In an article entitled "Turning Up the Heat" in *Control Engineering Asia*, Jonas Berge (Emerson Process Management) discusses some advances made in temperature sensor diagnostics that are facilitated by fieldbus networking. Read the complete article at http://tinyurl.com/kruvc7. Here's an excerpt:

"Diagnostic technologies now allow plants to leverage thermocouple condition monitoring and failure prediction features that were previously unavailable in transmitters. Deployment of these technologies helps reduce process downtime and decrease energy costs. Specifically, the two open technologies brought together for detection, delivery, and display of diagnostics are Foundation fieldbus and Electronic Device Description Language (EDDL).

"Conventional two-wire, loop-powered temperature transmitters with a 4-20 mA analog output have a power limitation as they must consume less than 4 mA. This limits processing power of the microprocessor, as well as the level of complexity of the device firmware.

"In comparison, two-wire, bus-powered fieldbus devices do not have this power limitation; a temperature transmitter can consume 12 mA or more, if need be. This enables the use of a more powerful microprocessor, and subsequently more sophisticated device firmware, allowing for new powerful diagnostics.

"As a further advantage, and unlike other communication protocols used in temperature transmitters, devices using Foundation fieldbus have a synchronized real-time clock that enables process and diagnostic alarms to be time-stamped in the transmitter.

"The time-stamps allow event recordings to be accurate, even if the communication is not instantaneous. Alerts are sent when state changes. This is the most efficient use of communication, eliminating the need to wait for polling from the system.

"Device diagnostics like those for thermocouple degradation, temperature tracking, and statistical process monitoring are prioritized and categorized as per NAMUR NE 107 recommendation. This allows the system to alert the right person without flooding others in alarms."

Diffuse photoelectric sensor with background suppression

Carlo Gavazzi launches a new long range diffuse photoelectric sensor with background suppression technology. The Carlo Gavazzi PD112 will detect black objects up to 2 m away, and white and gray objects up to 2.5 m away. Using triangulation technology, the PD112 can be easily and precisely adjusted, with a 28 turn potentiometer, company says; the user can fine tune the sensor to detect the target at the desired distance and ignore reflective objects only millimeters beyond. Normally open or normally closed output can be selected via a dip switch, and is automatically detected by the sensor when wired. Two adjustable timers (1 - 16 seconds) for ON and OFF delay allow for a customized solution. Sensor is available with a cable or M12 plug and carries UL and CE approvals.

Carlo Gavazzi *www.gavazzionline.com*

Module connects multiple analog signal conditioners to Ethernet

Acromag has released another member of its BusWorks Ethernet I/O module family to simplify the task of interfacing data from virtually any analog sensor to a Modbus TCP/IP network. The new 958EN model has 16 analog input channels and a quick-connect DB25 port to capture isolated and amplified sensor signals from a full panel of 8B signal conditioners. The module performs 16-bit A/D conversions to make temperature, frequency, strain gage or other sensor data available to any control device via Ethernet. Typical applications involve processes requiring high voltage isolation or a mix of signal types, such as power generation, glass and metal processing, test and measurement instrumentation, and SCADA systems. Units are configured using any Internet browser to set operating parameters on embedded Web configuration pages. An auto-copy function lets users apply a saved configuration to multiple units. The automatic calibration function uses built-in precision sources, and an on-demand self-test capability verifies calibration and performance.

Acromag

www.acromag.com

6-port managed industrial Ethernet switch

Aaxeon Technologies introduces a new 6-Port Lanolinx Managed Industrial Ethernet Switch, the LNX-602N-MM/SS30-T. It has a wide operating temperature, four 10/100BaseT(X), and two 100BaseFX ports. The switch has Ethernet redundancy protocol support (recovery time < 10 ms over 250 units of connection) and spanning tree/rapid spanning tree protocol (IEEE 802.1w/D) that helps protect critical applications from network interruptions or temporary malfunctions, company says. Operating temperature ranges from -40 °C to 75 °C.

Aaxeon Technologies

www.aaxeon.com

10-in. HMIs provide more speed, capability

Maple Systems' three new 10-in. graphic operator interface terminal (OIT) models have faster CPUs, enhanced graphic appeal, and enhanced capability in a choice of widescreen or high resolution displays. With a display resolution of 800 x 600 pixels, the HMI5104XH is a high-resolution graphic OIT with a 500 MHz CPU, 256MB of flash memory, and 256MB of DRAM. According to the company, this unit gives the same pixel coverage as a 12-in. HMI in a 10.4-in. unit, and will even run a video media player.The HMI5100N and HMI5100T (with Ethernet) are 10.2-in. widescreens that have a 400 MHz CPU with 128 MB of flash and 64 MB of DRAM. Widescreen models offer 20% more usable screen area than standard 640 x 480 screens, and imagery looks crisp on the 800 x 480 pixel 65K color TFT displays, according to the company. Units also feature a 4-wire analog resistive touchcreen, and built-in Ethernet, USB and serial ports.

Maple Systems Inc.

www.maplesystems.com

Extended range inductive proximity sensors

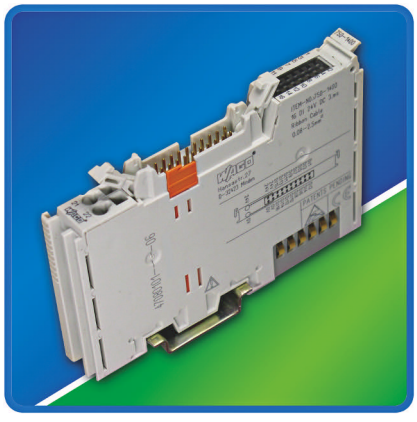
Pepperl+Fuchs X-Series Pile Driver Extended Range Inductive Sensors are available in 12 mm, 18 mm and 30 mm diameters to deliver sensing ranges of 5 mm, 10 mm or 15 mm - up to 2.5 times longer range than traditional inductive sensors. Stainless steel housings deliver durability more than 20 times that of brass and plastic housings, according to the company. The sensors' extended sensing field enables reliable detection of irregularly shaped contours, and increased sensor-to-target distances help eliminate contact-related scuffing of surfaces. Weld-immune models are capable of providing long range part detection with full immunity to ac and dc weld fields, and repelling weld splatter. X-Series Pile Driver's can detect all metals. Unlike traditional inductive sensors that are limited to IP67/68 protection, X-Series Pile Driver sensors are IP69k-rated to withstand high pressure washdown cleaning.

Pepperl+Fuchs

www.am.pepperl-fuchs.com

High-density, 16-point I/O modules

Sixteen I/O points in one 12mm-wide module make Wago Corp.'s 16-point I/O Ribbon Cable modules a compact solution for streamlining control-to-machine wiring. DIN-rail mount modules feature 16 inputs (750-1400), 16 outputs (750-1500) or 8 inputs/8 outputs (750-1502) and an HE10 ribbon cable interface. With the flat ribbon cable, the modules facilitate the use of pre-wired assemblies to minimize wiring time and errors. The modules are compatible with Wago's interface boards, ranging from an LED-equipped 120 V ac to 24 V dc input interface board, to a 3.75-in. wide, 16-channel relay interface board featuring 5 mm plug-in relays. For additional voltage flexibility, modules can pair with select interface boards and connect to any voltage up to 120 V ac - 6 Amps. All carry onboard LEDs for status indication and use Wago Cage Clamp spring pressure terminations for field connections. Users can integrate Wago I/O, including the new 16-point modules, into Rockwell Automation Allen-Bradley RS-Logix 5000 systems via Wago fieldbus couplers.



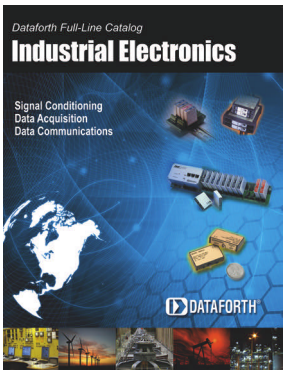
Wago Corporation
www.wago.us

Improve system reliability with trip coil, lockout relay monitoring

Schweitzer Engineering Laboratories Inc. (SEL) offers the SEL-2652 Trip Coil Monitor, which proactively monitors connections and circuit continuity of the circuit breaker trip coil and lockout relay. The self-powered SEL 2652 indicates circuit breaker status with a clearly visible external LED and a contact output for alarms or supervisory controls or data acquisition (SCADA). Unit features a panel-mount design and a SEL Connectorized terminal block. This one device is compatible with all systems from 48 to 125 V dc, reducing on-hand inventory.

Schweitzer Engineering Laboratories Inc.
www.selinc.com

2009 Dataforth Full-Line Product Catalog



Celebrating 25 years of excellence in design and manufacture of Instrument Class® Industrial Electronics, Dataforth Corporation has released a new, expanded Product Catalog. The 300-page publication provides the most up-to-date information and specifications for all signal conditioning, data acquisition, and data communication products. It also introduces new products including the SLX300 data acquisition system, ReDAQ™ software, and the 8BP01 DIN rail mount carrier.
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products

Acquire critical data in difficult terrain

A new licensed radio for North America from FreeWave Technologies provides a solution for rugged and heavily treed terrain applications in oil and gas, water/wastewater, electric and municipality markets. The LRS455 complements FreeWave's other licensed radios, the LRS-760 and LRS-140. It is said to provide a faster data rate and more noise immunity than competitive offerings, and its propagation characteristics at 430-470 MHz at 2 watts are significantly better than higher frequencies at 1 watt, making the LRS455 radio ideal for areas with heavy interference. Field tests also show that the LRS455 performs at a four- to five-times greater range than competitive offerings. The unit's 70 mile range with clear line of sight can be extended through a repeater. It features 19200 bps throughput on a 12.5 kHz channel. The LRS455 provides system and network management capabilities through FreeWave Tool Suite, an integrated software platform. Users can select whatever range they wish across the 435-470 MHz spectrum. Unit is available for immediate shipment and is available in board level or enclosed formats.

FreeWave Technologies
www.freewave.com

Digital mass flow controller

Bronkhorst High-Tech B.V. metal sealed mass flowmeters and controllers are designed specifically to meet the requirements of semiconductor manufacturers as well as other high-purity gas applications. Instruments feature high surface finish components and modular construction with metal-to-metal seals to eliminate sources of contamination and ensure long-term leak tightness. Nitrogen flow rate ranges start at 0.1 to 5 sccm with a maximum of 0.6 to 100 slm for standard units. Higher flows are available on request. These new offerings are equipped with on-board digital signal processing, and provide fast response with a settling time as short as 500 msec. Standard connectivity is RS-232 output and analog I/O; optional interface can also support DeviceNet, Profibus DP, Modbus-RTU, or Flow-Bus protocols.

Bronkhorst
www.bronkhorst.com

When you contact a company directly, please let them know you read about them in *Control Engineering*.

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Working with multivariable sensors

Many smart instrumentation devices can give you more than just one process variable.

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With growing sophistication, instrumentation devices can often provide more than one variable. These measurements are free in that they don't require any additional sensors or process penetrations. All they require is a way for you to extract the information.

Multivariable approaches fall into three categories depending largely on the needs of the primary variable:

Corrective measurements—Most electronic sensors are influenced to some extent by more than one variable. For example, pressure sensors that use capacitive or strain gage technologies are affected by temperature. Consequently, the transmitter for such a device takes its own temperature measurement and uses that data to correct the primary reading. Since that measurement is in the transmitter, it is usually a simple matter to provide it to the control system.

> "Most devices provide the primary variable via an analog signal or digital output. If more information is available, you have to find a way to get it."

The caution of using corrective measurement data is making sure you understand where it comes from. The temperature in this example will be taken where it is needed to correct the primary variable and may not reflect the process at all; it may only reflect the ambient temperature around the transmitter or electronic devices. Make sure you understand what it is before you use such data.

Multiple measurements—One of the most common flow measurement methods is using an orifice plate and differential pressure gage. There are many implementation variations, but the basic concept calculates flow based on pressure readings on both sides of a known obstruction. While the flow measurement only needs the differential pressure value, it isn't difficult to extract line pressure measurements as well.

Calculated measurements—With the growing sophistication of transmitter electronics, adding calculated values to measured process variables has become far simpler. Coriolis flowmeters use this technique, and can calculate a range of variables from the three that are actually measured. Probably the most common example of this is setting your Coriolis device to read in gallons or liters per minute, since the device does not measure volume. It calculates volume based on measurements of mass flow and density. The transmitter can be setup to provide whichever of the available values you need most as the primary variable.

Extracting the extra data

Most devices are designed to provide the primary reading via an analog signal (4-20 mA) or a digital output. However, if more information is available, you have to find a way to get at it.

A few devices offer multiple (usually two) analog outputs. This approach certainly works, but requires a cable for each variable.

The most common method for sending the secondary variable is via a HART signal on top of the primary variable. If you use a HART interface or have HART I/O connections with your control system, you can capture the secondary measurements and use them in any way that's valuable to the process. Complex devices, such as Coriolis flowmeters, allow you to choose which output comes over the analog signal and which others are overlaid. There are various types of HART reading devices. Some translate the secondary variables into appropriate engineering units for display. Others convert them into a second or third 4-20 mA signal for input into a DCS. There are even wireless approaches for capturing the information.

Fieldbus protocols make multiple variables very simple, if you use that networking approach and have suitable devices. Using fieldbus requires minimal setup since all variables, primary and secondary, will be available in the appropriate engineering units. Moreover, they can all be handled with the same importance.

Multivariable sensors can be very useful in the right contexts, but using them to your best advantage does require some homework. As your best first step, make sure you know what your process needs.

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