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Automation NOTEBOOK

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Issue 26

Cover Story

Modular Software Simplifies Complex Programming



By using function blocks, machine and robot builders can speed development time and add more functionality to their solutions.



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LED message displays

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What to know when selecting
an enclosure

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Theater Production of Medea

Precision Gearboxes

for Servomotors

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*SureServo Pro software is FREE when downloaded and is also available for \$9 on a CD
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For those who prefer to speak with us in person, please call 1-800-633-0405 x1845. Thanks for your interest, and we look forward to hearing from you.

Editor's Note

Here in Georgia, we have a saying, "If you don't like the weather, wait a few minutes. It'll change." This year, we have witnessed vast differences in our weather. One day we'll have temperatures in the 80s, the next day we're in the 50s. One day it will be sunny, the next it's raining like there's no tomorrow. As a matter of fact, as I am writing this, we have just ended a weekend of nearly constant rain. Parts of the Atlanta area received over five inches of rain. What's the good side of this? Climatologists are reporting that Georgia is finally on track to be drought free. In the meantime, we are grateful and can now plan on fun summer days in full lakes and waterways across our great state.

This issue of NOTEBOOK contains informative technical articles, new product announcements and more. With summer's heat knocking on the door, our Tech Brief article explains the importance of temperature control for enclosures. In our Student Spotlight, we focus on the Department of Theatre at Purdue University to see how their use of the CLICK PLC provides an "uplifting" performance. Our User Solution provides a fascinating story about a device used as a training aid in basketball offense. Plus, our cover story discusses the use of modular programming in manufacturing.

Of course, Chip McDaniel has provided us with another mind-tingling, brain-racking Breakroom, stocked with riddles and mind teasers that are sure to make you go, "Hmmm...". With everything we have for you in this issue, it's time to sit back, relax, and turn the page...



TJ Johns
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New Product Focus

What's New



ViewMarq™ industrial-grade LED message displays



The ViewMarq line of industrial-grade LED message displays utilizes the latest LED and communications technologies to help communicate important information in industrial environments.

Used to display preformatted messages or factory floor data, the displays can be controlled from a PLC or any device that uses supported protocols. Embedded data support allows real-time production data from the controller to be contained within messages.

ViewMarq LED message displays support embedded string and numeric variables, as well as blinking text and scrolling (left, right, up, down) messages. They feature tri-color LEDs (red, green,

amber) and are available in six models: 1 line x 12 character, 2 lines x 12 character, 4 lines x 12 character, 1 line x 24 character, 2 lines x 24 character, and 4 lines x 24 character.

The rugged industrial design features heavy-duty extruded aluminum housings with durable polycarbonate end caps and a smoked polycarbonate lens cover. Access covers with seal-tight cable glands offer reliable, easy installation of power and communication wiring. The displays are NEMA 4 and NEMA 12

from the AutomationDirect site (a CD version is available for \$10). The software utility provides multiple functionality; users can create and preview messages in the simulator window on a PC, send the message to the ViewMarq LED display, configure the display to communicate with a PLC, and create ASCII string commands to be used in the PLC program.

ViewMarq prices start at \$499 and include chain mount and adjustable wall mount bracket assemblies, cable glands for input wiring and a seven-foot Ethernet patch cable. Backed with a one-year warranty, all displays are UL 508 listed, CE, RoHS, and REACH compliant.

You can see the ViewMarq line of industrial-grade LED message displays at: www.automationdirect.com/ViewMarq.

(indoor only) rated and will withstand washdown conditions.

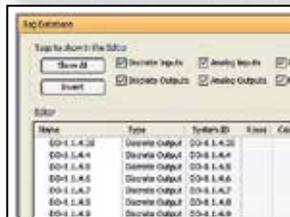
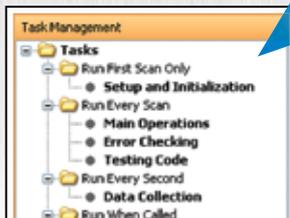
Displays have 140° viewing angles, can be mounted in any horizontal position (wall, ceiling, cabinet), and can be wired for 100-240 VAC or 24 VDC power. Each unit is equipped with an accelerometer to ensure your message is automatically displayed in the upright position.

All ViewMarq message displays are fitted with (1) RS-232, (1) RS-485, and (1) Ethernet port, and can be connected to a PLC, PC, or any device capable of serial ASCII master, Modbus RTU, or Modbus TCP communications.

Programming the ViewMarq industrial-grade LED message displays is easy. The ViewMarq Configuration Software can be downloaded at no charge

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PROGRAMMING



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Product Snapshots

Press Releases



Tongue (Key) Interlock and Cable-Pull Safety Switches



We have expanded our line of safety products with additional tongue interlock and cable-pull safety switches.

Tongue operated safety interlock switches are designed to fit to the leading edge of sliding, hinged or lift-off machine guards and provide positively operated switching contacts. They provide a tamper resistant actuator mechanism and robust position interlock detection for moving guards.

Offered in 22mm, 30mm and 40mm mounting profiles, models are available in plastic, aluminum and stainless steel housing options. The switches are designed with multiple actuator entry points and offer adjustable heads with 90-degree and 180-degree options; switch styles provide single and multiple half-inch female NPT conduit openings. Interlock safety switch prices start at \$15. Interlock switches require actuator keys which are sold separately in several styles, starting at \$1.25.

Additional cable-pull safety switches are also available. Cable-pull, or grab-wire, safety rope switches are designed to be mounted on machines and sections of conveyors which cannot be protected by guards.

Newly added models include a 57mm wide die-cast aluminum body which supports up to a 50-meter cable; 65mm models are available in aluminum or stainless steel and support cable lengths up to 100m. Models provide ½ inch NPT openings, and are available with or without reset button; units with an e-stop button, as well as red/green LED (24VDC or 110VAC) versions are also available. Cable-pull safety switches start at \$20.50.

Rope kits, starting at \$58, are available with galvanized or stainless steel cable and contain eye bolts, tensioner, and cable (up to 80m) with pre-mounted eyelet and quick link.

Additional accessories available include steel rope in lengths from 5-126 meters, stainless or galvanized eye bolts, springs, tensioners and pulley assemblies, as well as replacement LEDs.

Wera Wrenches, Ratchets and Socket Sets



Starting at \$17.50, combination ratchet wrenches feature a 12-point open end with a unique six-point stop plate for easier holding and turning of bolts. The fine tooth ratchet mechanism is exceptional for working in tight spaces. Ratchets (starting at \$61) and sets are available in three sizes (1/4-inch, 3/8-inch, and 1/2-inch), feature a swivel head that locks in five positions and include an easy-to-grip free-turning sleeve for faster work when using the ratchet as a driver. Also available is a heavy duty half-inch drive ratchet and hammer combination. A wide selection of bit drivers and sockets, in inch or metric sizes, is also available. Made of high

quality chrome vanadium steel, sockets are available in six-piece up to 43-piece sets starting at \$14. Also added are nut drivers, chisel drivers and additional screwdrivers.

All Wera tools are backed by a lifetime warranty. To see the full line of Wera hand tools, go to: www.automationdirect.com/tools.

New counter module for DL05/06 PLCs; 100Mb Remote I/O master modules for DL205 and DL405 PLCs



Designed for all *Direct*LOGIC DL05 or DL06 PLCs, the H0-CTRIO2 module offers great flexibility for applications requiring precise counting or timing, based on an input event or high-speed control output. Priced at \$199, H0-CTRIO2 is designed to work with incremental encoders or other field devices that send pulse outputs. The module features four 9-30 VDC sinking/sourcing inputs and two isolated sinking/sourcing DC outputs. Supported inputs include one quadrature encoder counter up to 250 KHz or two single-channel counters up to 250 KHz; supported outputs include two independently configurable high-speed discrete outputs or one channel pulse output control. Learn more about H0-CTRIO2 at:

www.automationdirect.com/pn/H0-CTRIO2.

Additional Ethernet Remote Master modules include the H2-ERM100 and the

H4-ERM100. The H2-ERM100 (\$201) connects any DL205 or Do-more H2 Series PLC's local CPU base to remote slave I/O over 10/100BaseT Ethernet. The H4-ERM100 (\$231) connects the **Direct**LOGIC DL430, DL440 and DL450 CPU bases to Ethernet Base Controller (EBC) slave I/O over 10/100BaseT Ethernet. For more information, visit: www.automationdirect.com/plcs.

SureGear™ Precision Gearboxes for Servomotors



The **SureGear** PGA series of high-precision servo gear reducers is an excellent choice for applications requiring accuracy and reliability.

Offered in a concentric shaft design with a maximum five arc-min backlash rating, the **SureGear** PGA series is an accurate, high-performance, and cost-effective solution for applications such as gantries, injection-molding machines, conveyors, and more.

The in-line planetary gear reducers are available in four gear ratios (5, 10, 15, 25:1) and feature thread-in mounting with industry-standard mounting dimensions. Additional features include helical-cut planetary gears for quiet operation and reduced vibration, and uncaged needle roller bearings provide high rigidity and torque. Mountable in any direction, the PGA series is maintenance-free with no need to replace the grease for the life of the unit.

SureGear PGA series prices start at \$398 and are backed with a five-year warranty.

For more information on the **SureGear**

PGA series servo gearboxes, visit: www.automationdirect.com/servo-gearbox.



NITRA™ Pneumatic Cylinder Position Switches

The NITRA line of pneumatics products now includes nine styles of position switches for pneumatic cylinders, including round, dovetail, t-slot, square, and D-shaped; additional dovetail accessories are available to accommodate larger dovetail slots. The new styles are solid-state electronic switches available in normally-open 3-wire DC PNP and NPN configurations, and can be purchased with an M8 wiring connector or 3-meter integral cable with wire leads. Mounting bands with adapters for round body cylinders are available ranging from 1/8" to 4" sizes. The pneumatic cylinder position switches start at \$11.

Learn more about NITRA pneumatic cylinder position switches at: www.automationdirect.com/cylinder-switches.

More Ultrasonic Sensors

The ultrasonic sensor offering now includes additional 18mm and 30mm round plastic DC models available with discrete or analog outputs. The sensors are equipped with LED status indicators and a push-button teach feature for configuration of normally-open and normally-closed states for DC output models and for adjustable sensitivity on analog output models. The IP67 rated



sensors are available in two-meter output cable or M12 quick-disconnect styles and are available in ten output types: single PNP, single NPN, Dual PNP, Dual NPN, 4-20 mA only, 0-10V only, PNP and 0-10V, NPN and 0-10V, NPN and 4-20mA, and PNP and 4-20 mA.

The UK1 series sensors, starting at \$99, have 18mm barrel housings and a 15 to 30VDC operating range, and are available in four sensing ranges: 50-400mm, 100-900mm, 150-1,600mm, and 200-2,200mm.

The UT1 series sensors, starting at \$185, have 30mm barrel housings and feature 12-30VDC and 15-30VDC operating ranges, and have a 250-3500 mm sensing range.

Backed with a lifetime warranty, both series are eULus, CE and RoHS approved. For more information, visit:

www.automationdirect.com/ultrasonic-sensors.

Flexible multi-conductor control cable

Flexible multi-conductor control cable is now available in sizes ranging from 18 to 10 gauge, with three to 41 unshielded conductors (including green/yellow ground). Individual stranded copper conductors feature black PVC/Nylon insulation and are marked with identification numbers. Fitted with a rugged premium grade PVC outer jacket, cables are flexible for easy installation and

Continued, p. 12>>

Cover Story

Function Block Programming

Modular Software Simplifies Complex Programming

Christine Leshar
ControlsPR

By using function blocks, machine and robot builders can speed development time and add more functionality to their solutions.

Many of us can remember when robot and machine builder OEMs developing an automation system only had the choice between relay ladder logic for PLCs, or assembly language for single-board computers and minicomputers. PLC logic was simple and basic, but they were very limited in computing capacity. They couldn't handle complex control or data handling, so separate controllers and computers were needed for these tasks.

Programmers needed to spend lots of time writing code for everything from real-time operating systems to PID algorithms. Computers often only had 16K memory, and OEMs got little or no support from the computer vendor for real-time control applications, as single board computers and early versions of PCs were primarily designed for commercial use.

Fortunately, those days are gone, but OEM automation systems have also become more advanced, and programmers are now expected to create advanced automation systems with very high-speed control and synchronization, complex motion, vision systems, animated HMIs, multi-touch panels, remote access and communications to higher-level computing systems. They're also expected to program these advanced machines and robots in mere weeks.

As a result many OEMs spend a considerable amount of time and effort developing software, which can adversely

Modular Programming Benefits	
1.	Reduces development time
2.	Improves reliability
3.	Increases standardization of the software development process
4.	Enhances the co-existence of multiple programming languages
5.	Enables code to be transported among controllers and HMI platforms
6.	Facilitates troubleshooting
7.	Simplifies modifications

Table 1: Modular Programming; Benefits

affect delivery schedules and costs. The good news is the introduction of modular software that can simplify code creation, allowing OEMs to quickly program complex systems at a reasonable cost.

Modules Make Development Faster

Modular software, with its standard blocks of code, offers a way to simplify the development of controller and HMI programs. It gives OEMs the option to supplement their own internal programming efforts by obtaining specialized blocks of code from suppliers and other sources.

Eventually, peripheral components on production lines, such as robots, will come with their own modular software that OEMs can drag and drop into their programming environments. In addition to speeding development time, the solution will be more standardized, thus making modifications and support easier for both OEMs and their customers.

In the Control Design February 2013 cover story "Machine Control: Tightly Woven Function Blocks," Jason Conner, principal engineer at Concept Systems (www.conceptsystemsinc.com), a system integrator in Albany, Ore., describes his company's use of modular software. "It's less expensive for Concept Systems because code reuse eliminates greenfield programming, which is generally very time-intensive." He adds that engineers can pick and choose software modules from internal libraries of code, knowing that the programs have already been well-tested and

proven within a production environment. Modular software also helps skid builders improve their solutions. Matt Bothe, senior process controls engineer at MC Polymers (www.mcpolymers.com), a producer of styrene-butadiene in Charlotte, North Carolina, says he prefers modular programming when his company purchases process skids. In the Control Design cover story, Bothe says modular programming for conventional utility systems benefits his company through reduced installation costs, greater available support, reliable operations, consistent performance and facilitated troubleshooting. He also adds, "Particularly in the batch world, modular programming has proven to be significantly superior in programmability, efficiency, portability and troubleshooting to the alternatives, such as custom algorithms with little if any standardized structure and terminology."

Application Examples

Table 1 summarizes some of the benefits of modular programming, and an application example from the cover story illustrates the point. D&V Electronics (www.dvelectronics.com) in Woodbridge, Ontario, Canada, builds test equipment. "We manufacture vehicle starter, alternator or hybrid electric motor/drive testing systems," says Ciprian Baciou, an engineer at D&V (Image 1). "These systems involve highly automated control and safety systems for actuators, pneumatic systems, and high-speed high-power dynamometer systems."

“Revised functional blocks and libraries that are improved and developed can almost immediately be validated and deployed very easily. The customer takes a lot of control of the test system by using modular software,” observes Baciou.

PeakLogix (www.PeakLogix.com) in Midlothian, Virginia designs and installs material handling systems (Image 2). In the cover story, their director of technical services Matt Cummings explains why modular subroutines work well in their applications. “In a distribution center, the picking process may have a Low Unit of Measure picking module,” notes Cummings. “Within the pick module, the conveyor moves totes to various zones within the module where the picking takes place. When the tote gets to a particular divert mechanism within the zone, the control program—which receives its directions from the warehouse management system—will sense the presence of the tote and divert it, using output signals to turn solenoids

on or off.”

Owens Design (www.owensdesign.com) in Fremont, California builds custom material handling equipment, primarily for the semiconductor, hard disk drive and solar photovoltaic industries (Image 3). Doug Putnam-Pite, director of software development at Owens Design, explains their use of modular programming in the cover story.

“For our PLC code base, we have created a set of re-usable modular state-based ladder logic code libraries,” he explains. “We have a library of re-usable PLC code modules for servo motors, stepper motors, XY pick and place, and other commonly used control components. We have a PLC design cookbook that our PLC engineers follow to ensure consistent coding and software design standards.”

As with other machine builders, modular software reduces their software development costs. “When using re-usable components, we often save 30% to 40% on

software costs, as new software technologies always take much longer than expected,” adds Putnam-Pite.

Working with Modular Code

The myriad solutions available in today’s automation software market means programmers deal with new terminology on a regular basis: object-oriented programming (OOP), layers of abstraction, encapsulation, function blocks, inheritance, class deviation, polymorphism and modeling. OEMs must be familiar with these new methods, and modular programming helps them stay on top of the latest technologies.

“Concept Systems uses a wide range of software for providing solutions to our customers,” Conner notes in the cover story. The solutions use many different software platforms, ranging from simple ladder logic to more-complex, object-oriented C++. He adds, “Each platform has its own breadth of modularity, but we always use whatever capabilities



Image 1: These automotive test systems are designed by D&V customers to develop starter/generator products.

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Cover Story Cont.

Function Block Programming

Continued from, p. 9



Image 2: Even the most complex material handling systems often make repeated use of common equipment, making them a good fit for modular subroutines that control common devices.

are available within the software package to implement modular and reusable code.” For example, with PLC-based applications, user-defined types and device-specific routines make Concept Systems’ PLC code capable of being constructed as building blocks. For custom software development, object-oriented techniques enable reuse and unit testing, as well as clean structured code.

As opposed to modular programming, traditional custom coding increases the chances of errors. Programmers typically start at the top when programming and execute all the code one line or one rung at a time, then start over. The more extensive the code gets, the more unstable it becomes. Object-oriented, modular programming

improves upon traditional monolithic programming methods by breaking code into objects, and then defining the interface between the objects. It also helps keep code isolated, which defines the concept of abstraction.

OOP seems to be widely accepted among vendors. It enables users to keep track of where their data is during program execution. Encapsulation and abstraction reduce complex code to simple blocks with inputs and outputs. For example, an advanced programmer creating a custom PID loop or a complex math function block can pass code between modules without fear of making a mistake in the rewrite of the software.

Machine builders’ customers also

benefit by being able to add and subtract features as required to meet their own changing production demands. Combined with a well-built version control system for their code, modular software becomes a powerful tool.

Vendor-supplied Code

Many vendors now supply modular software code, such as device drivers, communications interfaces, and software support packages that help OEMs build code libraries. An OEM often becomes familiar with a vendor’s software modules, and then chooses to use the particular vendor for future applications, creating a powerful incentive for vendors to supply free modular code to their customers.

Continued, p. 12>>

Safety is vital

Protect both people and machinery with affordable safety devices



Cable-pull

IDEM Interlock Safety Switches



Hinge



Tongue-operated

Cable-Pull Safety Switches

Cable-Pull (Grab-Wire) safety rope switches are designed to be mounted on machines and sections of conveyors which cannot be protected by guards. Get up to 100 meters of protection length; models with integrated E-stop button and/or LED indicators are also available.

Cable-Pull safety switches start at just \$20.50.

Hinge Interlock Safety Switches

Hinge interlock safety switches fit to the hinged axis of machine guard doors. The switch body fits to the door frame and the actuator fits to the door.

Hinge Interlock safety switches start at just \$14.50.

Tongue (Key) Interlock Safety Switches

Tongue-operated Safety Interlock Switches are designed to fit to the leading edge of sliding, hinged or lift-off machine guards to provide positively operated switching contacts and a tamper resistant actuator mechanism.

Tongue (Key) Interlock safety switches start at just \$15.

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Cover Story cont.

Function Block Programming

Continued from, p. 10



Image 3: Modular software helps Owens Design build state-of-the-art wafer handling systems along with leading edge staging for metrology or inspection tools.

By using modular design techniques, OEMs and their customers enjoy cumulative benefits from the efforts of an international standards organization, an automation vendor, and a solution provider.

InduSoft (www.indusoft.com) supplies HMI software to machine builders, providing them with modular software for applications in which machines and robots need to communicate with higher-level software applications. Fabio Terezinho, vice president of consulting services for InduSoft explains in the cover story that InduSoft Web Studio is designed with the concept of layers of abstraction.

"The idea is to allow the user to build an HMI solution in blocks or modules that can be integrated and reused in a simple and timely manner. OEMs can build applications with InduSoft Web Studio and run them on any Microsoft platform, from Windows CE to Windows 8, without having to recompile or redesign the application. They can configure ERP integration rules, transactions and even

redundancy regardless of the specific database engine used, including MS SQL Server, Oracle, Sybase and OS/soft PI," explains Terezinho.

While programming is more advanced than it was in the days of assembly language and ladder logic, it doesn't necessarily have to be more difficult. Thanks to modular programming and vendor-supplied code, OEMs can create better solutions faster and more efficiently. This benefits both OEMs and their customers, who can more easily modify and add features, making modular code a win-win technology.

Product Snapshots cont.

Continued from, p. 7

are available in 100, 250, 500 and 1,000-foot reels. Resistant to sunlight, oil, and moisture penetration, the cables are suitable for wet and dry locations and for indoor and outdoor applications. Starting at \$50 (100-foot reel), multi-conductor flexible control cables are UL and CSA approved and RoHS compliant. When combined with AutomationDirect's line of ZipPort multi-wire connectors, these cables are an economical way to organize and simplify control wiring. To learn more, visit:

www.automationdirect.com/control-cable

More Koyo high-resolution encoders



The Koyo medium duty encoder series now includes high PPR (Pulses Per Revolution) models. Available in Totem Pole (Push-Pull) or line driver (differential) configurations, the encoders feature a 50mm diameter body with a 35mm depth. Models are constructed with an 8mm diameter solid or hollow shaft and offer incremental resolutions of 3000, 3600, or 5000 PPR. The encoders are also fitted with a two-meter cable with tinned ends and are available with either 5 VDC or 5 to 30 VDC inputs; the high-PPR encoders provide up to 200 kHz response frequency. The high-PPR encoders start at \$175 and are available for same-day shipping.

For more information on Koyo encoders, visit:

www.automationdirect.com/encoders

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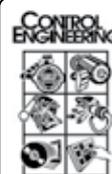
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C-more operator touch panels offer:

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- Analog touch screen for maximum flexibility
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C-more touch panels in 6" to 15" sizes are a practical way to give plant personnel easy access to controls and data. Check out the powerful yet easy-to-use configuration software by downloading a demo version at:

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FULL-FEATURED MODELS ADD:

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REMOTE ACCESS AND CONTROL BUILT-IN

No Additional Hardware required. The C-more Remote Access feature resides in all panels with Ethernet support, and requires no option modules. Access real-time data or initiate an action on a control system from anywhere, any time.

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C-more touch panel family:

6-inch STN grayscale	6-inch TFT 65,538 colors	8-inch TFT	10-inch TFT	12-inch TFT	15-inch TFT
Starting at: \$432 (serial) \$540 (adds Ethernet)	Starting at: \$540 (serial) \$757 (adds Ethernet)	\$1,081	\$1,727	\$2,051	\$2,484

8 to 15-inch units include both serial and Ethernet ports



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Business Notes

Goings on in the Industry

By Joan Welty

Earn Continuing Education credits with online PLC course

Our partner in PLC training, Doug Bell at Interconnecting Automation, is offering his latest continuing education course focused on PLCs; this is a “true” online curriculum with continuing education credits. With over 70 online-study videos, each lasts an average of six minutes; the course includes quizzes, progress testing plus a final comprehensive exam. The course uses AutomationDirect’s *DirectLOGIC* PLCs and the free version of the programming software to cover topics such as I/O addressing, creating and editing ladder logic program rungs, specific programming instructions and more. If you are completely unfamiliar with PLCs, this course also includes Doug’s “Introduction to PLCs 101” videos, which offer instruction on topics such as switches, sensors, and the basics of logic used to create programs.



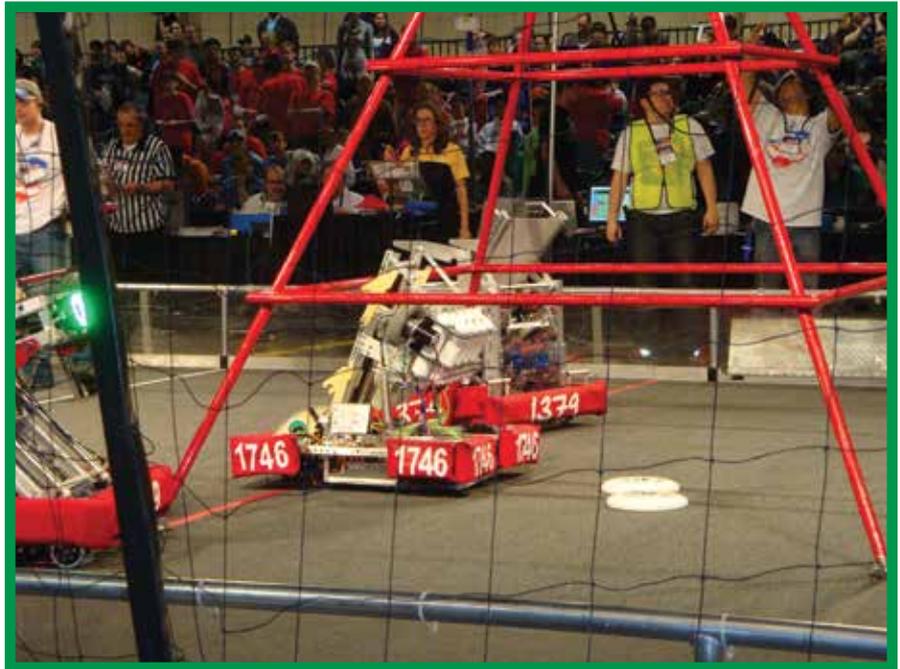
PLC hardware is not a requirement for the course. However, to get hands-on experience, once enrolled, you will be offered a discount of \$20 and free shipping on a *DirectLogic* PLC hardware trainer. You can use the trainer to test the projects you create; whether you have hardware or not, you will upload all programs you create for the course and the trainer will test them for successful operation.

Each student is allowed 120 days to complete the course of study. Upon satisfactory completion of the course, you

will receive three hours of continuing education (CEU) credits plus the ability to print out a Certificate of Completion on your printer. This course is offered for a “limited time” for \$195.00.

For more information and to register for this course, go to Doug Bell’s site at www.interconnectingautomation.com. For the complete list of topics and to view sample videos, go to: <http://bit.ly/14CbRtb>.

Forsyth Alliance shines at the FIRST Robotics Peachtree Regional



AutomationDirect has sponsored Forsyth County schools’ robotics involvement for the past eight years, facilitating participation in the FIRST, VEX, BEST and MATE competitions. This season, in FIRST’s FRC division, the newly-added rookie team from Forsyth Central High (Team 1746) competed at Atlanta’s Peachtree Regional and finished 9th overall after 90 qualification rounds. Several times throughout the competition, the team was ranked between 1st and 2nd.

While the Alliance was knocked out in the Championship rounds, the judges awarded the team the Regional’s Creativity Award for the dynamic pneumatically operated center-of-gravity solution to the technical challenge. Their robot was the only one in the field of 60 that succeeded in climbing the game field’s tower to the third level, quite a feat for a 109-pound machine, particularly considering that no motors were used for the operation! The entire climbing mechanism and dynamic CG (center of gravity) were comprised of AutomationDirect’s pneumatic cylinders, push-to-connect fittings, tubing, flow control valves; the robot even used a

digital pressure gauge so the team could manage the air pressure remotely. Watch the video at <http://bit.ly/13Ad1ks> to see this incredible accomplishment!



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Tech Brief

Enclosure Selection Help



What to know when selecting an enclosure

By Pat Phillips
Product Manager, Fluid Power &
Mechanical Products
AutomationDirect

NEMA enclosures house all kinds of electrical components from simple terminal blocks, to industrial automation systems, to high voltage switchgear. In industrial automation systems, NEMA enclosures often house motor controls, drives, PLC/PC control systems, pushbuttons, and termination systems. Some enclosures are shaped to be operator consoles.

AutomationDirect offers over 1,500 part numbers across NEMA 1, 3, 3R, 3S, 4, 4X, 6P, 12, and 4/12 standards. Our nonmetallic line of enclosures is designed for harsh outdoor environments requiring NEMA 3R or 4X ratings.

What is a NEMA enclosure?

NEMA enclosures meet the National Electrical Manufacturers Association standards for performance and protection of the electrical equipment installed within them. They are typically made from carbon steel or stainless steel. NEMA enclosures range in size from small pushbutton boxes to room-size panels. Enclosures are given a NEMA rating according to the types of applications the enclosure serves.

What kind of environment is your enclosure going to be in and what level of protection do you need?

You need to know your application to make this determination. Is it going to be inside? If so, does it need to be dust, oil, and water tight? If not, a NEMA 1 enclosure will be your most economical option. If you



need dust, oil, and moisture protection, a NEMA 4/12 or 12 enclosure is probably your best bet. Harsh environments subjected to pressurized washdown need NEMA 4 protection. The harshest of conditions, where corrosives are present, need the benefits of stainless steel. These applications call for a NEMA 4X enclosure. Most food processing applications also require NEMA 4X.

Determine the size enclosure you need.

Physical space for your components is not the only requirement. Considerations like watt loss and ambient environment must be taken into account. First, determine the height and width for your enclosure by laying out the footprint space needed for your control components on a standard sub-panel size. Remember to consider the mounting holes for the sub-panel when planning the required footprint space. The size of the enclosure will determine if you need a single-door, two-door, wall-mount or floor-mount. Next, you'll need to determine your panel depth. Remember that the sub-panel mounting takes up a small portion of the depth. Also, any pushbuttons, operator interfaces, indicators, meters, etc. that you plan to mount on the enclosure door will occupy some enclosure depth. Finally you must allow for heat dissipation. If you have estimated component sizes or heat generation, it's always better to over-size the enclosure when you have the available space.

You need to keep it cool

Heat inside an enclosure can decrease the life expectancy of controlling units such as your PLC, HMI, AC drives and other items. Excessive heat can cause nuisance faults from your electrical and electronic components: for example, overloads tripping unexpectedly. Heat will also change the expected performance of circuit breakers and fuses, which can cause whole systems to shut down unexpectedly. So, if you have any electronic equipment or other heat sensitive devices, you may need cooling.

What causes all that heat?

There are basically two sources that can cause the enclosure's internal temperature to rise above the ratings of the control equipment: internal and external.

Internal Sources

The same items that can be damaged by heat may also be the source of the heat. These include items such as:

- Power supplies
- Servos
- AC Drives/inverters
- Soft starters
- Transformers
- PLC systems
- Communication products
- HMI systems
- Battery back-up systems

External Sources

Other sources of heat that can cause the internal temperature of your enclosure to rise above a desired level involve the external environment. These include items such as:

- Industrial ovens
- Solar heat gain
- Foundry equipment
- Blast furnaces

Get the heat out

How do you get the heat out of your enclosure and away from those critical components? There are three basic cooling methods:

Natural Convection Cooling

If the ambient temperature outside the enclosure is cooler than the inside of the enclosure, then the heat can be dissipated into the atmosphere by radiating it through the surface of the enclosure and through the use of louvers or grilles with filters.

Forced Convection Cooling

If you have clean and cool ambient air outside of the enclosure, then a simple forced-air system may be adequate. A system such as a filter fan and the associated grille with the appropriate filter may be an acceptable option.

What size fan is needed?

To select the proper size (CFM) fan for your forced air cooling solution, you need to determine the amount of heat to be removed (in watts) and determine the Delta T (Max. allowable internal enclosure temperature °F – Max. outside ambient temperature °F).

CFM = Cubic Feet per Minute

P = Power to be dissipated in watts

CFM = $(3.17 \times P_{\text{watts}}) / \Delta T$

Delta T = max. allowable

internal enclosure temperature °F – max. outside ambient temperature °F

Closed Loop Cooling

A system that will keep the ambient air separate from the internal enclosure air is needed if the environment is harsh, there are washdown requirements, heavy dust and debris or the presence of airborne chemicals, and the ambient temperature is as high as or higher than the desired internal temperature. Air conditioners are an example of a closed loop system.

Air conditioner selection

To select the proper size air conditioner, the worst-case conditions should be considered, but take care not to choose an oversized unit.

There are two main factors in choosing an air conditioner for an uninsulated metal NEMA rated enclosure located indoors:

- Internal heat load
- Heat load transfer

Internal Heat Load

Internal heat load is the heat generated by the components inside the enclosure. This can be determined by a few different methods. The preferred method is to add the maximum heat output specifications that the manufacturers list for all the equipment installed in the cabinet. This is typically given in Watts, so use the following conversion:

$$\text{BTU per Hour} = \text{Watts} \times 3.413$$

Example: The Watt-loss chart for the GS3 Drives shows that a GS3-2020 AC drive has a Watt-loss of 750 watts.

$$\begin{aligned} \text{BTU per Hour} &= 750 \text{ watts} \times 3.413 \\ \text{BTU per Hour} &= 2559 \end{aligned}$$

Heat Load Transfer

Heat load transfer is the heat lost (negative heat load transfer) or gained (positive heat load transfer) through the enclosure walls with the surrounding ambient air. This can be calculated by the following formula:

$$\begin{aligned} \text{Heat load transfer (BTU/H)} &= \\ &1.25 \times \text{surface area (sq. ft.)} \times \\ &(\text{max. outside ambient air } (^\circ\text{F}) - \\ &\text{max. allowable internal enclosure} \\ &\text{temperature air } (^\circ\text{F})) \end{aligned}$$

$$\begin{aligned} \text{Surface Area (sq. ft.)} &= 2 [(H \times W) + \\ &(H \times D) + (W \times D)] / 144 \text{ sq. inches} \end{aligned}$$

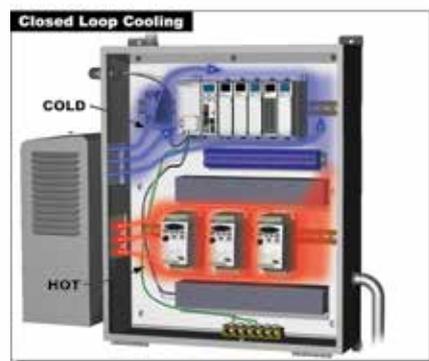
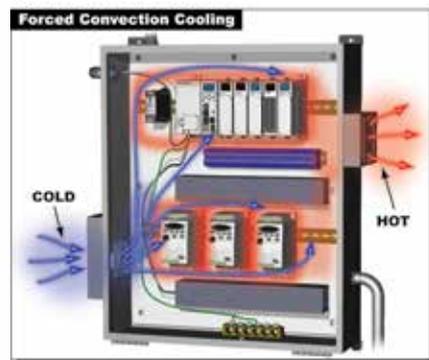
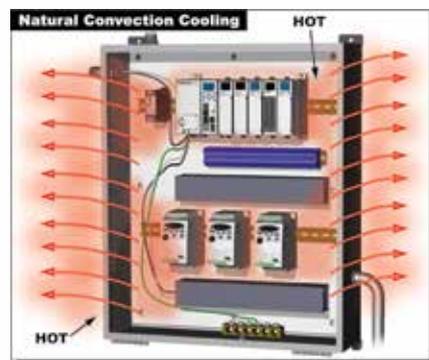
(Note: 1.25 is an industry standard constant for metal enclosures; 0.62 should be used for plastic enclosures.)

Once you have determined your Internal Heat Load and the Heat Load Transfer, you can choose the proper size air conditioning unit by calculating the needed cooling capacity:

$$\begin{aligned} \text{Cooling capacity (BTU/H)} &= \\ &\text{Internal Heat Load} \pm \\ &\text{Heat Load Transfer} \end{aligned}$$

Choose your accessories.

Do you need locks or latches, internal enclosure lighting kits, additional braces, feet, manual pockets? AutomationDirect offers a wide range of accessories for our enclosures. A full line of accessories, including carbon steel, fiberglass, stainless steel, and aluminum subpanels, are also available.



Student Spotlight

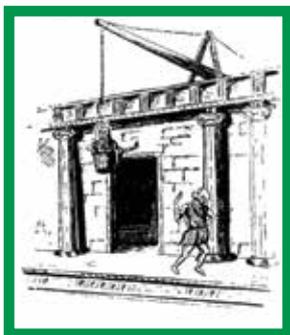
CLICK PLC and C-more Micro Perform

Automation 'Lifts' Purdue Theater Production of Medea

By Chip McDaniel,
AutomationDirect

From Wikipedia[1]: "A *mechane* (pron.: *mēkhanē*) or machine was a crane used in Greek theatre, especially in the 5th and 4th centuries BC. Made of wooden beams and pulley systems, the device was used to lift an actor into the air, usually representing flight. This stage machine was particularly used to bring gods onto the stage from above, hence the Latin term *deus ex machina* ("god out of the machine"). Euripides' use of the *mechane* in *Medea* (431 BC) is a notable use of the machine for a non-divine character. It was also often used by Aeschylus. It was used to allow actors playing gods to fly through the air.

Stage machines were also used in ancient Rome, e.g. during the sometimes highly dramatic performances at funerals. For Julius Caesar's funeral service, Appian reports a *mechane* that was used to present a blood-stained wax effigy of the deceased dictator to the funeral crowd. The *mechane* was used to turn the body in all directions."



When the Department of Theatre at Purdue University decided to stage a production of *Medea*, Richard Dionne (the Technical Director) and his students knew they had a great opportunity for some "stage magic". *Mechanes* and lifts of all types have been used to wow audiences for over 2500 years (albeit with varying degrees of safety). The Theater Dept.



already owned a RibbonLift™ (a telescopic stage lift), but they knew it would take some shrewd engineering to make it safe enough to "fly" an actor on stage during a performance.

The department also owned a number of products from AutomationDirect such as the CLICK PLC lab stations that Rich uses every semester to teach his students how to automate all sorts of theater-related tasks. These stations are comprised of a fiberglass enclosure, a CLICK D0-02DD2-D PLC CPU, two 24VDC power supplies (one for field power, and the one for the PLC), a CLICK digital input module, a CLICK relay output module, four pushbuttons, four indicator lights, a 6" *C-more* Micro monochrome touchscreen display, and multiple cable tails for connecting field devices.

The students realized that given the available lift and one of the PLC lab stations, they would only need a few additional purchased parts, along with some welded parts and brackets, and they could produce a stable and safe lift platform which would also conform to the theater's safety standards.

The project had to meet a number of specifications:

- 1.) Have a stable platform into which an actor can be secured to prevent falling from height.
- 2.) Include some feedback to prevent

movement of lift when the actor was not secured.

3.) Have a method for the actor to provide feedback that they feel safe to move.

4.) Include a distributed emergency stop system that meets NFPA 70 codes for disconnecting power from automated systems, with emergency stop buttons located beside the operator on stage, an additional stage hand on the other side of the stage, and the stage manager in the booth.

5.) Have a means for determining actual height of the unit.

6.) Include a means for entering a desired height at which to stop travel (a soft limit)—and, if possible, to enter multiple soft limits.

7.) Include hard limits at extreme up and down travel, independent of software limits.

8.) Have a means of controlling velocity in both the up and down direction of travel.

9.) Provide a means of remotely signaling the stage manager that the actor is secure, the actor is ready to move, that the lift is moving, and that an emergency stop has not been triggered.



Students designed a welded-steel base into which an actor could be belted using an after-market automobile seat belt; this base comprised a steel tube upright with a U-shaped bracket to wrap around the waist of the actor, to which the seat belt was attached. Weld-nuts at consistent spacing were used along the length of the steel tube column to allow for height adjustment. The seat belt was wired with a normally-open contact which closed whenever the seat belt was latched.

With the CLICK PLC lab station as a starting point, students in the class designed a control system that included:

- A normally-open contact sensor from the seatbelt

- A momentary-contact deadman switch for the actor, to be mounted on the post at the small of the back

- A normally-open limit switch with a roller-level arm for the upper limit and a normally-open limit switch with a rocker-arm for the lower limit

- A normally-open capacitive sensor placed as a position counter along the travel of the ribbon mast.

The motor which drives the RibbonLift is driven by an amplifier which normally receives DC voltages between -10 and +10 to control velocity and direction of travel; because the CLICK CPU analog output controls only vary DC voltage between 0 and 5 volts, students decided to build two op-amp circuits that varied

-10VDC to 0VDC for down travel and 0VDC and +10VDC for up travel based on two separate outputs of 0VDC to 5VDC.

For the emergency-stop system, the students felt it problematic to route 208VAC cable all over the theatre to allow for direct disconnection of power. Rather, they designed a system which controlled a 208VAC relay using distributed 24VDC power. By routing 24VDC through each normally-closed mushroom emergency stop button in series with the relay coils, they felt that they would be able to ensure that hitting an emergency stop button anywhere in the system would immediately cause the relay to cut off the 208VAC power supply to the motor. Additionally, the students decided to use this same 24VDC circuit to provide feedback to the PLC that an emergency stop button was tripped, ensuring that the PLC would stop sending movement commands to the unit (so that when power was restored, it didn't begin moving immediately).

The students opted to utilize an RS485 serial connection between the PLC controlling the unit and a remote PLC in the control booth to provide real-time feedback to the stage manager about the status of the effect, using both indicator lights and the touchscreen display, providing the stage manager with a mirror image of the operator's console.

Rich reports that the lift worked perfectly "The actress playing Medea, who was on the lift, said, 'I felt more safe than on a real elevator.'" and he went on to mention that the project also met all the cost constraints: "Given that the department already owned the RibbonLift, the PLC controls, and multiple limit and proximity switches, our set-up costs were minimal: less than \$250 to purchase some additional switches, connectors, cables, and enclosures. All the control devices were obtained from AutomationDirect."

After a successful run of Medea on campus in February, the students were honored to be asked to present their design at the annual USITT technical theatre conference in March in Milwaukee, Wisconsin. The lift was crated and shipped to Milwaukee for the show, where it became an instant hit, with attendees lined up and

down the aisle for a chance to "ride" it and get a bird's eye view of the show hall.

The students that worked on the lift project included: Michael Banks, Sean Cole, Steve Hnath, Jeremy Jenkins, Derek Miller, Ash Owens, and Addison Snyder.

Richard Dionne is the Production Manager and Technical Director for the Department of Theatre, Patti and Rusty Rueff School of Visual and Performing Arts at Purdue University where he also teaches classes in theater automation.

The Purdue University Department of Theatre offers a full complement of undergraduate and graduate degrees, emphasizing the collaborative spirit of theatre and a strong partnership between art and technology. The department is proud of its national and international connections and the success of its alumni. Purdue Theatre has the distinction of a dual mission; it serves a wide-ranging group of students, while also serving Purdue University and the Greater Lafayette area as a primary cultural resource for the community.

For more information about the Purdue Department of Theatre please visit: <http://www.cla.purdue.edu/theatre/>

1. Mechane. (2013, March 7). In Wikipedia, The Free Encyclopedia. Retrieved 12:54, April 17, 2013, from: <http://en.wikipedia.org/w/index.php?title=Mechane&oldid=542513923>

2. Additional credits for this production: Medea, by Euripedes, Translated by Ian Johnston, Directed by Michael Lenz, Music by Ian Sturges Milliken, Set Design by Derek Miller, Lighting Design by Michael Banks and Greg Freeman, Costume Design by Jill Van Brussel

FYI

ViewMarq LED Message Displays

What you need to know about ViewMarq Displays

By Greg Philbrook, Product Manager, Operator Interfaces, AutomationDirect

VIEWMARQ™
LED MESSAGE DISPLAY



Q. How many colors are displayed by a ViewMarq LED message display?

A. Currently ViewMarq offers a tri-color display with red, amber and green characters, plus scrolling and blinking options. White LEDs are not used.

Q. What are the viewing distances for ViewMarq?

A. Depending upon the model, LED message displays can be seen from 100 to 400 feet away and offer a viewing angle of 140 degrees.

Q. What type of information can ViewMarq display?

A. Virtually any information from devices such as sensors or components in your industrial applications may be displayed on ViewMarq LED message boards. This includes process and equipment status such as tank level, pressure level, oven temperature, and any information that will help operators be more productive.

Q. What hardware/software is needed to control the messages on the ViewMarq display?

A. The displays are slave devices designed to be controlled by logic controllers that can send ASCII or Modbus RTU strings via an Ethernet or serial connection. However, any devices which support these protocols can send command strings to the ViewMarq display.

Q. How do I create text messages for ViewMarq?

A. ViewMarq's FREE easy-to-use configuration software (may be downloaded or purchased on CD) includes a built-in message simulator so you can see the message on your PC as you type. Message creation and editing is simple. Easy-to-find tools assist in changing text color, adding blinking options, or inserting embedded variables. The command string viewer allows you to copy and paste the command string needed for your PLC ladder logic code.

The software utility can also send the message to the ViewMarq LED display and configure the display to communicate with a PLC.

Q. What size characters can ViewMarq display?

A. Depending upon the model type, either 2 inch, 4.75 inch, or 9.5 inch characters with 1-line, 2-line or 4-line versions, and either 12 or 24 characters per line.

Q. Can ViewMarq display graphics?

A. Not at this time; ViewMarq models display text messages only. Messages can be formatted to blink, and scroll left, right, up, and down.

Q. Is Ethernet support included?

A. While other LED marquee products might require an extra cost to add/support Ethernet, ViewMarq comes equipped with a 10/100BaseT Ethernet port; a 7 foot Ethernet patch cable is also included.

Q. For the Ethernet connection, do I need a cross-over or patch cable?

A. A key feature included with ViewMarq is auto-MDIX: automatic medium-dependant interface crossover. This feature allows you to use cross-over cables where you would normally use straight-through cables and vice versa. The switch detects the cable type and reverses its own TX/RX pair to match.

Q. Is the ViewMarq display firmware field upgradable?

A. Yes; the FREE downloadable

ViewMarq configuration software makes it simple to upgrade the message displays' firmware in the field.

Q. Which PC operating systems support ViewMarq software?

A. The ViewMarq configuration software is Windows XP (Service Pack 3), Vista, or Windows 7 and 8 (32 and 64 bit) supported; it requires a serial or Ethernet connection to connect the software to the display.

Q. Is ViewMarq suitable for outdoor use?

A. Not at this time; while ViewMarq is NEMA rated NEMA 4 for washdown, and NEMA 12 for dust, oil, water and dirt, the units are not intended for outdoor use.

Q. Can ViewMarq be used as a standalone product?

A. ViewMarq is intended for use with a PC or PLC-based system and not as a standalone unit. It is ideal for receiving information from any device capable of serial ASCII, Modbus RTU, or Modbus TCP communications. While it can be used to display preformatted messages, that information will be lost once power is removed from the unit.

Q. Does ViewMarq have a real time clock?

A. Since ViewMarq is a slave device, it relies on a master to provide data, including real-time clock information, for messaging. ViewMarq does support variables, which can be used to display the time data from the controlling device within the message.

Q. What agency approvals does ViewMarq offer?

A. UL508, CE, RoHS and Reach. Note: Only the wall-mount and cabinet-mount options are UL508 rated. The chain-mount option is not UL approved.

Q. Are there mounting limitations for ViewMarq?

A. ViewMarq displays can be mounted in any horizontal position, such as a wall, ceiling, or cabinet. Each unit is equipped with an accelerometer to ensure your message is automatically displayed in the upright position.

Q. What power requirements does ViewMarq have?

A. ViewMarq can be wired for 100-240 VAC or 24 VDC power.

User Solutions

"Not in my house son!"

DaMan revealed during the Final Four activities in Atlanta

by Rick Folea
AutomationDirect

Earl Bouse, with E. Larue Enterprises in Dahlonega, GA., has been developing his idea of the "perfect" automated basketball defender for the last two and a half years. Although Bouse says that his DaMan creation is not quite ready for prime time, he is ready for prospective customer feedback and field tests.

With the 75th Final Four happening "just down the street" in Atlanta this year, Bouse took advantage of the opportunity to debut his creation to the basketball world by participating in the NABC (National Association of Basketball Coaches) convention. Coaches and players alike were given the opportunity to experience what it's like to be the "Big Man" on the court.

Another exciting event for DaMan was an audition for the popular TV show Shark Tank which took place at Atlanta's historic Fox Theater. Even if they don't make the



DaMan in position to jump up and block a shot.

show, they were an overwhelming favorite of other co-inventors and local TV stations which aired several interviews asking the big question, "Is DaMan the next Million Dollar invention?" Bouse certainly hopes so.

What exactly is DaMan?

It's best described as a mobile, anthropomorphic, robotic, athletic defender. The original concept was to design and develop a more efficient and

user friendly basketball defender/shot blocker. But with input from several coaches, players and others who have seen DaMan in action, Bouse says, "We see other opportunities like volleyball and possibly even baseball in his future."

Functionally, DaMan is a three-dimensional device which can raise and lower his arms, vary his body height from 6'7" to 8'7" and rotate his body a full 180 degrees. DaMan is mobile, which enables him to go forward while rising up as a "closing leaping defender" as well as go backwards and sideways.

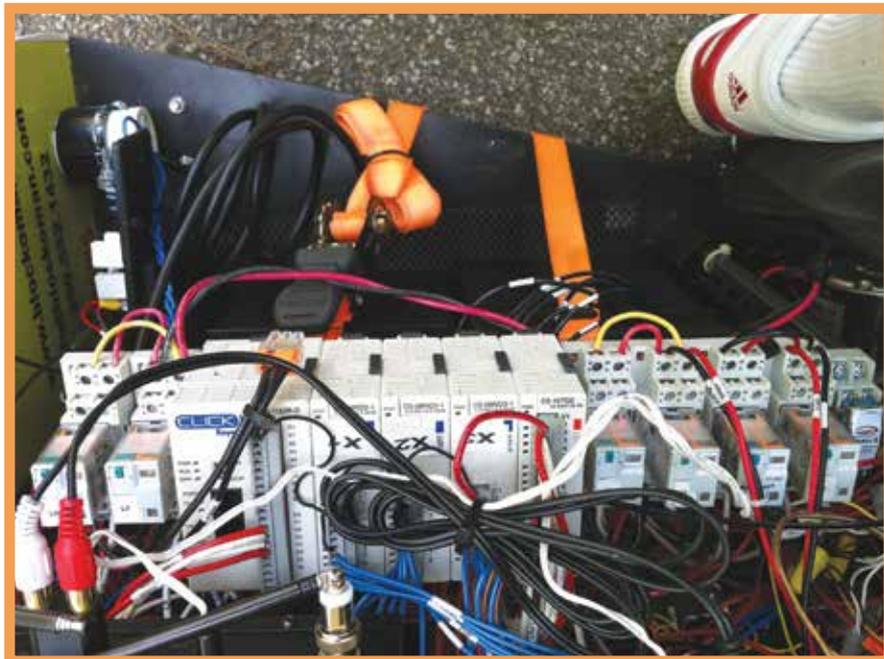
Not only is DaMan a mover and a shaker, he also has the ability to "talk a little trash" via a headset worn by the coach, which broadcasts his voice through a speaker mounted in the DaMan's chest (e.g. "Not in my house Son!").



DaMan jumps to block a shot.

The key to all this movement is five motors controlled via an AutomationDirect CLICK PLC, which enables DaMan to be operated in any one of three operational modes:

- 1). Radio control whereby he is controlled by a custom wireless radio transmitter



The AutomationDirect CLICK PLC is the brains behind DaMan

Continued, p. 22>>>

The Break Room

Brain teasers



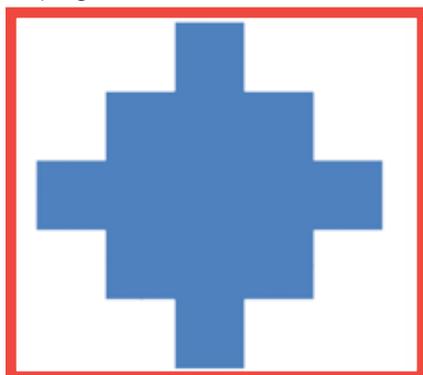
Brain teasers

By Chip McDaniel,
AutomationDirect



1.) Penny Wise

Place six pennies on a flat surface. Can you arrange the pennies in the exact positions shown, such that - IF you placed a seventh penny in the middle - it would touch all of the original six? You may not lift any of the pennies from the surface or use any other items, pennies, or measuring devices to assist, nor is it necessary to depend on your eye for judgment.



2.) Cutting Corners

Can you cut the previous shape into four identical pieces that will fit together to form a square?

3.) Tankless Task

A shipping company with a poorly maintained fleet of trucks was hired to convey a large number of tanks from a factory to be filled at a chemical plant across town. They loaded an equal number of the empty tanks on each of their many trucks. But as the drivers prepared for departure, it was found that 10 of the trucks would not start. So the tanks were redistributed, with one additional tank being added to each of the remaining trucks. Once the tanks were filled at the crosstown location, the drivers discovered that an additional 15 of the trucks would not start. So once again the tanks were redistributed; this time adding exactly 3 more tanks to each of the working trucks than had originally been loaded on each truck at the beginning of this shipping fiasco. By some miracle, all of these remaining trucks made it back to the factory. *How many tanks were there?*

4.) Cable Cobble

Four professors, each with one of their students, went to purchase some flexible multi-conductor control cable. Each professor bought twice as many feet of cable as their respective student, and each person bought exactly as many feet of wire as the number of dollars he/she paid per foot of cable. Prof. Jones spent \$76 more than Prof. White; Nancy bought 3 feet less than Prof. Brown; Glen bought 2 feet more than Hal, who spent \$48 less than Prof. Smith. *What is the name of Mary's Professor?*



Did you know that AutomationDirect recently began selling flexible multi-conductor control cable? At the lowest prices in the industry! But not by the foot - we sell it on convenient 100', 250', and 1000' reels.

User Solutions cont.

Continued from, p. 21

- 2). Sensor mode which reacts to sonic range sensor inputs, and
- 3). Autonomously to a scripted PLC program which enables DaMan to follow a reflective tape using input from AutomationDirect reflective photoelectric sensors and respond accordingly.

The CLICK automation controller was the "tool of choice" for Dan Formella, their programmer and former Lanier Technology graduate. Bouse said that Dan's familiarity made using the CLICK PLC a "no brainer" because of its low cost, I/O modularity and zero license fee!

The fact is that almost all the electronics, including relays, switches, indicator lights, ON/OFF, mode and limit switches are sourced from AutomationDirect.

Field tests are scheduled for this summer and fall with customer availability expected next spring. Bouse said the company is also considering a partially assembled version that would be targeted to both technical and non-technical high school and college students. This would introduce them to robotics and broaden their interest in sport activities as well. As students learn how to program the CLICK PLC, the potential is limitless. You can be assured that students will expand the possibilities; we are just beginning to explore the options.

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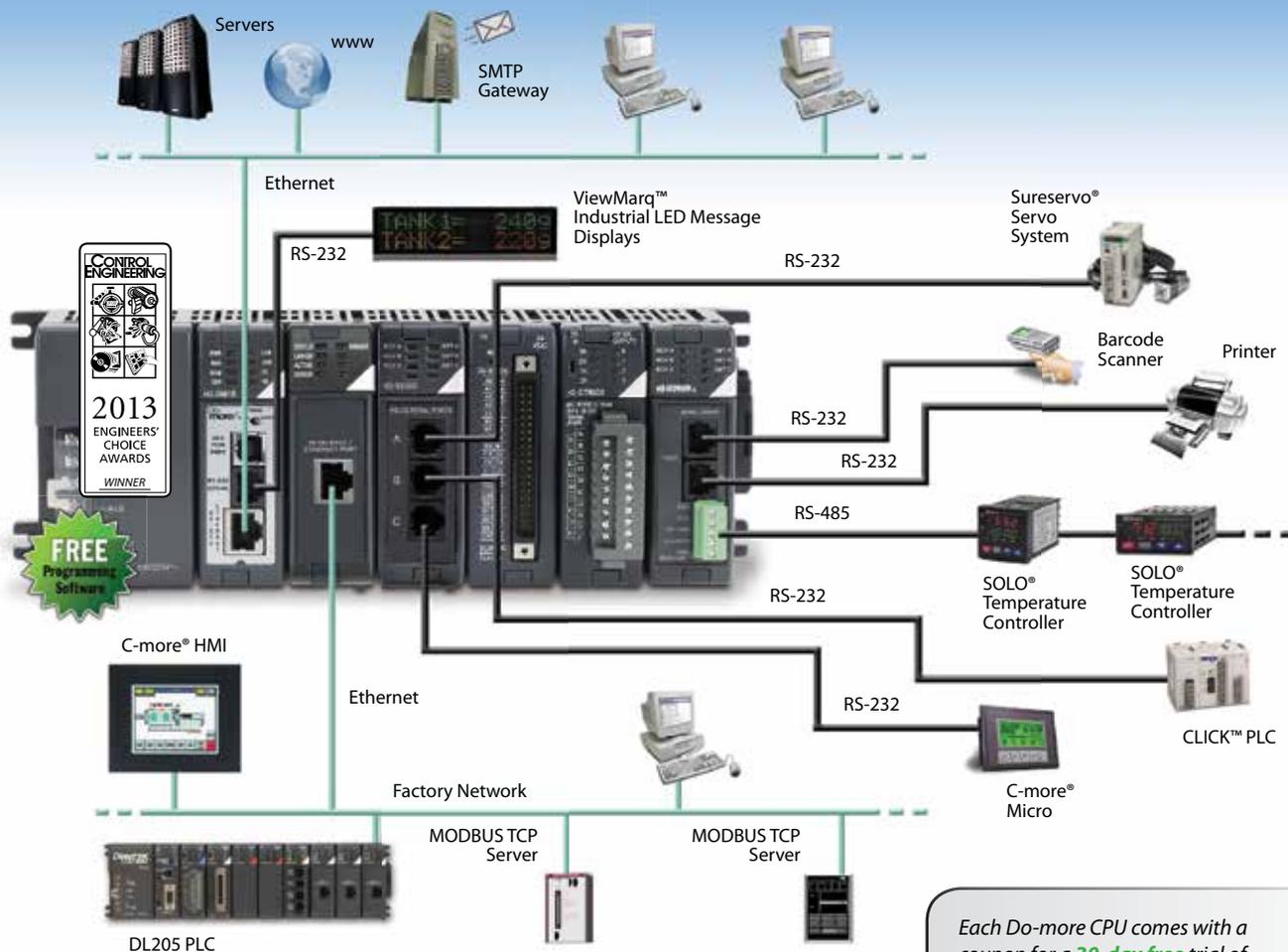
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