Motion and Logic in the Drive Helps Drive Down Automation Costs

Today's fast-changing, highly competitive global marketplace is driving many system and machine designers (both end-users and OEMs) to aggressively seek goals that are very demanding: greater machine performance, at a lower cost system overall.

For packaging end-users such as plant operators, this means a push to get more and more product throughput out of smaller, low cost machines, without sacrificing one iota of product quality. OEMs are driven by parallel requirements – to offer highly flexible solutions, at lower and lower costs. They must deliver system/machine scalability, meet changing market demands, and support simplified integration to the rest of the line. Their primary goal: offer solutions where end-users pay only for what is needed. From a controls perspective, integrating Motion and Logic in a scalable hardware package can help fulfill this need.

Centralized Control
The advent of a centralized architecture for motion control and logic has provided some advantages. The integration of the motion control into rack-based PLCs did help reduce the component count in the control panel enclosure, and made it possible to program motion and logic from a single point in a single program. This delivered an initial round of cost savings; ultimately, however, this was only true when a single processor was used with a medium axis count.

A centralized control has an inherent limitation: there is a fixed amount of microprocessor resources available for all required functions: motion, logic, overhead tasks, communications, etc. In any operation, top priority is always given to the motion task. Whenever an axis is added, a new burden is placed on the centralized processor.

Limits reached
At a certain point the processor hits its limit and starts reducing performance to accommodate the additional axis. This reduction might be in the form of a slower response to registration inputs, not being able to run complicated cams, programmable limit switches, or not being able to run the system as fast as the machine is capable. This in turn can set up the need to add more processors, so the machine can run at full capacity. Once this becomes necessary, there is little or no cost advantage, or operational advantage, if a design engineer is forced to install complex PLCs for simple, low-axes count applications.

The disadvantage to PLC-based motion controllers is the centralized control architecture. In a number of situations, it has proven to be the limiting factor in providing low cost, scalable, high performance solutions. On simple machines like fillers, augers, infeeds, wrappers and cartoners, using a PLC for the motion control can be overkill. It can add prohibitive costs that make it difficult to create a machine that fully meets an end-user's cost-performance requirements.

In addition, centralized control can limit an OEM's ability to optimize machine performance. Packaging machines are very motion-centric, which makes the motion control critical to maximizing efficiency and throughput. For example, a vertical form fill and seal machine that can mechanically run at 200 pieces-per-minute (PPM) might only be able to do 145 PPM, due to limited controls performance. In some cases, using a centralized control architecture can double the price of the control system.

Centralized control has reached the limit in the value it can offer. With today's fast-changing markets calling for much more production flexibility and scalability, the limitations of PLC-based centralized motion control are more and more evident. New technology and new approaches to motion control and logic have created a powerful alternative: Distributed Intelligence.

Distributed Intelligence
Distributed versus centralized control is defined by the location of processing power for the motion control. With a centralized architecture, a fixed amount of PLC processing power is divided among all the axes. As axes are added, the available processing power is reduced.

Distributed intelligence (DI) solves the problem in a simpler way: Move the burden of controlling an individual axis out to the drive. Thanks to advances in microelectronics, intelligence can be distributed throughout a machine – to the sensors, motors, drives and other components.

In a DI system, each drive is capable of closing the feedback loop and can handle such advanced functions as cam tables, absolute feedback, Electronic Line Shafting (ELS), diagnostics, and high-speed registration. It is even possible to add Safety On Board and Predictive Maintenance functionality at the drive.

The processing power that can be built into the drive with today's low cost processors and memory allows the drive to be quite intelligent. Most importantly, when you add a drive, you add *more* intelligence to the system. This is the exact opposite of centralized control, where every additional axis drains processing performance.

Distributed intelligence not only reduces the processing load on the controller, it changes the controller's role in motion control to a supervisory one. Decentralized controls such as the ones offered by Bosch Rexroth can handle up to 64 axes. There is no degradation in system performance as you build machines from 1 up to 64 axes.

Enhanced scalability
Distributed intelligence is a modular, responsive architecture. It supports the scalability that is an absolute requisite in current operating environments. Adding an axis is greatly simplified: just add a new servo axis. There is no need for additional expansion cards or functionality to the controller. The intelligence is in the drive itself.

Adding functionality and intelligence in a drive-by-drive distributed fashion frees design engineers to create machines that serve end-user demands for more convenience and flexibility. Because processing power has ceased to be a limitation, more servo-controlled axes are practical – along with the advantages of faster setup, greater precision and higher reliability.

DI architecture can also enhance operational uptime and flexibility by supporting integrated safety and predictive maintenance at the drive level. It is made easier because of the quicker response and data monitoring inherent in a distributed intelligence platform. For example, integrated drive safety features offered on Bosch Rexroth systems respond as much as four hundred times faster than centralized safety functions, because safety is implemented at the drive level.

Implementing DI
Implementing a DI system requires several components engineered to work in a de-centralized architecture. These include intelligent drives and a DI-ready controller.

Some may think an intelligent drive is one that can simply handle the position loop and receive inputs. However, this type of drive still places a heavy burden on the processor. For true distributed intelligence, a drive should be able to handle tasks such as closing the position loop, absolute positioning, high-speed registration, cam tables, ELS, and diagnostics.

As more and more remedial tasks are handled by the drive, the load on the controller is reduced. A perfect example is to provision safety and predictive maintenance tasks at the drive level. These tasks do not necessarily have to be managed from a central location; plus, by making them drive specific, problems can be quickly isolated, downtime can be reduced, and machine throughput optimized.

The motion controller is the next component in this architecture. A DI-ready controller must take full advantage of intelligent drives. Its key tasks will include running logic, overseeing drive communications, I/O peripherals, HMIs and system networks. Involvement in the motion will be at about a supervisory level.

Integrated Logic and Motion Control in a Drive
Integration of the logic and motion control in a drive implements the distributed intelligence model, without sacrificing – in fact, enhancing – machine performance and ultimate value. This fits perfectly into packaging systems such as carton erecting, flow wrappers, smart belts, infeeds, cartoners and labelers.

One implementation of the distributed intelligence architecture is Bosch Rexroth's IndraMotion MLD solution. The MLD product from Bosch Rexroth merges drive functions, motion control and processing logic into a distributed, open automation platform for modular machine concepts.

The main hardware component is Rexroth's highly scalable digital drive system, IndraDrive. The MLD utilizes the SERCOS III standard to interface with up to 7 additional slave drives. A Rexroth HMI can be connected directly to the drive via Ethernet for a complete system solution, and deliver a single connection point for all programming of system elements.

The MLD delivers real-time motion control combined with an IEC 61131-3 compliant PLC programming language for both motion and logic. Rexroth utilizes the IEC 61131-3 compliant IndraLogic sequence control system in all its 'IndraMotion for Packaging' controllers. The common elements ensure that program components can be reused even at different levels of automation. It is based on modern .NET technology and allows even third-party software modules to be integrated.

To facilitate start-up, Rexroth offers the IndraWorks engineering suite. This programming environment makes for easy installation of a single piece of software to handle motion, logic, HMI, networking, setup, programming, diagnostics and data gathering.

This approach simplifies machine commissioning and changes over time. It eliminates the frustration and effort of installing different software packages for the motion, logic, networking and HMI. Technology functions for registration, CAMming and gearing make startup faster and easier.

True scalability and hardware cost savings is only the tip of the iceberg with the MLD. All connectivity to the MLD system is done with OPEN fieldbus standards. Installing one MLD unit replaces these tasks: mounting and wiring the motion controller, and all the handshake programming of a Motion controller, Logic controller and drive.

The MLD is a core building block of the IndraMotion for Packaging solutions. The programming of the motion and logic can easily be migrated up to the MLC controller while still using the same IndraDrive hardware. The rack-based MLC controller can currently handle 32 axes (soon to be 64.)

Savings in Multiple Areas
The IndraMotion MLD platform demonstrates how OEMs and end-users achieve dramatic hardware and software savings using distributed intelligence, while still assuring improved machine performance.

The cost savings with the IndraDrive MLD comes in many forms. First and foremost, the PLC and motion controller hardware are eliminated and integrated into the servo drive. Eliminating the PLC also leads to reduced wiring requirements, installation costs, and a smaller electrical cabinet. Analyses indicate this reduces hardware cost from $7,000 down to $1,000 in a typical application. Plus, eliminating the interface card and wiring between the PLC and servo drive can provide an additional $2,000 savings. Low axes count machines such as infeeds, wrappers, cartoners, casepackers and palletizer applications can derive the greatest cost-performance benefit in these situations.

Other significant savings include elimination of communication programming between the PLC and motion controller, and reduced machine footprint and cabinetry, because of the reduced component count. Installation time and associated engineering costs drop because there is less hardware to install. Machine documentation complexity and production time is reduced. Diagnostic and troubleshooting of hardware can be done from one point to help with quicker recovery. This results in more uptime and a better bottom line for the end-user.

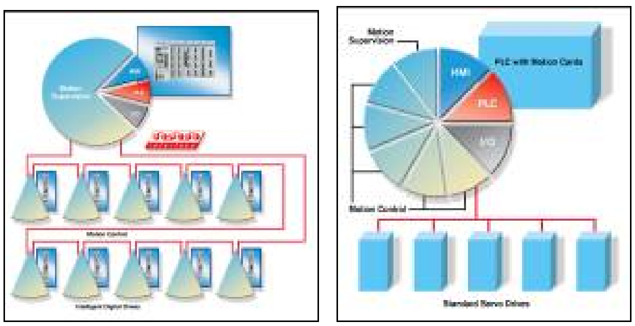
On the software side, the IndraWorks software suite is a one time purchase and does not require a yearly renewal which can save end-users as much as $40,000 to $50,000 a year on renewal fees. And integration with overall enterprise systems is easy: Upward connectivity to the MES or plant floor Information network is done via standard onboard Ethernet connectivity.

Integrating motion and logic in a drive is the way to achieve the flexibility and scalability today's fast-changing production environment requires. As OEMs strive to create high performance, low-cost machines, and end-users in the packaging industry push to keep a lid on capital expenditures, the distributed intelligence solution provides an innovative path forward. It leverages the advantages offered by today's advanced microelectronics, and supports a complete, high performance system at the lower cost end-users require.


BR IndraDrive_H.jpg - The processing power that can be built into the drive with today's low cost processors and memory allows the drive to be quite intelligent.


Packaging Machine.jpg - Adding functionality and intelligence in a drive-by-drive distributed fashion design makes machines more convenient and flexible.


IndraMotion-MLD_H.jpg – A compact drive-based solution is perfect for applications with up to six axes that require specific functionality.


Machines are becoming more motion-centric; as axes increase, machines can become more flexible and productive. Distributed intelligence is designed around the motion-centric machine, so you can add more intelligent digital drive axes without having to upgrade or change the control platform.

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