

Uptime and equipment reliability are critical in process applications like oil and gas production where even a short period of downtime can prove extremely costly. This is where the implementation of intelligent motor control centers (MCCs) are playing an increasingly vital role, performing critical protective and troubleshooting functions while providing detailed diagnostics to help improve productivity and minimize downtime. Advances in MCC technology include an integrated design that streamlines installation and setup, delivers real-time monitoring, and easily integrates into a facility-wide network. This paper provides an overview of the industry drivers and evolution of MCCs, including technology considerations, configuration methods, networking advantages, as well as costs and benefits gained from real-world application examples.

Intelligent Motor Control Centers Lay the Foundation for Improvements in Manufacturing Efficiency and Reliability

Access to critical process data increases critical asset availability, helps protect investments, and can lead to improved plant safety



Summary

Keeping manufacturing processes running smoothly often hinges on the ability of engineers to access real-time production data. Fortunately, advanced monitoring and sensing technologies that integrate smart devices, device-level networks and software into motor control centers now exist, allowing manufacturers to capture and use equipment and process data.

Today's intelligent motor control centers (MCCs) offer a textbook example of this, with an integrated design that delivers real-time monitoring and detailed diagnostics to help improve productivity and maximize critical asset availability. These systems occupy a prominent role in control schemes, housing a comprehensive array of control and monitoring devices, and a built-in network that opens up access to process data from virtually every corner of the plant.

MCCs have moved rapidly to include the latest component technologies. Integrating these advanced technologies presents a major opportunity for manufacturers to transform islands of data into useful information. This paper provides an overview of the industry drivers and evolution of MCCs, including technology considerations, configuration methods, networking advantages, as well as costs and benefits gained from real-world application examples.

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Traditionally, MCCs consisted of primarily electromechanical components with hard-wired connections. These components remain the workhorses of MCCs, but advances in solid-state technology are ushering in a wave of more intelligent, programmable devices that do more than just turn on and off a motor. These include variable frequency drives, solid-state starters and electronic overload relays.

Today's MCCs monitor motor current and thermal capacity, perform protective troubleshooting functions, and provide detailed diagnostics to help avert downtime. Distinguishing itself from a standard unit, the intelligent MCC integrates three major system components – communications, hardware and software. While early versions of MCCs with communication networks contained variations of these elements, today's solutions leverage a harmonized design that deliberately integrates these elements into a unified solution.

A Reliable, Robust Network

The communication network lies at the heart of an intelligent MCC. Therefore, it's important to implement the right network. The trend toward open networks offers clear and well-documented advantages. In general, the network should provide adequate throughput (up to 500 kbps), offer a low cost per node, and be accepted by a wide range of suppliers and users. The best choice is a robust, reliable network, such as DeviceNet, which provides ease of configuration advantages and superb diagnostic capabilities.

Users also should consider differences in network media. Because of the way data is handled for various applications, most facilities require multiple networks. However, providing seamless communication from one network to the next can present a major obstacle when using different network protocols.

Using a range of network protocols is similar to dialing a three-way telephone call from the United States to extensions in France and Japan. Just because the phone rings on the opposite end and someone answers doesn't mean all parties can understand one another without a translator. A common language is needed for conversation.

This is where a common application layer, such as the Common Industrial Protocol (CIP), proves to be a major differentiator. CIP is a single, media independent platform that provides seamless communications between plant-floor devices and enterprise-level systems. This allows manufacturers to integrate control, configuration and data collection across multiple networks, getting real-time information to where and when it is needed.

The CIP networks including DeviceNet, ControlNet and EtherNet/IP – are open networks that share the CIP at their upper levels while remaining media independent at lower levels. This allows manufacturers to specify the best network for each application and eliminate costly gateways when connecting dissimilar upper-level networks. More importantly, it opens the door to system-wide communication while offering better tools to control motors and increase plant efficiency.



The Value of Process Data

When properly deployed, the intelligent MCC allows users to monitor and analyze operations from anywhere at anytime. With access to more detailed information over longer periods of time, users can better predict potential problems and prevent catastrophic failures. Moreover, the improved quality and availability of data helps improve troubleshooting speed and accuracy. Rather than relying on obscure fault codes, maintenance personnel receive simple descriptions to pinpoint specific problems.

For maximum network efficiency, engineers can configure devices to report data as often and in whatever format as needed. For example, a drive controlling a rapidly fluctuating process might report status every 50 milliseconds, while a motor on a slower changing process may only be required to report status every 60 seconds. For most parameters, devices can be configured to communicate only on a change of state. Diagnostic data can be accessed outside of the regular data scan, keeping all data available without clogging the network with information that's only used occasionally. Information reported by devices in the system can be recorded for later analysis, if needed, or used to generate alarm messages as important events occur in the process.

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A More Optimized Design

Up until now, MCCs lacked interwiring and required extensive field wiring, documenting, testing and system integration. Conversely, the intelligent MCC arrives preconfigured, pretested and ready to install. The communication cables are installed and tested, intelligent devices are preprogrammed (with baud rate, node number, trip current, etc.), and software screens are pre-configured, all of which help reduce startup time.

The primary drawback of many network configurations, such as those in a daisy-chain configuration, is the inability to make device changes or additions without shutting down the network. With this type of topology, moving or adding devices requires the technician to break the chain, thus disabling the network.

A better approach is to isolate trunk and drop lines behind barriers, avoiding potential damage to communication cables during installation and maintenance activities.

Trunk and drop network design provides easy-connection communication ports that allow devices to be plugged or unplugged without network disruption. This configuration should also provide independent, readily accessible ports to simplify installing, withdrawing, relocating and adding plug-in units.

Engineers require detailed documentation for fast startup and efficient troubleshooting, but this documentation is often misplaced or incomplete. With an intelligent MCC, users can access electronic documentation on the same PC running the monitoring software. This allows users to view real-time status of the MCC, as well as view computer-aided design (CAD) drawings, user manuals and spare parts information applicable to their specific MCC units.

The Core Components

To qualify as an intelligent MCC, every unit needs communication capability to replace the traditional control interwiring with a single communication wire. Ideally, all the units should have input points to monitor devices, such as disconnect switch, contactor, overload relay or a hand-off auto selector switch. Users also need a network scanner module or network linking to collect and distribute the device data in the MCC.

At the minimum, an intelligent MCC should be comprised of the following components and capabilities:

- Intelligent overload relays – The most common device in the MCC is the motor starter, so overload relay intelligence is paramount. Users should expect:
 - Built-in network communication
 - Input points (for monitoring disconnect or selector switch)
 - Output points (for controlling contactor)
 - LEDs for status indication
 - Protective functions – thermal overload, underload, jam, current imbalance, stall, phase loss, zero sequence ground fault, and PTC thermistor input
 - Programmable parameters for the protective functions – trip level, warning level, time delay and inhibit window
 - Current monitoring – phase, average, full load, ground fault, imbalance percent and percent thermal capacity used
 - Diagnostics – device warning and trip status; time to overload trip; history of last five trips; time to reset
- Miniature I/O module for non-intelligent units – Traditional electromechanical starters and feeder disconnects have no means to communicate with networks. Wiring to a distant I/O chassis is not the ideal solution. The preferred approach is an I/O module within the unit – small enough so the MCC unit size is not altered – to link the device and the network. The I/O module should have an adequate number of inputs and outputs, according to the unit functions. For a starter, four inputs and two outputs can satisfy 99 percent of applications.
- Network communication interface module with input points – Intelligent devices often require an external communication module. Ideally, this module should contain input points (again, to eliminate wiring to a distant I/O chassis). Four inputs are sufficient for most applications.

Pre-configured monitoring software for Intelligent MCCs should be available to help integrate the hardware elements and provide a window into the MCC and related equipment. The software eliminates the need to create costly customized MCC screens within an operator interface software, providing users with a plug-and-play setup and configuration.

Following is a benchmark checklist for intelligent MCC software:

- Operates in a familiar environment – The software should offer a user-friendly Windows operating environment.
 - Includes unique MCC documentation to initialize screens – The MCC vendor should supply a database with each intelligent MCC that allows the application program to generate screens containing data pertinent to that MCC.
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- Initiates network communication – Establishing devices as recognized entities on a network can be a time-consuming step. Ideally, the MCC manufacturer should download user-specific information – like node addresses and baud rate – and test the entire system for accurate functions and communication. Upon installing the MCC and software, the user simply lets the software poll the pre-configured devices to match the device information with the user database.
- Displays pre-configured screens showing most common parameters – The software accesses the user’s specific data files and builds the corresponding screens.
- Includes all user-specific documentation – A comprehensive documentation database minimizes frustration and downtime experienced while trying to locate misplaced documentation. Documentation components include:
 - Unit wiring diagrams
 - As-built drawings of the MCC lineup
 - Product user manuals
 - Spare parts list
- Can be accessed at any network level – The user should be able to view the MCC by plugging into any network level. This feature gives users the flexibility to locate the software on a maintenance laptop, in a control room or at an engineer’s desk.
- Efficiently handles MCC changes and upgrades – MCCs often have units added and rearranged, so the software must readily accommodate such data changes. The software should easily handle new units and any location changes for existing units.

Installation Advantages

Intelligent MCCs deliver considerable cost savings in the form of reduced design, installation and documentation time. Savings occur as a result of the significant reduction in cabling requirements, including cable supports and interface equipment, such as terminal boxes, control system I/O modules and interposing relays. In fact, intelligent MCC users report installation costs are reduced by up to 15 percent, compared to a conventional MCC installation. Users achieve additional cost savings through improved diagnostics, which helps provide faster troubleshooting.



Case in point: a mining company in the southeast United States built a plant and installed low and medium voltage intelligent MCCs equipped with electronic overload relays, with built-in DeviceNet communication. The transition from start-up to operation required only one week to accomplish. During startup, whenever engineers encountered problems with any motor, they could make adjustments over the network via the operator interface.

The MCC software allowed monitoring, troubleshooting and, when necessary, configuration and reconfiguration of devices. Without intelligent motor controls, preconfigured MCC software, and a network architecture that allowed technicians to collect data and configure devices, engineers would have been forced to use trial and error. With all these features, engineers spent minutes troubleshooting each problem instead of hours.



This type of detailed ongoing analysis is a common requirement in process applications around the globe. Take the Northwest Passage exhibit at the Memphis Zoo for example. The project required designers to recreate a habitat mimicking the cool, dry environment of the Pacific Northwest thousands of miles away.

Challenged with summer temperatures in Tennessee of 100 degrees Fahrenheit and humidity pushing 100 percent, engineers needed to maintain the exhibit temperature around 70 degrees Fahrenheit +/- 1 degree,

with a relative humidity of 50 percent to meet regulatory guidelines and maintain the animals' health. Animal health – and the visitor experience – depended on the delicate balance of water chemicals, such as ozone and bromine, and carefully monitoring pH levels.

In this zoo application, a highly accurate and reliable instrumentation and motor control system proved critical to monitor equipment operating status for all process measurement instrumentation, drives and motors. System alarms needed to do more than simply alert maintenance staff that a problem occurred. They also needed to predict potential problems and alert the maintenance staff to trigger them to resolve issues before they occurred.



To meet those requirements, the zoo installed an Allen-Bradley® ControlLogix® programmable automation controller (PAC), Allen-Bradley CENTERLINE® MCCs with IntelliCENTER Technology and Allen Bradley PowerFlex® drives from Rockwell Automation to control motors connected to pumps and fans throughout the exhibit. DeviceNet connects the PAC to the AC drives controlling the motors, which circulate the air and water as needed. The IntelliCENTER software is the heart of the system, as the MCC and software monitor and manage most of the pump and fan motors in the system.

Using networked intelligent MCCs paid off on many levels:

- The comprehensive alarming and remote-monitoring capabilities reduce the number of on-site staff needed to monitor the system, saving the zoo up to \$80,000 annually in labor costs alone.
- Using the preconfigured MCCs saved three to four weeks in startup time for the motor control system, and six to eight weeks in installation costs due to the flexible connection capabilities.
- Overall, the installation costs were reduced nearly \$100,000.

“Because of the IntelliCENTER MCCs, we didn’t have to wire each individual I/O,” said Rober Gaines, director of Process and Automation, Ellers, Oakley, Chester & Rike Inc., designers of the system.

“And we could remotely configure instruments, drives and associated motor control devices, all of which saved a tremendous amount of time in installation.”

Better Energy Management

Improving energy efficiency is becoming an increasingly important benefit of installing intelligent MCCs, especially in energy-intensive industries like oil and gas production. The key to energy efficiency is information and knowledge – information on what’s happening in the manufacturing process and the knowledge to respond appropriately. This is where intelligent MCCs networked to high-performance controllers and advanced energy-management software helps provide the analysis and understanding needed to maximize energy savings.

The controllers provide a common collection point for data from the motor control devices. The controllers work with the PCs running the human-machine interface (HMI) and logging software to automate data collection. The energy-management software serves as a centralized database for all power parameters that can be accessed within a facility or across multiple facilities in various locations using a standard Web browser. Being able to “see” a problem often gives additional meaning to the information derived from the raw data and in turn, leads to the proper corrective actions.

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This same software enables manufacturers to model their energy profiles by measuring peak demands and power quality parameters; determining demand patterns; correlating energy consumption to weather patterns; aggregating loads; and calculating energy costs by business group, department or site. This modeling approach saves a significant amount of money since solutions can be verified before committing capital expenditures for new systems or equipment.

A Prime Opportunity

As the cost of intelligent devices continues to decline, intelligent MCCs offer manufacturers an excellent opportunity to benefit from advanced technology of these control systems, including improved diagnostics, increased system reliability, design flexibility and simplified wiring. While a robust, reliable design is critical for helping to contain faults and minimize downtime, equally important is the device-level networking capabilities of today’s intelligent MCCs.

Technology has reached the point where it is both practical and affordable to utilize networked intelligent motor-control devices. This integrated networking offers expanded opportunities for advanced monitoring, control and diagnostics, providing users with significant new information for preventing or minimizing downtime. Also, since most information can be obtained remotely, an intelligent MCC can help improve safety by reducing exposure to hazardous voltage during startup and troubleshooting.

In this era of focus on reduced expenditures, cost is the real driver behind implementing this new technology. With a lower installed cost than traditional MCCs, plus the above benefits, engineers should make intelligent MCCs a top priority for future MCC projects.

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