Optimizing Lean Operations and Achieving Condition-Based Maintenance With Integrated Human-Machine Interface and Supervisory Control and Data Acquisition

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Managers of maintenance systems continually strive for leaner, more optimized work flows to provide asset repair and maintenance services. Gaining access to and harnessing as much information as possible are keys to achieving this endeavor.

But in many cases, the maintenance management systems at manufacturing and industrial plants operate in isolation from other systems that contain valuable information. These include human-machine interface (HMI) systems, which contain information directly related to the state or condition of an asset.

Integrating with HMI systems and channeling the information these systems contain helps maintenance managers determine more effective ways for maintaining assets. The additional information, to the greatest extent possible, can help a company's maintenance staff become more proactive and ensure that asset service schedules do not interfere with production or operations schedules.

In addition to benefitting the maintenance management system, interoperability also benefits HMI systems and their associated work flows. By having information on the maintenance and repair status of assets, managers of each of these systems can also operate their departments more efficiently, since they have the ability to make more informed decisions.

Presented are the challenges to maintenance managers and the critical roles they play in an organization looking to optimize operations efficiencies; the benefits of interoperating between a computerized maintenance management system (CMMS) and HMI systems, including both supervisory control and data acquisition (SCADA) and distributed control systems (DCS); and the potential options available on how to accomplish varying levels of integration, including a low-cost CMMS that seamlessly interconnects with HMI systems.

The Pressure to Create Leaner Maintenance Management Systems

Maintenance managers constantly feel pressure to create leaner systems. They must keep service costs to a minimum, while ensuring that assets perform optimally and function for as long as possible.

With an effective maintenance management solution, addressing these challenges is possible. Resources can be managed and assets can be tracked so that repairs and preventative maintenance are completed on time to keep assets functioning properly.

But, isolated maintenance management solutions prevent industrial and utility plants from achieving optimal asset performance. The isolation makes it difficult to bring resource-utilization rates close to 100 percent, with maximize production output, as well as determining the overall lifecycle of each asset.

One of the keys to achieving a leaner system with the highest level of efficiency is to create an environment where maintenance management interoperates with HMI systems, which contain valuable information that allow maintenance processes to operate at peak levels. In return, the maintenance system can provide valuable information to production or manufacturing personnel utilizing the interconnected HMI.

Stakeholders Demand High Asset Performance at the Lowest Possible Cost

The need to integrate maintenance management with HMI systems is driven by today's business and political environments, where businesses and governments come under close scrutiny by business partners, customers, taxpayers, and other stakeholders. Those charged with maintaining infrastructure, facilities, and valuable capital equipment must provide effective, timely, and reliable services—all while doing so at an efficient level of operation to help manufacturing firms and municipalities maintain lean budgets and justify strategic capital investments.

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All organizations also need to ensure that every asset generates maximum output. This includes maintaining assets that operate close to 100 percent utilization, or at high overall equipment effectiveness (OEE) levels, as well as keeping assets in optimal condition so they are productive for as long as possible. Machines and other assets that break down frequently or need replacements sooner than expected hamper the output capacity of any business or organization and negatively impact the bottom line.

Human-Machine Interface Interoperability Helps Maintenance Operations Gain New Efficiencies

Maximizing an organization's return on asset investment is paramount to operational success, regardless of the industry; so, the utilization optimization of enterprise assets becomes a key focus. And, for enterprises of any industry, the ability to integrate and share information among software systems provides substantial benefits and increased productivity organizationwide. Maintenance management, integrated with HMI systems, provides automated and streamlined solutions for higher levels of efficiency in handling an organization's assets. This capability holds true for machines with SCADA interfaces, as well as mission-critical plants and lines that rely on DCSs.

Maintenance management software that seamlessly integrates with HMI systems provides a platform for implementing usage-

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based preventive maintenance schedules, instead of, or in conjunction with, traditional calendar-based preventive maintenance (PM) approaches. Events such as runtime hours, starts and stops, and cycle counts, can be used to create PM schedules.

Integrating with SCADA and DCS also helps the maintenance management process by automatically triggering maintenance work orders and requests based on machine condition. Maintenance becomes more predictive by giving maintenance managers the ability to configure rules for creating very detailed work orders that are triggered automatically. The rules can be based on any set of machine conditions and parameters that fall out of specification or reach particular levels. Integration with HMI systems also makes it easier to monitor and place just-in-time orders for spare parts in conjunction with the predictive/condition-based maintenance process.

An example is where an HMI senses that a critical parameter of an industrial machine, such as pressure, vibration, or current level, is drifting continually out of specification. The machine may be operating this way due to a broken component, or it may have operated for a period of time and now requires maintenance. By integrating the HMI and CMMS and using a condition-based maintenance (CbM) approach, a specific work order, based on the actual out-of-spec condition(s), can be triggered and appropriate personnel notified.

The work order will list exact tools and procedures to address the issue based on the condition that triggered the event. This type of process not only dramatically reduces errors, but is a substantially lower-cost maintenance (and operations) event than one where the asset is damaged greatly and operations are halted for a much longer period of time.

For processes that require the monitoring of liquids, gases, or other materials that are part of optimal asset operations, integration with HMI systems enables the CMMS to create purchase orders or requests for these materials if volume or quantity threshold levels are reached.

The HMI system operators also benefit by having their SCADA and DCS interfaces integrated with maintenance management. With integration in place, operators gain visibility into planned maintenance activities so they know when machine production will be interrupted. They also gain access to machine operating manuals to help them participate in total productive maintenance initiatives whereby they can fulfill the roles of conducting real-time inspections and preliminary maintenance. Operators of HMI systems can also submit work-order requests more easily in real time when machine breakdowns or degradations occur. Integration with the maintenance management system also gives operators the ability to view records, such as past work-order or repair history, when trying to troubleshoot finicky machines. All of these capabilities can be managed without leaving the native HMI application.

Finally, another benefit achieved by deploying maintenance management applications that integrate with HMI solutions is synchronization with the plant-floor operating model, including the automatic creation of assets and their associated hierarchies each time a new piece of equipment is created and deployed in the factory automation system.

Options for Integrating Maintenance Management with Human-Machine Interface Systems

Operator Mobility

One way to achieve data exchange between the SCADA system and an organization's CMMS is to schedule periodic inspection rounds where employees with mobile devices collect data on key asset condition parameters. The parameters, such as runtime or other equipment utilization levels, can be recorded and then input electronically into the CMMS for PM condition-based work-order triggers. This is an especially effective solution if the scheduling of these rounds already exists, and asset condition or usage level recording is simply a matter of adding additional steps to an existing work order or inspection.

One initial point of consideration with this approach is the mobile strategy itself. Is the enterprise-wide environment such that secure, real-time mobile connectivity can be readily put in place or already exists? If not, then off-line, mobile applications can be used to collect the data. Ideally, these off-line mobile modules already exist and are seamlessly integrated into the CMMS platform. If not, then the organization's information-technology team, or vendors, must incorporate the ability to ensure an accurate and seamless method of collecting and then exporting data from the handheld devices to the CMMS.

In addition, the ability for the CMMS to import, record, and then react intelligently to the data must also be reviewed. Given the non-real-time nature of inspection-rounds-based data collection, this means the CMMS needs to have the ability to create PM schedules based on imported data that represents utilization levels, such as runtime hours or other meter values.

Database Connectivity

Another methodology that can provide interoperability between the SCADA systems platform and the CMMS is creating a link between the CMMS and the control system Tag Historian database (a database that stores the point values that systems constantly measure about a machine). This is done by interfacing with the Historian database directly or via an open database connectivity (ODBC) interface, and then viewing or periodically polling specific tag values being tracked. Then, as specific tag levels or values are reached, as measured by the PLCs within the controls/SCADA system, the CMMS rules then trigger work orders or inspections in response.

The benefit of such as approach is that the frequency, and therefore accuracy, of the information being published to the CMMS rules engine is much higher than that of mobile or inspection-round-centric data collection. This may not be a significant factor in the case of many utilization based triggers (i.e., runtime hours), but if the enterprise is looking to also add a CbM component to its asset management strategy, then a near real-time (set by polling frequency) level of information collection and measurement becomes highly advantageous.

Areas to consider with this approach include understanding the architecture of the Historian database and its ability to expose data values. This may mean the addition of a gateway module provided by the controls vendor, or the option of creating an export of the historized tag values to another database (i.e., a warehouse) and linking that intermediary database to the CMMS. Either way, both costs and expertise regarding how the Historian database and the relevant data values will be properly exposed must be considered. This includes incorporating effective security practices, ensuring that, in no way, can data values be artificially fed back to the controls platform.

Middleware Applications

Another approach to consider when choosing to add value to the enterprise asset management system by integrating with the controls platform is to use third-party applications that utilize protocols such as object linking and embedding for process control (OPC). Depending on the organizational structure, this approach may be beneficial since the burden of ensuring successful and effective interoperability now resides with the chosen middleware vendor and not on internal or external information technology resources.

Another benefit of this approach is that using a communications protocol such as OPC produces a real-time read of any tag value that is being monitored, versus that of a polling interval by connecting to historian tags

via ODBC. This is especially important when true condition-based maintenance management CbM is the goal.

As with any other integration approach, cost and return on investment must be considered and any risks to controls/SCADA security must be mitigated.

Maintenance Management Software That Incorporates Human-Machine Interface Interoperability

Another approach to consider when deciding on a strategy to integrate HMI/SCADA and controls systems with the enterprise CMMS is a maintenance management software solution with a module that seamlessly integrates with any industry standard HMI or controls system.

The benefits of such a system include the real-time connectivity to the SCADA or DCS tags via OPC or native protocols. This provides a platform for not only triggering PM work orders based on asset utilization values exhibited by an appropriate tag, but also one that gives the enterprise a rules-based CbM foundation, triggering work orders for individual, or combination of, tag values that reach specific levels, exceed thresholds, or fall below specification. Then, upon the trigger, a work order with appropriate instructions or procedures, including properly specified parts and equipment, can be emailed, faxed, or electronically transmitted.

Operators can also view a maintenance activity dashboard, directly from within the HMI. Functionality can also include access to critical manuals, diagrams, or manufacturer specifications that are linked or attached to the asset or equipment master within the CMMS.

As with other approaches, proper thought and actions regarding security and system requirements must be considered and factored into any decision making. One advantage of this approach, however, is that fewer technology vendors are engaged, and dramatically fewer information technology resources are required. This approach does assume, however, that no viable existing CMMS/asset management software application is in place or that the organization has contemplated a major upgrade of its existing CMMS platform.

It's All About Increasing Asset Up-Time

The integration of maintenance management with HMI systems is about increasing asset up-time—either that of production equipment or facilities infrastructure. Connecting to these systems allows the asset-maintenance staff to gain access to valuable information it previously could not consider when planning maintenance activities. By having this new information, maintenance can then be managed more proactively so that assets perform at optimal levels for as long as possible.

The integration also allows senior management to have a more accurate picture of how much of an impact the conditions and the status of assets will have on production. This leads to improved forecasts that allow the company to act ahead of time to possible threats that might cause production or operations to diminish.

Four different approaches to achieving this integration need to be considered: information technology resources, security, existing systems, and costs. Each option must be reviewed from organizational policy perspectives. It's a matter of defining tangible benefits, while acknowledging existing realities, and then ultimately determining the true return on investment.