The use of SCADA techniques to improve Overall Equipment Effectiveness

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Abstract

Supervisory Control And Data Acquisition (SCADA) has been used for the past 40 years to monitor and control utility networks and manufacturing processes and provide asset performance information to allow business decisions to be made. Standard solutions now exist which are field proven to very large scale and these deliver high reliability and repeatability in a cost effective manner.

Effective management of OEE (Overall Equipment Effectiveness) is key to the prevention of costly downtime of high value plant. Sensors are available to provide valuable information in the quest to improve OEE but to date there are few comprehensive systems that allow plant owners to readily measure OEE and take prompt and proactive action to improve it.

This paper considers the use of standard SCADA solutions and the experience gained from the utilities business to produce a cost effective solution to allow plant owners to monitor and manage OEE in their asset base.

Introduction

Effective management of the Overall Effectiveness of Equipment (OEE) together with proper maintenance and inspection regimes are proven to greatly improve the availability of plant and vastly reduce unplanned outages.

In order to manage OEE, it is common to need to collect large amounts of data from a wide range of sources and process this data. This can be time consuming and potentially prone to error unless great care is taken.

Supervisory Control And Data Acquisition (SCADA) systems are widely used in the utilities and manufacturing industries to monitor and control production and distribution of products.

OEE management can benefit from the application of SCADA techniques. SCADA solutions could be used to cost effectively automate the collection of plant data and compute key performance indicators (such as availability) in real time to provide the information required to allow manufacturing organisations or equipment manufacturers to manage OEE.

OEE measurement

Jack Welch, one time CEO of General Electric, famously stated that “if you can’t measure it you can’t manage it”. The idea of capturing statistical information on performance of processes is well established. In the manufacturing industries the calculation of Overall Effectiveness of Equipment (OEE) is common.

OEE is a single measure of the availability, performance and quality and can be applied to a single machine, a production process, factory or entire business if desired.

In its simplest form, OEE is calculated as:

*Availability% * Performance% * Quality%*

And the terms above are defined as follows:

Availability is the percentage of time that the machine, process, factory or

business was operating out of the total potential operating time.

Performance is the percentage of goods produced out of the total potential quantity of goods that could have been produced.

Quality is the percentage of goods passing inspection out of the total goods submitted for inspection after manufacture.

A high OEE indicates that equipment is operating well, but a low OEE can mean many things. By providing a breakdown of, the reasons for unavailability, for low performance and for rejected goods, plant managers can begin tackling the key issues.

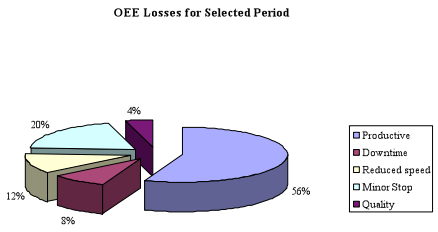

Figure 1. A breakdown of failure causes helps plant managers to see where to target most effort to make improvements.

On-line monitoring

Online monitoring of equipment parameters can help to provide additional information to help with OEE analysis. Typical parameters that can be measured to help identify equipment status include:

- Vibration
- Oil temperature
- Oil viscosity
- Water content in oil.

Predicting equipment failure

John Moubray, founder of Aladon and a leading proponent of Reliability-Centered Maintenance (RCM) created what is known as the "P-F curve" which shows the theoretical area between when equipment can potentially fail and when it finally does fail.

In general, the earlier failure is identified and avoided the cheaper the resolution is as a result of the costs of repair of the equipment, and also the ability to schedule in downtime rather than have unplanned outages.

Continuous monitoring of OEE and online collection of equipment status, together with regular inspection and maintenance processes all contribute towards the identification of potential failure early in the P-F curve.

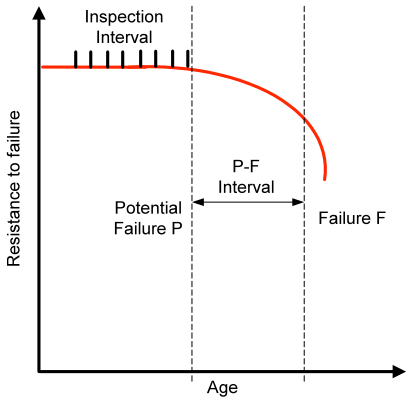

Figure 2. Moubray's P-F curve shows the opportunity for identifying failure before it occurs.

Utility management using SCADA

The utility industry has adopted SCADA as a fundamental requirement for their operations. Network management systems provide the utility (water, electricity, gas) with critical information on the status of the network components and allow the network

operators to effectively manage the production and distribution of their relevant product.

Originally based on meeting safety requirements (such as alerting a control room when a level is too high or low) SCADA systems are now used to collect performance information on their network assets, such as the number of hours a pump or motor has been running for (so servicing can be scheduled accurately).

Whereas SCADA is commonly used in manufacturing at a local plant level, SCADA in the utility industries is used over very wide areas to manage whole networks using a single system.

Typical manufacturing SCADA systems will provide current information on the state of local processes, but utility SCADA systems are used to collect a wide range of data from a wide area and present valuable information automatically derived from this data. These features provide the ideal proven solution for collecting and calculating OEE and online equipment status.

Experiences from the Utilities Industry

Utilities use SCADA systems to manage their overall production and distribution network. The scale of these SCADA systems varies from small (a few hundred monitoring devices) to large (10s of 1,000s of monitoring devices).

For example, a major water utility in the UK has over 10,000 monitoring devices that are scanned continuously for data on water and wastewater treatment processes.

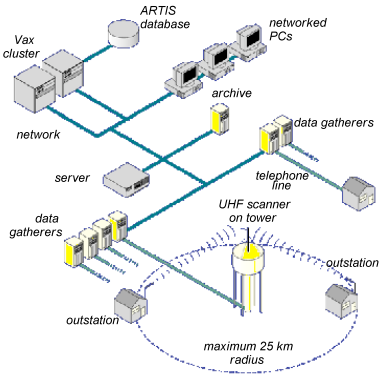

Figure 3. Over 10,000 sites are monitored by the SCADA system of a major water utility in the UK.

This utility needs to:

- Have early warning of process problems (such as low or high levels).
- Collect data to analyse the usage of assets (such as pumps and motors) to determine maintenance schedules and coordinate engineering time.
- Collect data to determine production and usage levels.

Using the information from SCADA systems

Utilities collect a large amount of information from their monitoring devices in remote locations.

Figure 4. A typical utility monitoring device in a remote location.

A primary feature of utility SCADA systems is to monitor production and distribution sites (such as water treatment works, electricity substations, gas compressors) in real time. Schematic representations of these sites are provided for users to easily see what is happening. This type of view is common in manufacturing SCADA, but in the case of utility SCADA the data displayed may come from a wide area and/or range of equipment.

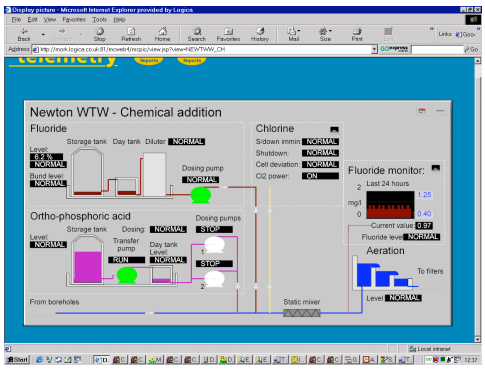

Figure 5. A schematic view of a utility site showing levels in tanks and the status of pumps in real time.

Having collected information to display the real time status of a utility site, it is straightforward then to store this information for subsequent analysis.

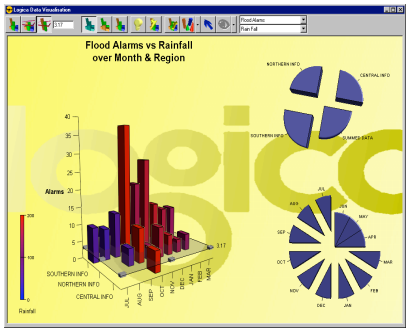

Figure 6. A typical report for a utility, showing information extracted from the SCADA system, in this case flood alarms versus rainfall on a monthly basis.

Once data has been collected by the utility SCADA system it is generally provided to users and other systems to help manage the utility business overall, by:

- Plan equipment maintenance based on hours run rather than periodic visits.
- Manage energy consumption by combining agreed tariffs with pump and motor control
- Automate their management of incidents by allowing early identification and rapid corrective action

So there is a high degree of functional overlap between utility SCADA systems and systems which could provide a viable means of automatically calculating OEE and related parameters for manufacturing plant.

Using standard SCADA solutions for OEE management

Figure 7 shows a potential architecture for a SCADA-based OEE management system. The key features are as follows:

- Sensors are attached to plant to monitor key parameters such as speed of conveyor belt, temperature, oil viscosity, etc
- Remote telemetry equipment is used to collect all data from all plant in a factory and relay this to the central data store/processing system.
- The central system is configured to store and process the data for use by all concerned.
- Users can view data for a specific item of plant, a factory a group of factories or the entire organisation.
- Data is retained long term to allow users to perform comparisons between current and historical data.

Once the central system is configured to process the incoming data there is no requirement for user intervention, thus

freeing up staff to perform other tasks whilst being able to see OEE and related performance data whenever required.

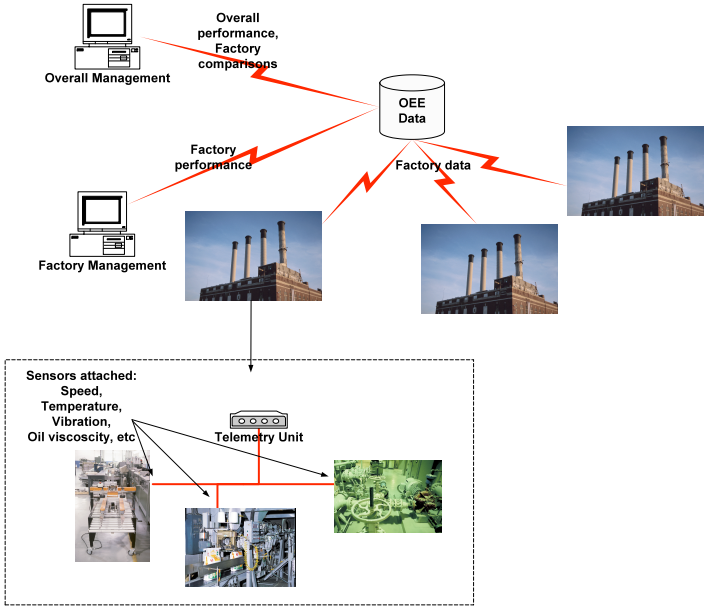

Figure 7. A utility SCADA solution used for OEE management.

The benefits of SCADA solutions for OEE management

The key benefits of a SCADA-based solution for OEE management are:

- The technology for collection, transmission, processing and display of data are already proven, all that is required is to configure the system appropriately.
- Changes in the collection or calculation of data can be made easily, thus allowing the use of new sensors or improved algorithms.
- Users can view reports on a machine, factory, region or entire organisation thus allowing comparisons of machinery, factories or regions.
- As data is processed and displayed automatically in real time, problems are quickly identified before they become too serious and there is a resultant unscheduled outage.

Summary

Systems to effectively manage OEE could be readily provided using the standard SCADA solutions widely used in the utilities industries.

Using standard SCADA solutions would allow users to have access to all the data collection, processing and reporting features already used by the utility industry thus providing a cost effective and proven solution in the shortest possible timescale to enable the effective management of OEE.

Further information

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