Driving Continuous Improvement
Through Delay Accounting

A White Paper

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By
Paul Cooper
Director, MES Solutions
Schneider Electric
SCADA & MES Competency Center
Ph: +1 678 462 4605
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Background

Paul Cooper is currently the Director of MES Solutions at the SCADA & MES Competency Center of Schneider Electric based in Atlanta.

Paul joined the company, then known as Citect Pty Ltd, in 2004 in the Perth, Australia office as a Senior Project Engineer, before moving into the Citect Consulting group. Shortly thereafter Paul moved into a business development role managing the largest two mining customers in the region. In 2006, Citect was acquired by Schneider Electric and since that time Paul’s role has developed to lead the MES team in the USA.

Major projects/achievements during this time have been:

- Business improvement and productivity initiatives
- Definition of end to end MES mining solutions
- MES solution architecture
- MES project implementation

About Schneider Electric and the S&MCC

As a global specialist in energy management with operations in more than 100 countries, Schneider Electric offers integrated solutions across multiple market segments, including leadership positions in energy and infrastructure, industrial processes, building automation, and data centers/networks, as well as a broad presence in residential applications. Focused on making energy safe, reliable, efficient, productive and green, the company’s 114,000 employees achieved sales of more than $23 billion in 2008.

The SCADA & MES Competency Center is a worldwide leader in industrial automation SCADA solutions and next generation manufacturing execution systems (MES). VijeoCitect, CitectSCADA and Ampla analysis modules are complemented by professional services, customer support and training. These solutions are enhanced by strong partner programs and are sold in numerous industries, including manufacturing, mining, metals, food and beverage, facilities monitoring, gas pipelines, pharmaceuticals and power distribution.

Introduction

In the drive for efficiency in today's mining industry and in an environment where the race is on to streamline processes ahead of the competition, delay accounting is becoming increasingly important. Moreover, automated delay accounting systems are fast becoming business critical systems. The ability to determine constraints in one's process in real-time and make decisions to affect the business immediately is a significant competitive advantage.

However when embarking on a delay accounting system and associated workflow, it is imperative to ensure that business benefit and ROI will be realized. There are several key areas that must be considered to ensure this will be the case:

- Workflow is set to ensure data is trusted and to ensure data is used for improvement activities
- Downtime trigger points and thresholds are valid for the process
- Optimization processes are in place to drive increasing benefit out of the system

This paper will explore these areas and the ways in which an organization might embark on a delay accounting project and deliver these benefits.
Workflow Considerations

Experience has shown that while a delay accounting system’s integrity may be sound, if the correct workflow breaks down (possibly because of data flooding) or if the data is simply perceived to be incorrect, the underlying system is often incorrectly considered the cause.

It is important then to ensure that workflow is considered in a delay accounting project. Workflow impacts the usage of the system in many ways, but arguably the two most important areas are:

- Entering and validation of data
- Cause analysis and improvement activities

Entering and validating data in an agreed way is essential in building trust in the data set and ultimately driving value out of the system. Similarly, ensuring that cause analysis is done regularly and used to direct maintenance and continuous improvement activity is critical.

It is not so important that a particular workflow is used; more that some thought has been given to what is required and that it has been agreed to among the stakeholders.

Downtime Triggers

Overview

The levels at which downtime triggers are set will determine the visibility into the performance of the plant. Setting them too low will result in the plant appearing to be running in an optimum way, while major constraints exist within the process. Setting them too high will result in flooding the operator with records and demanding too much data input; possibly resulting in erroneous records. In both cases the integrity of the data will be called into question and the system will no longer be trusted.

By expending some effort at the outset of a delay accounting project in determining the correct triggers, considerable expense can be spared in the acceptance testing of the installed system.

Perhaps more importantly, the following points show the benefit of following correct processes around trigger points:

- Ownership of the system is more readily obtainable from the users of the system if it performs efficiently the first time.
- Man-hours will be minimized by imbedding the new triggers and thresholds. Correct analysis of the resultant data means faster improvements and quicker savings
- KPIs can be benchmarked against industry best practices
- There is a methodology around the target values so it becomes easier to understand the reasons driving any need to modify the triggers
Sustainable Throughput

Sustainable throughput is the threshold point signifying the plant, process zone or machine’s maximum throughput capacity. This is a critical figure because it defines optimum operation. Slow running downtime events will be triggered based on this number. If it is set too high, the plant will be in continuous downtime. Setting it too low will result in plant KPIs appearing much better than they really are.

There has long been discussion in the industry about setting the level of sustainable throughput. The level set will determine the amount of relative downtime that will be recorded and once these downtime events are classified as planned maintenance, breakdown losses or performance losses, they will impact operational KPIs such as availability, utilization and OEE. Most senior operational managers will have a performance pay component attached to these figures and hence the setting of sustainable throughput will usually generate considerable interest.

During the feasibility study of an ore body and the associated mine and processing plant, return on investment will be calculated based on the projected mine life and the expected production from the mine over the life of the ore body. Generally the processing operation will be sized based on these two figures.

While this a fairly simplistic view of an ore body feasibility study, clearly any asset optimization initiative must be focused on delivering production to the plant design capacity (capacity expectation). Otherwise, the financial premise upon which funding to construct and develop the operation in the first place would not be met.

Given this, sustainable throughput may be set using the following guidelines:

- Lowest nameplate rating from a number of machines operating in a serial process
- Maximum sustainable historical throughput if it exceeds nameplate rating.

There are no defined rules around what is considered sustainable, however a good rule of thumb is if the plant throughput was consistently at this new number for a financial reporting period (month end for example is generally the lowest reporting period to corporate levels) then it is sustainable.

Sustainable throughput becomes more challenging when product changes take place and this figure must change to reflect the difference in throughput. As an example, an iron ore processing plant cannot run “fines” at the same rate as it can process “lump” iron ore.

Difficulty is found in accounting for a sustainable throughput change in relation to downtime events. Analyzing data, which effectively consists of more than one trigger point, may then only be done when one is mindful of the changes in the way data is sampled due to product type.

Depending on the type of analysis required, it may be desirable to display data from the downtime system in two ways; based on product type or based on sustainable throughput. In the case of the latter, the system must log the sustainable throughput change with a “product change” cause code, allowing calculation of a sustainable throughput set of KPIs in addition to those produced around the new product run.
Downtime Thresholds

Downtime is generally logged when a plant or process zone stops producing or runs below its sustainable throughput. In the case of a stoppage, there is little to consider. For slow running events however, the threshold at which this will occur is generally set at something less than sustainable throughput and must be considered carefully. As the threshold is increased towards sustainable throughput, the number of resultant records will increase. This provides a greater opportunity for improvement but also requires greater operator input into record classification.

Bailey and Konstan* noted in their research paper in February 2006 that as a result of a controlled experiment they could show that when peripheral tasks in a windows environment interrupted the execution of primary tasks the following occurred:

- Users require 3% to 27% more time to complete tasks
- Commit twice the number of errors
- Experience 31% to 106% more annoyance
- Experience twice the anxiety

Given the complex processing environment that most operators work in, a twofold increase in primary task error rate is significant. This means that any downtime system in the production environment is potentially capable of increasing the operator’s error rate and anxiety levels to an unacceptable level; because of the periphery interruption it introduces to the operator’s primary task of controlling the process.

Experience has shown that introducing an average of 12 downtime records per shift to an operator is an acceptable number for attention, at least initially. Creating too many new tasks will not only increase the error in the operators primary task, but will result in poor accuracy in the completed downtime record.

To determine the correct downtime thresholds for the slow running conditions created under each downtime location, the system designer must consider the following:

1. **Delay on each trigger condition.** Generally some delay will be introduced to mask minor fluctuations of production. This will be dependant on the process and can generally be selected based on process variability. For example, if a primary stockpile will always remain at 50% based on a five-minute primary crushing truck dumping sequence, the downtime measurement at this location may be delayed by five minutes in order to mask out measurements not contributing to meaningful analysis

2. **Threshold on each slow running condition.** Generally some analysis will take place around the production data being sampled – usually with a set of production trends. These may be filtered already with the anticipated delay times to aid analysis. The threshold should be set to give around 12 records per shift. Over time, continuous improvement initiatives will mean that the number of records per shift will decrease. This is typically when system reviews will recommend that the thresholds be increased to allow the continuous improvement efforts to focus on new areas for improvement.

Ultimately the aim of every improvement program is to manage the rate of improvement to a sustainable level until the process reaches sustainable throughput or as close as is practical.

* On the Need for Attention-Aware Systems: Measuring effects of interruption on task performance, error rate and affective state, 7th Feb 2006
Process Optimization

Overview

Process optimization can be carried out at many levels. In the context of this whitepaper, process optimization shall be considered in the context of key performance indicators and their use in continuous improvement.

KPI Targets and Best Practices

KPI targets with respect to best practices are not necessarily readily available for each particular stream of the mining industry.

In manufacturing, the Toyota Production System (LEAN) centers on eliminating waste to reduce cost. Overall equipment effectiveness (OEE) was intended to identify the major losses in performance.

World class OEE in manufacturing has been defined in several studies as 85%. The components of OEE are defined as:

- Availability – 90%
- Performance - 95%
- Quality – 99.9%

Across manufacturing production, these may be considered best practices.

In respect to specific mining operation types and benchmarks, the industry is relatively new to the concepts of automatic data aggregations and KPI calculation. It will take some time to amass enough data to reliably report best practices across all aspects of mine production reporting.

Generally an enterprise would begin a benchmarking process alongside their continuous improvement initiative, such as a Six Sigma program defined as:

- Definition
- Measurement
- Analysis
- Improvement
- Control

In the absence of best practice KPIs for the mining industry, most operations begin best practice benchmarking at their own business unit level and once the majority of operations are performing adequately, the enterprise can turn its attention outward.
Summary

In summary, these three components of delay accounting must be considered during the design phase of a system implementation:

- Good workflow practices for trusted data
- Well designed downtime triggers and thresholds for manageable data levels
- Leveraging the downtime system inside a continuous improvement program for production improvement

Following these practices ultimately drives the ROI upon which any good downtime system was designed. In providing a financial benefit, the system is validated and remains an increasingly important tool in business management.