# ASSET MANAGEMENT APPLICATION FOR AN IRON ROLLING UNIT

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## Abstract

*Nowadays, the modern rolling units are becoming more complex and there is and industry consolidation, with apparently growth on the emerging markets. In this scenario, be financially effective is one of the biggest challenges for the companies in this segment. Units are being designed to operate at maximum rates, with maximum savings. With the operations scale increase, even small increases on the plant availability can represent great economical benefits. The asset management implementation has a good potential to offer significant benefits.*

## Resumo

*Atualmente, as unidades de laminação estão se tornando cada vez mais complexas. Neste cenário, ser financeiramente eficaz é um dos maiores desafios para as empresas deste segmento. Unidades são projetadas para funcionar no máximo da capacidade, com o máximo de economia. Com o aumento da escala das operações, mesmo pequenos aumentos na disponibilidade da planta podem representar grandes benefícios econômicos. A aplicação da gestão de ativos tem um bom potencial para oferecer benefícios significativos.*

**Palavras-chave**: Gerenciamento de Ativos, Robusto, Honeywell, Asset Management, Alumina, Papel, Celulose, Petroquímica, Iron Rolling.

# 1 INTRODUCTION

## 1.1 Overview

Nowadays, the modern rolling units are becoming more complex and there is and industry consolidation, with apparently growth on the emerging markets. In this scenario, be financially effective is one of the biggest challenges for the companies in this segment. Units are being designed to operate at maximum rates, with maximum savings. With the operations scale increase, even small increases on the plant availability can represent great economical benefits. The asset management implementation has a good potential to offer significant benefits. These benefits are mainly translated on plant availability increment. On the Rolling unit, key area of the metalworks industry, any availability increase will represent big financial benefits.

## 1.2 Availability

In this scenario, availability is the measurement of the available days for the operation, with 100% utilization potential. From another stand point, this is the ability to operate an unit, when needed, with the capacity regulated by the market demand. Some ways to increase availability [1]:

- Reduction of downtime for corrective maintenance
- Reduction of preventive maintenances
- Reduction of unplanned shutdowns

## 1.3 Asset Management

In order to help the availability increase, Asset Management is a systematic process of maintenance, improvement and financially effective asset operations during their lifetime. Engineering principles are combined with good business practices and economic theory. Rather than this, tools are provided to support a more logical and coherent decision making process. Thus, Asset Management provides an stratified work to deal with short and long term planning [2].

Regarding this definition, Asset Management for a Rolling Unit means manage the whole unit, including the stakeholders that can influence on the operations. The main steps on the asset management are [2]:

- Identification of the needs for each asset, including whether it has to be managed or not;

- Asset support, including its maintenance plan

- Asset operation;

- Possible asset replacement, due to business or process requirements;

From the maintenance stand point, the asset management should cover the following items:

- Maintenance management: management of the human resources to proceed the maintenance, inventory and spare parts management;
- Fail diagnostic capacity (root cause, trouble, solution);
- Planning of corrective, predictive and preventive maintenances;
- Integrated access to information that will support the decision-making à DCS, Inventory, Maintenance.

This paper will discuss the Asset Management solution for Rolling Mills.

## 1.4 Roling Process Description

Rolling is the main method of forming molten metals, glass, or other substances into shapes that are small in cross-section in comparison with their length, such as bars, sheets, rods, rails, and girders. Rolling is the most widely used method of shaping metals and is particularly important in the manufacture of steel. The process consists of passing the metal between pairs of rollers revolving at the same speed but in opposite directions and spaced so that the distance between them is slightly less than the thickness of the metal [3].

There are 2 kinds of rolling: hot-rolling and cold-rolling

### 1.4.1 Hot Rolling

The metallurgical process of Hot rolling, used mainly to produce sheet metal or simple cross sections from billets describes the method of when industrial metal is passed or deformed between a set of work rolls and the temperature of the metal is generally above its recrystallization temperature, as opposed to cold rolling, which takes place below this temperature. Hot rolling permits large deformations of the metal to be achieved with a low number of rolling cycles [4].

Because the metal is worked before crystal structures have formed, this process does not itself affect its microstructural properties. Hot rolling is primarily concerned with manipulating material shape and geometry rather than mechanical properties. This is achieved by heating a component or material to its upper critical temperature and then applying controlled load which forms the material to a desired specification or size [4].

### 1.4.1 Cold Rolling

Cold rolling is a metal working process in which metal is deformed by passing it through rollers at a temperature below its recrystallization temperature. Cold rolling increases the yield strength and hardness of a metal by introducing defects into the metal's crystal structure. These defects prevent further slip and can reduce the grain size of the metal, resulting in Hall-Petch hardening. This method is most often used to decrease the thickness of plate and sheet metal [3].

If enough grains split apart, a grain may split into two or more grains in order to minimize the strain energy of the system. When large grains split into smaller grains, the alloy hardens as a result of the Hall-Petch relationship. If cold work is continued, the hardened metal may fracture [4].

During cold rolling, metal absorbs a great amount of energy and some of this energy is used to nucleate and move defects (and subsequently deform the metal). The remainder of the energy is released as heat [3].

While cold rolling increases the hardness and strength of a metal, it also results in a large decrease in ductility. Thus metals strengthened by cold rolling are more sensitive to the presence of cracks and are prone to brittle fracture.

## 2. Applying MPC to Mining & Metals and Other Areas

To implement the asset management solution in a rolling mill, a set of tools were used [5,6]:

- Field instruments management software;
- Field instruments calibration procedures and records software;
- Mobility tools (as wireless hand held devices);
- Early Event Detection software;
- Loop performance monitoring software;
- Operational procedures monitoring software;
- Information database integrator software

## 2.1 Field instruments management software [7]

This tool is a standalone configuration tool for HART devices that allows configurations to be managed, monitored and changed for a large number of HART devices. The tool is based on the HART Communication Foundation (HCF) SDC 625 standard HART host and Device Descriptor (DD) IDE products. All HART device configuration settings can be accessed and changed.

The methods to access the devices were short, step-by-step programs issuing sequenced commands to direct a device-related task.

The implementation methodology to commission this tool was:

1) Plant-wide communications system architecture and topology analysis;
2) field devices mapping and definition of implementation priority on the asset management system;
3) technical requirements specification, to support the asset management implementation (like network requirements or communication system changes);
4) Technology commissioning: network changes, system installation, training to the users;
5) Support after implementation: after the commissioning, the support and monitoring is extremely important to maintain the system at the same operative level, during its lifecycle. Systematic revisions and periodic database updates are relevant issues, to maintain the system effectiveness.

## 2.2 Field Instruments Calibration [7]

This solution was designed to manage the calibration procedures in the rolling mill. The software used is a maintenance documentation solution that allows the management of plant assets and field instruments. This software consisted in an automated change management solution that keeps history on all changes made to the assets. It was developed to organize all information required for regulatory, quality, and safety requirements, as well as the days of creating, maintaining, and supporting manual or self-developed databases are over. To design the solution, it was used as guidance the requirements of 21CFR Part 11, Electronic Records and Electronic Signature. This compliant configuration meets all Life Sciences requirements for instrument calibration, signature and electronic documentation.

The implementation methodology to commission this tool was:

1) Mapping of all field devices;
2) Collection of all calibration and maintenance procedures for each equipment;
3) Definition of maintenance and calibration classes, in order to organize each instrument by class;
4) People training, to use the tool and standardize the calibration procedures;
5) Continuous supervision of procedures and people, in order to ensure that the procedures are being done in the correct way;
6) Support after implementation: after the commissioning, the support and monitoring is extremely important to maintain the system at the same operative level, during its lifecycle. Systematic revisions and periodic database updates are relevant issues, to maintain the system effectiveness.

## 2.3 Mobility Tools [7]

This solution includes: wireless instrumentation, paper spreadsheets elimination (replacement of manual records by records in “palm tops”, connected straightly to an integrated database). The data inserted on this system can be accessed by the field operator, using his hand held computer. The data that can be accessed is: production data, process control system data (loop tuning parameters, setpoints, process values, valve openings; operational procedures, inventory and spare parts data).

The implementation methodology to commission this tool was:

1) Field devices mapping and definition of implementation priority on the asset management system;
2) Project Document: describes the implementation project, which includes: definition of the main system aims; detailed design of the initial needed applications; existing IT structure evaluation. The project document is a master reference and the project has to be executed acordingly with this document;

3) Field installation and on-site engineering: sincronization server instalation, database server installation, access profiles management, interaction with security systems and field data collection modules;
4) Installation and integration with ERP's;
5) On-site people (operators and engineers) training, to make them able to interact with the system;

## 2.4 Early Event Detection [7]

This tool acts an intelligent assistant to minimize the number and impact of abnormal situations that can result in serious safety, operational, and economic impact to a processing plant. It does this by providing early awareness and a measured response to abnormal situations. Abnormal situations in a plant range from equipment-related faults and startup/shutdown-related problems to major process upsets – all requiring human intervention.

EED applications provide early indications of an incipient event or malfunction that is threatening key process functions which are essential for achieving reliability, safety, and quality and production goals. This is made by statistical modelling and application environment to identify, localize and support the reduction of abnormal situations in processes and plant equipment. The techniques for the detection can vary from operator-based alerts, related to process variables or simple fault logic models, to algorithms for detecting valve non-linearity's or oscillation in the process.

The main issue on this tool is define which would be the normal operation and, based on that, define which would be the different abnormal situations. Those abnormal situations will be mapped and modelled, in order to generate scenarios, to be used on the general recommendation plan that the tool generates.

The implementation methodology is the following:

1) Field devices mapping and definition of implementation priority on the asset management system
2) Implementation project, which includes: interview with engineers and operators, in order to define the most common abnormal situations for that unit; other potential abnormal situations (using other plants benchmarking);
3) Field installation and on-site engineering: sincronization server instalation, database server installation, access profiles management, interaction with security systems and field data collection modules
4) Installation and integration with ERP's;
5) On-site people (operators and engineers) training, to make them able to interact with the system;

## 2.5 Loop performance monitoring software [7]

This software collects loop behavior data, compares with a benchmarking database and shows which loops have problems, which would be the maintenance priorities and which ones should be available for a normal operation. The real time data collector collects normal operating data for fast loops at one second, and slower loops at five or thirty seconds based on loop type or user-defined configuration. Loop configuration parameters (tuning constants, point description…) are collected without additional user effort. The real time data collector runs on a GUS, APP node or any network that is OPC compliant.

In this analysis, the tool tries to optimize the tuning parameters, using the most common PID algorithms. Rather than this, other problems can be identified, like valve stiction and actuator problems.

The implementation methodology is the following:

1) Field devices mapping, in order to identify all the existent loops in the unit
2) Communication system architecture definition (mainly the way to collect data à OPC collection frequency represents a problem in many sites);
3) Field engineering installation work;
4) Installation and integration with ERP/s
5) Engineering and operation training

6) Analysis results and result analysis
7) Action plan definition, in order to fix the most prioritary loops

### 2.6 Operational procedures monitoring software [7]

Operations Monitoring is a software application that systematically monitors process plant performance against targets and limits, and highlights problem areas. It also helps to determine causes of downtime and production inefficiencies. By studying operations history, the plant staff can more efficiently manage and control the plant's operations.

Through regular, systematic performance monitoring and reporting, Operations Monitoring tracks and compare actual operations against the operations plan, and identify areas for improvement.

This tool has to be supported by a historization system, which should provide data collection, storage and management. The main actions for this tool are:

• Define operational targets for the main operational parameters, specifying when those targets should become active;
• Summarize the plan and the real plant results, integrating the operational records and automatic monitoring;
• Track the deviation from the plan, through the time;

The implementation methodology is the following:

1) Interview with operators and engineers, in order to define which would be the normal operation status and which would be the results;
2) System architecture definition;
3) Field engineering installation work;
4) Installation and integration with ERP/s;
5) Engineering and operation training;
6) Definition of people to make the plan and update it on the tool.
2.7 Information database integrator software [7]

In order to maintain all the solutions in an integrated and standardized platform, it's necessary the integration with a system easy to use, easy to maintain and easy to access. The proposed architecture for the system is described on the picture 1:

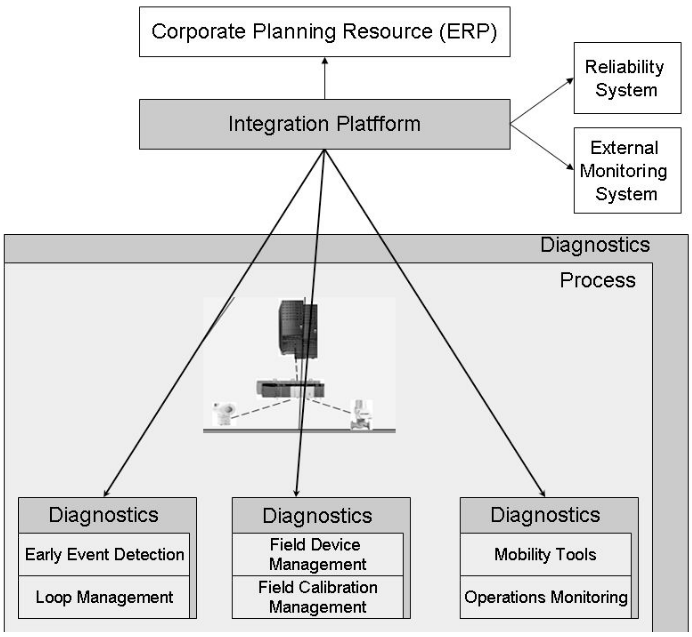


**Figure 1 - System Architecture**

With this tool, the user has access to all the asset management database system. Using this information, the maintenance plan can be improved, as well as the inventory system. This data includes: equipments that have to be maintained, equipments to be replaced, procedures to be reviewed, accomplished and unaccomplished maintenance goals, control loops to be adjusted and other relevant parameters to the maximization of asset utilization.

## 3 Implementation Results

### 3.1 Field instruments management software

Benefits found for the Operations Team: Usage of device information to determine that the correct device is connected and basic configuration is correct, and that the device is operating without fault.

Benefits found for the Engineering Team: The tool could be used during the initial loop setup and commissioning phase to establish initial configuration settings for the device and to complete loop checkout.

Benefits for the Maintenance Team: Once the initial setup and startup phase is completed, the tool could be used for related device configuration, calibration, and maintenance. Also it helped maintenance personnel distribute clients and communication interfaces, such as multiplexer networks, across the plant.

### 3.2 Field Instruments Calibration

Benefits found for the Operations Team:
• Quicker calibration and inspection data acquirement for investigations into problem process areas;
• Better plant operation, due to of consistent proper calibration procedures and testing details;
• Custom reports could be created and regularly sent to or made available to operations.

Benefits found for the Engineering Team:
• Data analysis became easier due to the access to historical calibration data;
• Detailed specifications could be stored for all process control Instrumentation and standard plant assets;
• A link to the Engineering Server for access to P&I and other related drawings was configured through this tool;
• The tool provided direct access to smart instruments for less time-consuming modifications or replacement.

Benefits found for the Maintenance Team
• Reliability analysis using historical data could provide basis for instrument calibration maintenance decisions.
• Special data analysis could be developed
• Calibration and maintenance scheduling could be provided directly by the tool or driven by maintenance management systems.
• Standard procedures were entered in the tool, or the tool could link to procedure files on the customer's network.

### 3.3 Mobility Tools

Benefits found for the Operations Team:
• Reduction of maintenance time and consequently increase of productivity;
• Reduction of wiring work and wiring maintenance;

Benefits found for the Engineering Team:
• Communications with an unified database and consequently more data reliability.

Benefits found for the Maintenance Team
• Improvement on the inspection tracking and report, due to the drastic reduction of the paper work involved on these tasks;

### 3.4 Early Event Detection

Benefits found for the Operations Team:
• Reduction of abnormal situations that can result in serious safety, operational, and economic impact to a processing plant.
• The tool increased planning and operational constraints.
• The tool enabled operators to participate in fault localization and response.
• The tool allowed the operator to detect a fault in time to return to normal rather then move to the out-of-control state, ensuring safe status of the process.

Benefits found for the Engineering Team:
• The tool provided a common data analysis infrastructure for root-cause failure analysis

Benefits found for the Maintenance team:
• Communication with the integrated asset management implementation provided the potential for advanced decision support capabilities and asset management.
• Early event detection decision support component identified and isolated, when possible, the root cause of a specific event.
• The tool provided information for proactive equipment maintenance.
• The tool provided a common data analysis infrastructure for root-cause failure analysis.

### 3.5 Loop performance monitoring software

Benefits found for the Operations Team: The tool improves project execution—receiving objective guidance during control system, advanced process control (APC), valve and pump upgrade projects
Benefits found for the Engineering Team: The tool addressed regulatory performance problems, by combining a system that incorporates advanced statistical benchmarks with internet infrastructure. It enables the control engineer and maintenance technician to turn their data into action.

Benefits found for the Maintenance Team: The tool reliability-centered maintenance became more effective than traditional reactive or preventive maintenance approaches. For example, it helped eliminate unnecessary valve pulls and positioner upgrades.

### 3.6 Operational procedures monitoring software

Benefits found for the Plant/Mill Manager: Lower operating and maintenance costs, increased safety and improved environmental compliance.

Benefits found for the Operations Team: Better management and control of plant operations through studying operations history.

Benefits Found for the Engineering Team: Ability to manage engineering limits and constraints; monitor performance to plan and limits; and follow up on

### 3.7 Information database integrator software

Benefits found for the Operations Team: The process knowledge was proliferated throughout the business enterprise for faster, informed decision-making.

Benefits found for the Engineering Team: Single view that drives engineering work activity in the most efficient way. Access to extended asset information enabled smart, informed decisions to be made.

Benefits found for the Maintenance Team: Notification of potential problems, due to the reconciled database, opportunity for repair or replacement of faulty equipment, eliminated unplanned downtime, and reduced maintenance time and labor costs.

## 4. Results Discussion

The following table shows the quantified benefits to a real hot Rolling Unit.

**Table 1 - Benefits Numbers for a Real Hot Rolling Unit**

| Tool | Gain | Cause |
|---|---|---|
| Field instruments management software | Hot rolling unit startup time after a planned shutdown: 5 days<br><br>20% reduction on the startup time → *1 day of production* | Reducing of startup times, due to a better initial configuration and instruments situation database. Rather than this, reduction of search for the failure points, during a plant shutdown, due do continuous tracking. |
| Field instruments calibration procedures and records software | Maintenance Time: 160 downtime hours per year, to maintain the rollers and related parts.<br><br>40% reduction of maintenance time → 64 hours (*2.7 days production*) gain | 40% of the maintenance time was destinated to review and search of procedure calibration. |
| Mobility tools | Data collection and recording: 1050 man-hours per year (1 hours per shift of recording → 3 hours per day of recording). This record in mainly due to continuous product specification changes and constant temperature conditions monitoring<br><br>30% reduction of maintenance software → 315 man-hours gain<br><br>Considering that each shift has 15 operators → 15 *24 = 360 man-hours per day → *0.875 days of production* | The maintenance acquired a focused guideline, regarding which kind of data should be collected. Rather than this, there is a drastic recording time reduction, due to the direct data filling on an automated system (reduction of paper work) |
| Early Event Detection software | Reduction of *1 day of production*, due to an unplanned equipment maintenance | The early event detection helped on a possible failure detection and consequently 1 day stoppage for a rolling part maintenance |
| Loop performance monitoring software | 1.0 % increase in production, reducing process variability. The rolling temperature is maintained more constant, improving the metal working process<br><br>350 days * 1.0% = 3.5 *days of production* | Loop Management Services trims up to 75 percent of unnecessary control valve repairs and prevent incidents that could cause future downtime. |
| Operational procedures monitoring | 0.2% increase in production<br><br>350 days * 0.2% = *0.7 days of production* | The operation and process is improved, due to a better operations monitoring |
| Information database integrator software | Maintenance planning time: 4 people involved, 1 day per month, 8 hours per day: 4 x 1 x 12 x 8 = 384 hours<br><br>Reduction of 70% in maintenance planning → 268.8 man-hours gain<br><br>268.8 man-hours → *0.75 days of production* | Mainly, the gains are related with the maintenance planning. The reduction on maintenance planning is translated on:<br><br>Higher system reliability (database integrity checks)<br><br>Fewer incidents (improved maintenance planning, avoid accidental shutdowns) |
| Total Production Days saved per year | *10.525 Production Days Saved = 3.1% Production Saving* | Calculated Gross Margin for the Rolling Mill = USD 50 MM<br><br>Calculated Saving = USD 50 MM * 3.1% = USD 1.6 MM |

## 5 Conclusion

The asset management strategy implementation for a Rolling Unit presents potential to offer significant benefits. Those benefits are mainly translated into plant availability increase. On this key unit for the siderurgical process, any improvement on the plant availability represents big financial benefits.

But, a well succeed asset management technology implementation shall have well defined methodology and scope. For this specific case, the full implementation takes more than 12 months of continuous engineering services. With a structured methodology, the asset management solution can provide the maximum utilization of all tools, delivering maximum benefits. Rather than this, the solution shall have a wide functionality spectrum, since the asset management concept is spread in a diversified way, through the whole business process.

The potential benefits generated for the Rolling area were around USD 1.6 Million/year, which represent 3.1 % of availability increase in a mid-size Rolling Unit.

## REFERENCES


1 Organ, M., Whitehead, T. and Evans, M. (1997). “Availability-based maintenance within an asset management programme”. Journal of Quality in Maintenance Engineering 3(4), 221–232. United States

2 WHAT IS ASSET MANAGEMENT? Midwest Regional University Transportation Center. United States. 1997. Available in <http://www.mrutc.org/assetmgmt/index.htm> Accessed in May 23rd, 2008.

3 PROCESSO DE LAMINAÇÃO. Available in <http://www.inf.pucrs.br/~eduardob/disciplinas/FerramentasComputacionais/sem03.2/trabs_alunos/Mauricio_Caroline/laminacao.html> Accessed in May, 15th, 2008

4 MANUAL DE LAMINAÇÃO, Siemens, São Paulo, Brazil (2002)

5 GESTÃO DE ESTOQUES DE PEÇAS DE REPOSIÇÃO DE BAIXÍSSIMO GIRO, 2007. Available in <http://www.centrodelogistica.com.br/new/fs-busca.htm?fr_art_gest_pecas.htm> Accessed in May, 16th, 2008

6 GESTÃO DE ESTOQUE DE MATERIAIS DE BAIXÍSSIMO GIRO
CONSIDERANDO PROCESSOS CRÍTICOS PARA ORGANIZAÇÃO
Available in <http://www.ead.fea.usp.br/semead/8semead/resultado/trabalhosPDF/107.pdf>
Accessed in May 20th, 2008

7 Honeywell Product Guide, 2006. Honeywell Inc. USA (2006)

8 SOLUÇÒES AVANÇADAS, 2009. Available in <www.solucoesavancadas.com.br> Acessed in May 22th, 2009


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