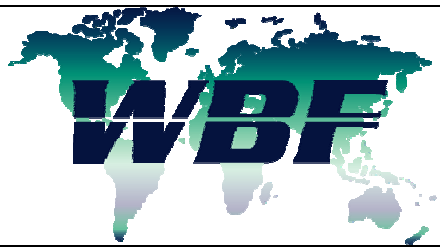
Presented at the WBF North American Conference Atlanta, GA March 5-8, 2006		195 Wekiva Springs Road, Suite 200 Longwood, FL 32779-2552 +1.407.774.5764 Fax: +1.407.774.6751 E-mail: info@wbf.org www.wbf.org

Benefits of Integrating PAM & Production Management Systems

J. Ruhe
Evolution Product Manager
ABB
29801 Euclid Avenue
Wickliffe, OH 44092
USA
+1 440 585 5542
+1 440 585 8589
joachim.ruhe@us.abb.com

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ABSTRACT

Discover sustainable financial opportunities when Plant Asset Management (PAM) systems are integrated with real-time production management functions. Avoid foreseeable conflicts between production and maintenance schedules. Minimize deviations from normal manufacturing procedures caused by equipment failure and/or performance degradation.

PAM systems collect and display a tremendous wealth of information from intelligent field devices installed on equipment modules and control modules. Information from individual devices is then aggregated into a measure of overall asset condition. This aggregate asset condition can be applied to any level in the ISA-88 or ISA-95 Models (e.g. Equipment Module, Unit, Process Cell, etc.). Making aggregate asset condition information available to the real-time production scheduler, the equipment selection process can; select equipment with best overall asset health, avoid equipment with pending maintenance or limit use of equipment with marginal performance.

Integrating PAM system with real-time production management provides many potential benefits. Reduce cycle time by minimizing abnormal occurrences caused by asset failures. Improve process performance and increase resulting product yields by selecting equipment with optimum asset health. This paper will describe and discuss methods to quantify these benefits.

INTRODUCTION

The objective of every manufacturing organization is to provide tangible and sustainable improvements to the financial performance of the overall manufacturing facility. Competitive pressures caused by the global economy faced by all manufacturers continue to exist and only show signs of increasing in magnitude. These pressures have driven manufacturers to make significant investments in diverse hardware and software technologies with typical objectives defined around; improved asset reliability and performance, reduced maintenance costs, increased production asset utilization, reduced scrap and rework, improved quality, etc. The often overlooked challenge is that these objectives, without concerted effort to co-ordinate, may result in sub-optimal results when reviewed against the overall manufacturing facility.

Many manufacturing companies continue to be organized along functional boundaries (e.g. "Operations", "Maintenance", etc.) or departments. Traditional organizational structures often result in investment and deployment strategies that adhere to, or mirror functional silos. This often results in improvement projects/programs that deliver benefits narrowly focused along functional boundaries that adversely affect performance outside of their functional area. "We successfully increased production output, but maintenance costs are soaring…" or "Our maintenance costs are down 20%, and production yield is only down 5% …" are examples of improvement projects that may have met their original objectives, but failed to sufficiently consider collateral affects.

Lean Manufacturing, or "Lean Thinking" suggests taking a new holistic approach to the entire manufacturing facility. Lean thinking is about the removal of waste from the value chain. Waste can be defined as any activity which absorbs resources but creates no value. This definition includes mistakes which require rectification, production of scrap material and processing steps that are not actually necessary. Examples include; transferring a batch from one unit to another unit due to an equipment failure on the original unit, performing multiple washes due to reduced performance of a filtration unit or pausing a batch while maintenance is performed on downstream equipment. These examples of waste, according to the lean manufacturing definition of waste, represent opportunities for improvement. These opportunities can be addressed by integrating Plant Asset Management system functions with real-time Production Management system functions. Specifically this paper proposes that information from Predictive Maintenance and Asset Health Reporting functions of the Plant Asset Management system be integrated into the real-time Production Scheduling and Resource Management functions of the Production Management system.

Plant Asset Management and Production Management functions are not typically integrated today due to traditional organizational structures along functional boundaries. Typically, it is the Maintenance organization that specifies, implements, and uses the PAM system. Similarly, the Operations organization will perform these tasks for the Production Management system, although typically associated with the base control / automation system. Both organizations focusing on their functional silos optimize their respective systems to meet objectives of their organizations. One area where Maintenance & Operations have begun to work together is Instrumentation & Control devices. Intelligent devices providing advanced information via field buses such as Profibus, FOUNDATION™ Fieldbus, and Hart® are dramatically increasing in market share. The increased success of intelligent devices, although partially driven by declining price premium, is largely driven by the value propositions they offer to both Maintenance & Operations organizations. These value propositions are only partially recognized until PAM are integrated with Production Management system functions.

MAINTENANCE PRACTICES CONTINUE TO EVOLVE

There are typically four strategies for maintaining plant assets used in manufacturing industries today. They are Corrective Maintenance, Preventative Maintenance, Predictive Maintenance and Reliability Centered Maintenance (RCM).

Corrective or Reactive Maintenance is the most basic. Corrective maintenance can be described as a, "Fix on Failure" strategy. This strategy predates Asset Management/Optimization philosophies. Very basically, the device is repaired only after the fact that a failure has been detected. Today, this approach is only used on devices that pose a low economic cost on their failure.

Preventative Maintenance was the first improvement to the basic practice of reactive maintenance. Its primary objective is to reduce the total time (cost) of maintenance by performing maintenance according to a fixed schedule. Maintenance schedules typically coincide with planned plant shutdowns. The challenge with this strategy is caused by the fact that manufacturing facilities with regularly planned shutdowns (e.g. Summer and/or Winter) are becoming increasingly rare.

The rise of Predictive Maintenance is closely tied to the rise of intelligent field devices and increasing use of field buses such as Profibus, FOUNDATION™ Fieldbus, and HART®. Intelligent device and Fieldbus technologies have enabled Predictive Maintenance solutions to become cost effective and as a result greatly increased the adoption of this maintenance practice. Asset Monitors continuously monitor the operation of the device and report when condition(s) that signify the need for maintenance have occurred.

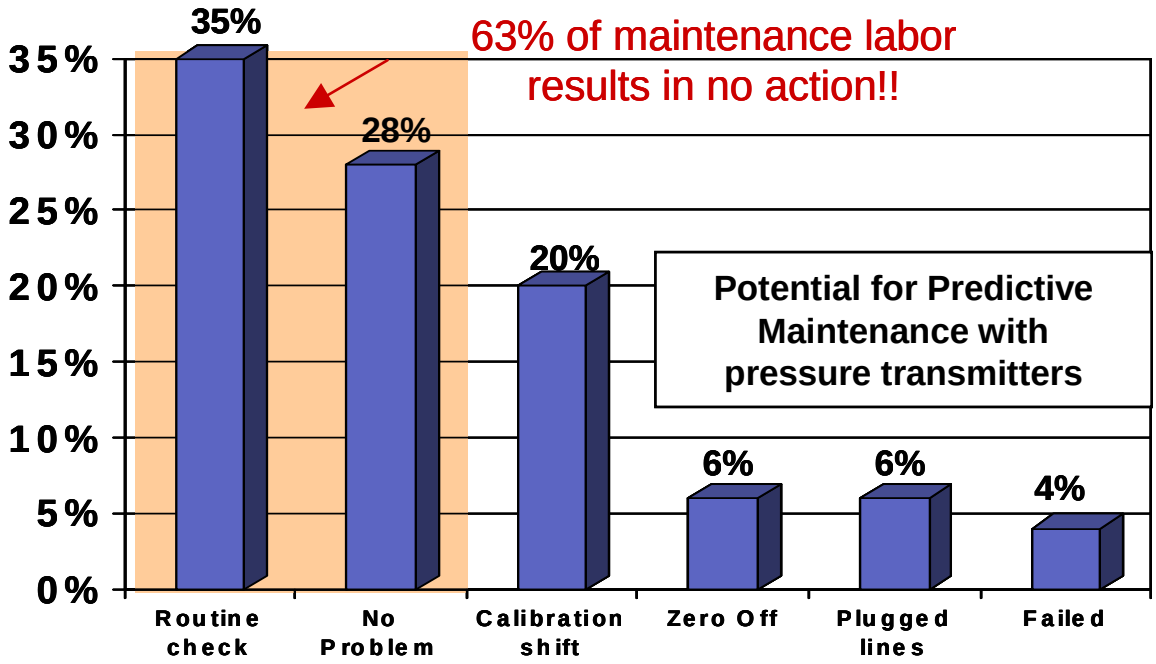
Reliability Centered Maintenance (RCM) actually is a blended approach to maintenance. RCM says the criticality of the individual asset to production determines which maintenance practice should be used, on an individual asset-by-asset basis. Even in "World Class" manufacturing facilities, the "Fix on Failure" approach of Corrective Maintenance may be the most appropriate strategy for a small percentage of assets. RCM recognizes the traditional "one size fits all" approach to maintenance practices is not the optimal solution. It recommends that the maintenance practice that best fits the business objectives of the manufacturing facility be applied on an asset-by-asset basis. RCM, sometimes also referred to as Proactive Maintenance, is currently the fasted growing maintenance practice.

Corrective	Preventative	Predictive	RCM (Blended Strategy)		
Fix on Failure	Fix on Schedule	Fix on Condition / Event	Strategy \ Mfrg Class	Typical	World Class
Can cause unplanned downtime	12-18% saving over Corrective	30-40% saving over Corrective	Corrective	~55%	< 10%
Leads to fire fighting mentality	Avoids catastrophic failures	8-12% saving over Preventative	Preventative	~31%	25-35%
		Extends life of assets	Predictive	~12%	45-55%

The table below compares the four maintenance strategies. The % comparisons under RCM indicate the percent of total assets that a given strategy is applied. It is important to note that approximately 50% of total assets in "World Class" manufacturing facilities are managed by Predictive Maintenance practices.

ASSET CONDITION MONITORING ON S88 EQUIPMENT HIERARCHY

As previously described, Predictive Maintenance strategies are based Asset Condition Monitoring. Asset condition monitors are typically applied to field device level (Control Module). Asset monitors continuously monitor the performance of the asset and determine the overall health of the asset. The overall asset health condition is used by PAM system functions to determine or predict when maintenance will be required on the asset. The chart below shows the financial motivation behind adopting predictive maintenance strategies. In this example, Shell Global Solutions tracked maintenance activities associated with pressure transmitters for one year. Shell Global Solutions has stated that they believe this data to be applicable to other plant assets as well. Thus, the conclusion, nearly 2/3 of the maintenance labor costs can be greatly reduced and/or eliminated by adopting Predictive Maintenance practices.



Source: Shell Global Solutions

Asset health conditions indicate the probability of future problems with the asset, rather than current problem/failure of the asset. Therefore, asset health conditions are often handled differently than process alarms. Process alarms will typically be: assigned priority levels, displayed in alarm summaries or process graphics and drive audible alarms. Asset health conditions more typically will notify maintenance personnel via e-mail and/or paging systems. The key reason for handling asset health conditions differently lies in the fact that they indicate potential future production problems rather than immediate problems to current production.

However, in some ways asset health conditions (or sub conditions) can be managed in manner similar to process alarms. Similar to alarm priorities, sub condition severities can be assigned to indicate different levels of urgency to individual sub conditions. The number of severity levels, and the meaning of each level are typically user assignable. Higher severity indicates that asset performance degradation/failure is more imminent.

In addition to e-mail and paging systems, many PAM systems offer “Maintenance Screens” that display plant assets and their current health condition. The information displayed in maintenance screens is not limited to sub condition severity. Additional performance indicators, or key performance indicators (KPI) and “Next PM Date” associated with individual assets are often provided in maintenance screens. KPI and Next PM Date for individual Control Modules can aggregated to Equipment Modules, Units and Process Cells. At these levels, this information can be useful in equipment selection processes.

USING ASSET HEALTH CONDITION IN EQUIPMENT SELECTION

Although asset monitors are most often applied to field devices at the Control Module level, business and application benefits can be achieved by applying asset monitors to higher levels in the S88 equipment hierarchy, e.g. Equipment Module, Unit and Process Cell. Specifically, it is particularly useful to aggregate asset conditions and performance indications of individual Control Modules into an overall asset health condition associated with the corresponding Equipment Module or Unit. The main reason for integrating PAM and Production Management systems is to make key asset condition information available to Production Management for decisions involving equipment selection. Many modern Production Management systems allow equipment selections to be made off-line in the production planning process, as well as on-line while batches are running. Advanced Production Management systems support manual and automated equipment selection. Some systems even allow equipment selections to be scripted to select equipment at run-time based upon “cost factors” that are calculated dynamically. When “Cost Factors” may include aggregate asset health condition (KPI) equipment selection process can select equipment with the best overall asset performance. This enables tighter control tolerances, minimizes process variation and improves production quality.

AVOID EQUIPMENT WITH MAINTENANCE PENDING

In typical PAM applications, asset condition monitors can be configured to predict when an intelligent field device (Control Module) will require maintenance. This attribute is often referred to as “Next PM Date” and represents when the asset will require some maintenance activity to be performed in order for the asset to continue to provide acceptable performance. By aggregating the asset condition monitors of individual Control & Equipment Modules, the “Next PM Date” for the Unit or Process Cell can be determined. This information coupled with statistical data (e.g. average procedure execution times) allows informed equipment selections to be made. For example, a biotech fermentation process that can run for 12 to 18 days can remove fermenter vessels from the equipment selection for units that have an aggregated “Next PM Date” that is less than 20 days in the future. The basic objective is to remove unnecessary manufacturing steps to transfer a batch from a unit to another unit of the same class due to an asset failure on the first unit. Avoiding one such occurrence will typically pay for the PAM to Production system integration effort.

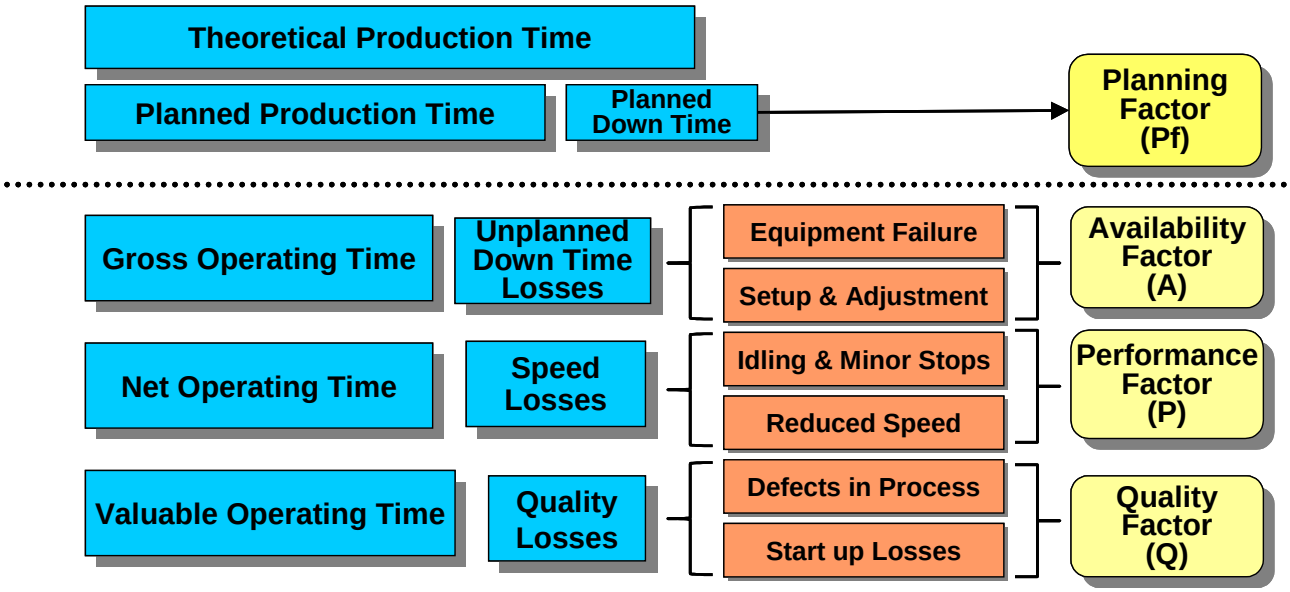
SELECT EQUIPMENT BASED ON AGGREGATE ASSET HEALTH

Another way to exploit integrated PAM & Production Management systems, is to focus on improving overall process performance. Again, the premise is very basic. Enable the equipment selection process to use aggregate asset health information. This time the focus is on asset health state and the severity of detected sub condition(s). As mentioned in a previous section of this document, higher severity values

indicate greater imminence for required maintenance. Stated another way, “Overall Asset Health” is inversely related to the aggregate sub condition severity. Therefore to increase potential process performance, the equipment selection process could select Equipment Modules, Units and/or Process Cells based on best overall asset health as indicated by lowest sub condition severity. In some processes it may be necessary to modify how individual asset health values are weighted in the aggregated values of higher level assets. This is particularly true for processes in which the KPI’s change based on which product is being made, or which materials are being processed. However, for most processes one standard method of aggregating asset health conditions yields suitable results.

APPLYING METRICS: OEE & RONA

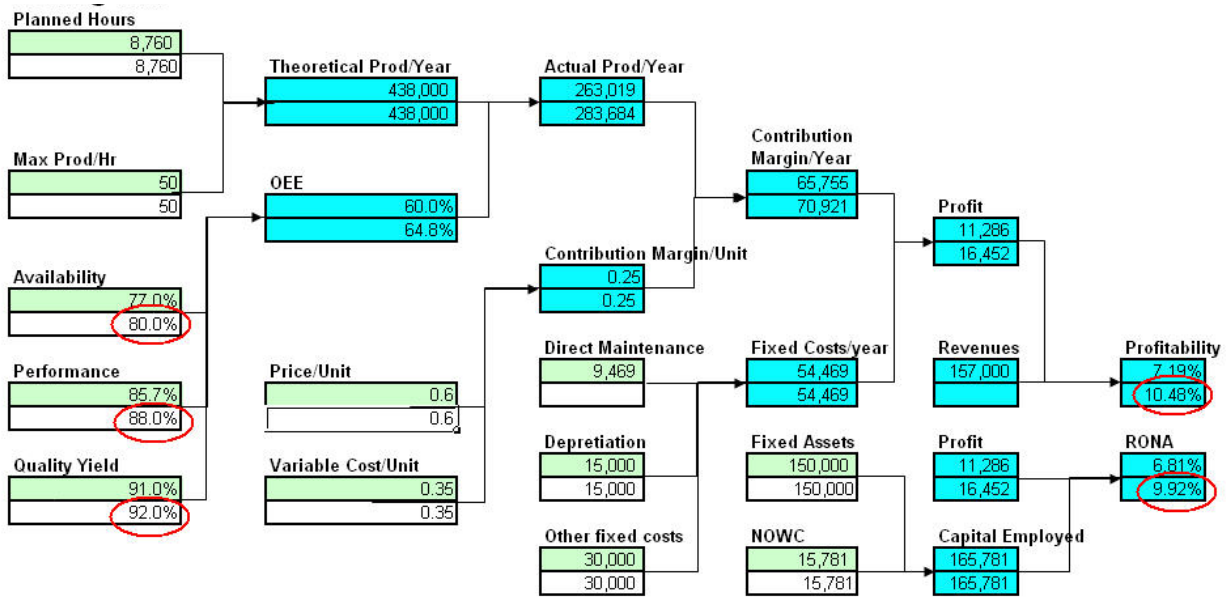
Two typical ways of measuring the financial performance of an origination are plant profitability and Return on Net assets (RONA). One of the key factors in determining these financial numbers is the use of Overall Equipment Effectiveness (OEE). Basically, OEE is calculated as the product of Availability, Performance and Quality as shown in the figure below. The process of calculating OEE involves accounting for the 6 major production losses: Equipment Failure, Set-up & Adjustment, Idling & Minor Stops, Reduced Speed, Defects in Process and Start-up Losses.



Overall Equipment Effectiveness : OEE = A * P * Q

Total Productivity = OEE * PF

The concepts presented in this paper focus on reducing Equipment Failure, Set-up & Adjustment and Defects in Process. The impact that OEE can have on the financial performance of an organization can be seen in the following figure. Making very modest improvements in OEE can result in a dramatic improvement in financial performance as shown below



So how do we achieve this without the investment in process improvements? By applying Lean Thinking principles to remove waste from the value chain. Not scheduling production on units with pending maintenance, and/or by not having to pause batches while unplanned maintenance is performed, improves OEE by increasing Availability and Performance. Selecting units for production with best overall asset health condition improves OEE by increasing Quality yield.

INTEGRATION LEVEL: ERP VS. MES

The integration between PAM and Production Management systems can be accomplished at either the enterprise level or closer to the process in the automation / MES level. The basic philosophy of providing asset health information to planning functions remains the same in either case. Only the details of specific communication protocols and message transactions change. The enterprise system may typically more adept at including financial data for materials and labor into calculations, however both approaches have advantages. The advantage of automation / MES level is that the nature of real-time data is typically better resulting in an implementation that is more agile to process upsets. The decision on which level, enterprise or automation/MES, to implement the integration between PAM and Production Management should be made on a case-by-case basis. The implementation that provides; total lowest cost to implement & maintain, and best fits existing infrastructure should be selected.

SUMMARY

Plant Asset Management and Production Management systems provide numerous benefits to maintenance and operations organizations respectively. PAM systems provide calibration management, asset condition monitoring / health & performance reporting and advanced maintenance strategies such as Preventative and Proactive maintenance. Production management systems provide resource management, production scheduling / dispatching and recipe management functions. Both PAM and Production Management systems each provide sufficient return on investment so that they can be justified on the value they provide to maintenance and operations individually.

However, with minor engineering effort, additional incremental financial benefits are possible by integrating these systems. The required effort is small, and little to no additional capital investment is required. By avoiding the need to re-route or pause batches due to equipment failures, or tightening control targets thus improving product quality, results in small improvements to OEE. These small improvements in OEE directly impact Profitability and RONA. Many manufacturing facilities have already invested in PAM and Production Management systems based on their separate value propositions. Therefore, the added financial benefits achieved by integrating Plant Asset Management and Production Management systems represents "found money" to many manufacturing facilities.

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