Achieve Best-in-Class Reliability

An integrated enterprise asset performance management (EAPM) system can help companies to eliminate failures, optimize strategies, and meet intended production targets.

Richard Beck
Meridium, Inc.

THE CONTINUED HIGH PERFORMANCE of assets is essential for refineries and petrochemical facilities that need to meet production demands, eliminate defects, achieve safety and environmental regulations and initiatives, limit lost production opportunities, and reduce costs. The goal is to move from reactive to proactive maintenance strategies that maximize up-time and minimize equipment failure. To that end, companies have focused a great deal of time and money deploying the best technology and subject matter experts, only to find themselves stuck in a reactive mode. A case in point was recently made by a major petrochemical executive, who commented, "We bought the best point solutions. Then, we hired respected experts to employ the point solutions. And yet, years later, we are still 60% reactive."

How can this situation be turned around? A growing body of evidence suggests that it is possible to move to a highly proactive state by implementing a well-structured, integrated, and comprehensive approach to reliability called enterprise asset performance management (EAPM).

In its simplest form, EAPM is defined as:

- the creation of strategies aimed at maintaining and improving asset performance
- the execution of those strategies, including the generation of key performance indicators (KPIs)
- assignment of criteria to initiate a thorough analysis of the asset's performance
- selection of decision support tools for evaluating the performance of the asset
- implementation of revised strategies when the initial or currently employed approach does not achieve the desired results.

The three primary domains encompass EAPM are strategize, evaluate, and execute. In Figure 1, they are depicted as a continuous flow, which emphasizes that one does not end at the evaluation phase. Rather, the focus should be on the initial or previously employed strategy and the re-strategizing that continually occurs.

To comprehend the EAPM approach, one must understand the typical activities that take place in each domain. Keep in mind that some of theses activities overlap and can be conducted in one, two, or all three domains, depending on the work processes within the organization.

The strategize domain. Some, but not all, of the typical activities that occur in this domain include:

- maintenance
- equipment design
- process design
- criticality analysis
- functional process design
- human resources needs analysis
- spare parts evaluation
- tools and test equipment determination
- regulatory compliance
- documentation and data needs
- contract administration
- inventory management and control
- purchasing and procurement
- HAZOP
- vendor reviews.

This paper was presented at the AIChE Spring National Meeting (Mar. 30–Apr. 3, 2003; New Orleans, LA)

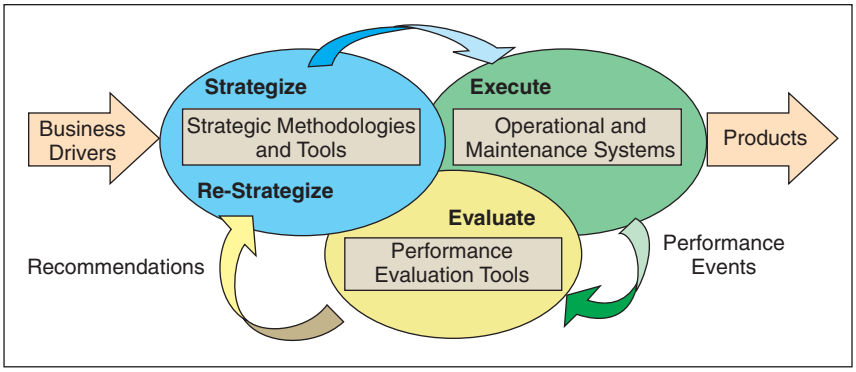

Figure 1. The three primary domains of enterprise asset performance management (EAPM) are strategize, execute and evaluate.

The execute domain. The activities that typically occur within the this domain include:

- plant operation
- process activities
- maintenance tasks
- inspection tasks
- incident/event recording
- turnaround activities
- condition monitoring
- regulatory compliance activities.

The evaluate domain. This domain includes analysis of how well assets performed, along with accountability for how well tasks were completed. Typical tasks identified are:

- Strategy effectiveness
- accountability
- KPI measurement
- efficiency measures
- performance measurement analysis
- capacity management
- system reliability
- root cause analysis.

Challenge #1
Choosing the right methods and tools

There are literally hundreds of methodologies to consider for developing asset strategies. A few of the more popular choices include reliability centered maintenance (RCM) and risk-based inspection (RBI). Both of these have proven to be well worth the implementation effort. In the case of RCM, RCM-certified facilitators are available who assist in identifying necessary tasks.

Another necessity is a long-term investment in an equipment taxonomy. A taxonomy, in asset performance terms, is commonly associated with the incorporation of equipment event information, KPIs and, in particular, the relational grouping of assets within a hierarchy. Figure 2 depicts the considerations that typically are given to assets when working within the strategy domain.

The author's experience includes work in facilities where maintenance or reliability engineers reported daily to operating unit meetings. These meetings addressed process problems and equipment that was unexpectedly removed from service due to process or mechanical problems. The engineers would focus their efforts that day, and perhaps on subsequent days, on remedying the problems and, in the end, would be positively reinforced for specific behaviors that led to a successful return to operations.

What was usually missing from this process was consideration of the criticality of the asset, either at the functional system or asset level. There was no consideration of the impact on safety, business or asset performance. Instead, all efforts were focused on returning the "problem-of-the-day" equipment back to service.

To further clarify the point of focusing on the problem of the day, consider the example of an engineer who worked on a spared water pump with low safety impact, limited business impact, and hardly any history of maintenance. The problem was an imbalanced rotor assembly due to long-term impeller wear. An entire day was spent disassembling the rotor and balancing the refurbished assembly.

The engineer assisted the maintenance workers with procuring spare parts, witnessing the balancing, and ensuring that all maintenance and engineering specifications were followed — including proper completion of inspection checklists. The result was a well-balanced rotor assembly, ready for return to service. But the pump was not returned to service for another month, because the plant had instituted a spare running program. Why was so much effort and attention given to an asset with such limited impact?

Finally, consider another "real world" problem of a highly critical, non-spared hydrocarbon pump. The pump was in service and performing, but its mean time between failure (MTBF) was less than three months. Data revealed that this highly critical pump had a greater than 75% probability of failure, but no one was working on improving that figure. Instead, they were focused on that day's issues, which was reinforced by all levels of management. In-

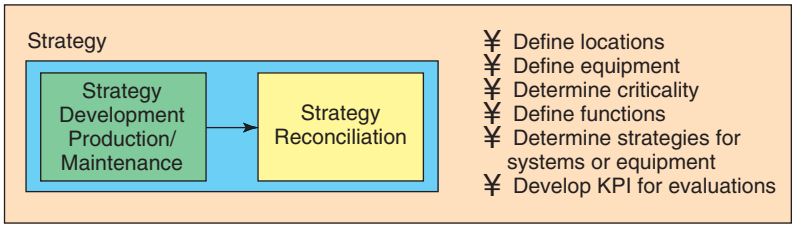

Figure 2. Taxonomy considerations in the strategy domain.

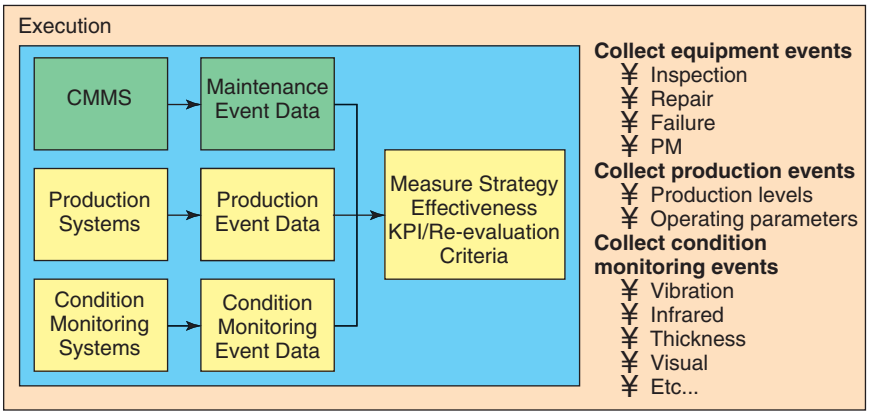

Figure 3. Typical data collection activities in the execution domain.

evitably, the pump failed, and the plant went down. Reliability engineers, maintenance staff, and operating personnel shifted into the reactive mode to fix a critical problem that previously had no (or limited) focus.

In each of these examples, a taxonomy would have made it possible to identify the location of critical assets within a facility, eliminate unnecessary reactive activities, and ensure that well-thought-out maintenance strategies were identified and employed. If a taxonomy is not selected and a strategy not employed, scenarios like the ones described above can become commonplace. Moreover, failure to identify assets that are highly critical and have a high probability of failure can only result in the loss of profits, productivity and opportunity.

Challenge #2
Producing product on-spec, on-time, with no failures

Within the domain, there are items and activities related to computerized maintenance management, production and condition monitoring systems. There are also complementary event-recording activities. An example of event and data recording activities appears in Figure 3.

In defining an EAPM strategy, companies should understand the value of capturing event data and interfacing or linking information from maintenance, production, and condition monitoring systems. A common mistake in many companies is attempting to "force" maintenance management systems into becoming a place to capture data related to asset performance. The fact is that these systems are primarily designed to manage work and to procure parts for performing work. Valuable asset performance data can be retrieved and maintained, but usually at a significant cost.

At the same time, engineers, technicians and analysts spend most of their time collecting data, rather than analyzing it. The goal should be for staff to spend 80% of their time analyzing data and making informed, timely decisions, rather than producing reports and searching for data by repeatedly creating the same reports.

Currently, many asset performance reliability personnel may spend 80% of their time, if not more, collecting data that they don't have time to analyze. Or, they're too caught up in reactive work to perform proactive analysis and maintenance. It is only by automating data retrieval, and interfacing it with critical maintenance, production and condition monitoring systems, that asset performance improvement becomes an achievable goal.

Challenge #3
I've got data. Now what?

Inherent in the ability to improve asset performance is the evaluation and analysis of data to make informed decisions. When faced with the challenge of evaluating performance and event data, the right tools and methodologies are critical. Figure 4 lists a few of the typical task groupings performed within the domain.

There are thousands of point solutions that provide engineers, technicians and analysts with the ability to perform data analysis. Risk-based inspection, root cause analysis, trending tools, and Weibull programs are just a few of the tools commonly in use. The technologies employed to analyze data range from spreadsheets, to databases, to specialized PC-based applications and legacy systems.

Unfortunately, these analytical tools are often responsible for creating vast information silos — the results of the analyses sit on departmental PCs or in desk drawers and are seldom, if ever, integrated with other point solutions. The results are problems that can include:

- a skewed view of the issues, because reliability analysts do not have access to the full breadth of data from the many systems involved
- no ability to integrate analyses from PC-based tools into operational and maintenance systems
- a disproportionate amount of time spent on data collection and manual data entry, rather than on analysis
- little or no re-evaluation of strategies; inefficient, ineffective work processes are continued, and attempts to eliminate defects fail.

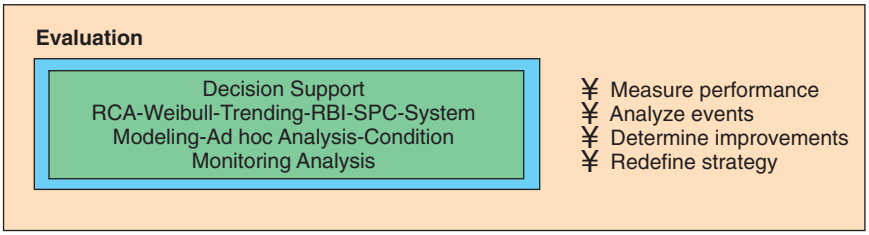

Figure 4. Typical activities in the evaluation domain.

Unlike these other approaches, comprehensive EAPM solutions operate on an enterprise-wide basis. They use information generated in computerized maintenance management systems (CMMS) and enterprise resource planning (ERP) systems, along with data generated by predictive maintenance tools and process historians.

Successful implementation

Various steps can be taken to implement a comprehensive, successful EAPM strategy.

Identify business drivers. These can include financial incentives, achieving production targets, safety, environmental, and health impacts, etc.

Define criticality of assets. Which production assets have a significant impact on items like safety, environmental, health, production, and maintenance and reliability costs? If you do not know what is critical, you cannot know where to begin to set a path for asset performance improvement that results in minimal impact.

Develop strategies. Select tools, methodologies and best practices for proactive tasks designed to prevent failure or identify defects that will lead to unexpected events (RBI, RCM, company and industry best practices).

Select and implement a taxonomy. Provide a means to classify assets and capture repair, failure, inspection, and information-type events.

Capture event-related data. This includes data on asset repairs, failures, inspection and information-type items. Do not get too caught up in defining differences between repairs and failures. Many teams have hit a roadblock because of passionate discussions about differences between repairs and failures.

The details of the maintenance event are critical when attempting to evaluate asset performance, not the tag of repair or failure. A suggested default is to simply call it a maintenance event. Capturing events in a maintenance management system that is typically designed to handle work and parts management is not a viable solution. Although most work management systems have the ability to capture failure-related data, the system's primary function is work management, not asset performance improvement.

Furthermore, in a work management system, most of the user's time is spent in data collection and repeating routine work steps (like retrieval of routine key performance indicators) month after month when addressing failure or repair information. Automating the retrieval of data from a maintenance management system to an event record in an asset performance system ensures capture of pertinent event data and work-order-related information vital to the asset.

Analyze data with the right tool set. To manage an asset performance initiative whose goal is to avoid unscheduled events and meet production targets at the lowest sustainable cost, there must be a way to measure the results of the asset-related events. Growth analysis is one tool that allows users to quantify improvements by measuring MTBF.

By making true improvements, users could measure growth before and after material replacements are made — the results should show an increase in MTBF. If not, then the root cause of the reliability problem or the current employed strategy was not effective, and further investigation is required.

Additionally, reliability and availability improvements should be noted at the production unit level. While this is not always the case, significant revenue improvement can be recognized by improvements in KPIs such as cost per unit of production. If the evaluation of the processes and events related to KPIs — such as lost production costs and failure to meet capacity requirements — shows a decline, or the improvement is not what was expected or targeted, then another plan needs to be formulated. Having analytical tools and KPIs in place are key drivers to evaluating performance.

Address the root causes and failed strategies. To address chronic asset problems, root cause analysis methodologies and tools are imperative. Actions or recommendations to address root causes are not tracked, and typically end up lost in a point solution that does not automatically track progress to completion. Integrated APM solutions have the ability to track individual recommendations and action items.

Equally important is the handling of failed strategies. For example, one task could be defined as "monthly monitoring of bearing vibration shall be performed at P-101, a highly critical asset." Perhaps monthly is not frequent enough, because the failure pattern for this bearing is extremely rapid once a defect is identified.

The missing piece to many asset performance improvement puzzles is the fact that organizations do not address original or currently employed strategies. An integrated APM system promotes the review of these strategies, along with the implementation of the refined or new strategy for the impacted asset or system.

Using the above example, the evaluation data may show that this pump's bearing fails rapidly once a defect occurs. The MTBF is noted at 1.2 years, so an appropriate approach is to identify the defect early and plan a scheduled replacement shortly thereafter. Understanding the importance of evaluating performance, a better strategy might be, "Bearing vibration monitoring shall be conducted daily following one year of service." CEP

RICHARD BECK is the asset performance management consulting group leader at Meridium (10 S Jefferson Street, Suite 1100, Roanoke, VA 24011; Phone: (540) 344-9205 x1186; E-mail: rbeck@meridium.com). He has worked primarily in the inspection, maintenance and reliability fields for the past 22 years. Beck has extensive experience in machinery vibration analysis, major compressor, steam turbine and other machinery design review, and quality assurance activities. He was formerly the machinery reliability department supervisor for the Chevron Phillips Chemical (CPC) Cedar Bayou, TX, plant. Beck is a former API task force team chairman (API-685), and is currently in his fifth year as a member of the Texas A&M turbomachinery advisory committee. He received his bachelor's degree in education, mathematics from Mississippi State Univ.