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Quantifying the ROI of an asset performance management program

Here's how a typical refinery can obtain nearly $4 million per year in benefits

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An asset performance management (APM) program can increase processing plant availability and reliability, optimize operation and maintenance costs, and help control risk. This article will quantify the annual benefit from APM programs for a typical refinery and also describe the functionality APM programs provide. Many processing plant executives want to know the return on investment (ROI) in an APM program before they make that investment, and this article will quantify that "return."

Asset performance management. The military, along with the electronics, automotive and airline industries, has achieved an incredibly high level of safety and equipment reliability through the application of APM techniques. Innovative process industry companies are now applying the same APM techniques, using state-of-the-art technology and software to increase total production and decrease production costs.

What exactly is APM? A commonly used definition is: The goal of an APM program in the process industries is to "achieve the largest possible predictable production at the lowest sustainable cost safely by integrating reliability-related data with best-practice reliability tools and proven reliability work methodologies." APM achieves these goals primarily by focusing on reliability.

There are some key words and phrases in the APM definition. The first is "predictable production." To meet production and market goals, plant managers want to be able to meet production goals repeatedly and with confidence. Another key phrase is "lowest sustainable cost." Top performers typically have the lowest maintenance costs and the highest plant availability.

To be able to achieve these benefits, an effective APM program is a combination of engineering methodologies and work processes, along with a state-of-the-art technology/software solution that supports, enforces and enhances those methodologies. While the engineering methodologies have been available for decades, what has recently changed is the development of software technology solutions that "enable" those benefits to be realized. In addition, to be most effective, many companies now realize that APM reliability programs must be addressed in a comprehensive integrated fashion, just like process safety.

Benefits of asset performance management. The main economic benefits of an APM initiative fall into the following categories:

TABLE 1. Estimated annual benefits of an APM program for a typical 100,000-bpd refinery

Category	Annual benefit, $
Avoiding abnormal incidents	500,000
Reducing lost profit opportunities	1,750,000
Reducing maintenance budget	800,000
Improving staff productivity	300,000
Reducing capital costs	400,000
Reducing liability insurance premiums	200,000
TOTAL	**3,950,000**

- Avoiding abnormal incidents (accidents, explosions, releases)
- Reducing lost profit opportunities (unplanned and scheduled maintenance turnarounds)
- Reducing the maintenance budget (optimizing preventive maintenance and reducing overtime)
- Improving productivity (by increasing the effectiveness of the reliability staff)
- Reducing capital (by reducing the amount of capital investment needed)
- Reducing liability insurance premiums (from a reduction in risk recognized by insurance companies).

Some additional benefits are more difficult to quantify and/or are smaller. These include benefits resulting from safety improvements, fewer environmental incidents, increased mechanical integrity, reductions in the IT budget (from a reduced number of IT systems to maintain) and energy savings (resulting from fewer unit startups and shutdowns). These additional benefits can be significant, but will not be estimated in this article.

Total annual benefits for a 100,000-bpd refinery are estimated and summarized in Table 1.

Avoiding abnormal incidents. As a result of one company's plant explosion in 2005, that company has lost an opportunity to invest approximately $1 billion of business capital into new programs and budget items.[1]

APM technology initiatives can impact incident avoidance because more reliable systems can prevent fires, environmental releases and injuries. One paper documented a "28% reduction in the number of episodic releases and 48% reduction in pounds released."[2] APM software assists in meeting compliance requirements and provides a lower risk of incidents.

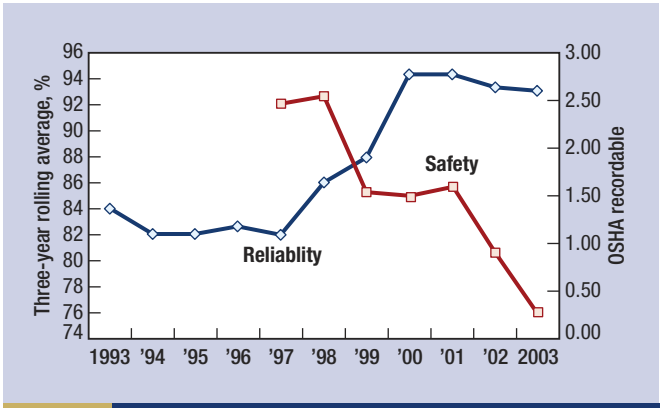

FIG. 1 Reliability and safety improved for a petrochemical company after implementing an APM program.

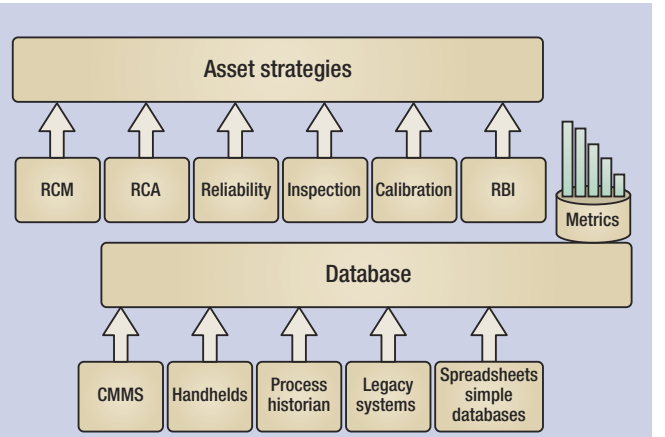

FIG. 2 Using a database and asset strategies to optimize asset performance.

A reasonable abnormal incident avoidance risk reduction is 0.05% of replacement asset value (RAV). For a 100,000-bpd refinery, this would amount to a benefit of approximately $500,000 per year for an assumed $1 billion RAV.

(Please see the liability insurance premium benefit described later where actuaries at insurance companies are acknowledging the risk reduction from APM software and are reducing liability premiums.)

Reducing lost profit opportunities. One refining company installed APM for analyzing heat exchangers at five of its refineries. A post-audit of this initiative concluded that this analysis method has now become the de facto standard practice for determining the scope of heat exchanger bundle replacement during turnarounds at this company.[3] To date, this technique has assisted the company in avoiding an estimated $13+ million in lost production.

Fig. 1 shows how reliability and safety improved for a petrochemical company after an APM program was implemented.[4]

A 2% increase in availability equates to an additional seven operating days per year. For a 100,000-bpd refinery using a conservative margin of $2.50 per barrel, a 2% increase in availability is roughly a benefit of $1.75 million per year.

Reducing the maintenance budget. One major processing company's APM program helped the company reduce maintenance costs by 30% and increase availability by 2%.[5] Another company's APM initiative helped reduce its onstream inspection budget by 50%.[6] These benefits were the result of:

- Less reactive work
- Establishment of a reliability culture
- Reduction of overtime
- Reduction of expedited materials
- Reduction of unnecessary inspections and maintenance.

For a 100,000-bpd refinery, using an estimated normal maintenance budget of $40 million and a conservative 2% reduction in its maintenance budget, results in an annual benefit of $0.8 million per year.

Improving reliability staff productivity. One APM software user said, "Instead of spending 80% of my time on data entry and 20% on analysis, I now spend 20% on data entry and 80% on analysis." This is the equivalent of increasing productivity and effectiveness four times (400%).

For a typical 100,000-bpd refinery, using a conservative improvement of 20% in productivity, 15 staff members working in reliability teams, inspections, etc., and an annual cost of $100,000 per person results in an estimated benefit of $300,000 per year.

Reducing capital. Better life-cycle risk management by using preventive maintenance optimization, reliability-centered maintenance (RCM) and other APM techniques can result in longer life for capital assets. For a typical 100,000-bpd refinery, using a conservative 2% reduction of total material costs of $20 million, results in an estimated benefit of $400,000 per year.

Reducing liability insurance premiums. Liability insurance companies and their actuaries are now acknowledging the reduction in risk that results from installing APM software. At one company, the annual liability insurance premium was reduced by over $500,000 per year. For a typical 100,000-bpd refinery, a reasonable, yet conservative, benefit is a reduction of $200,000 per year in insurance premium costs.

How asset performance management achieves these financial benefits. In most plants, there are many sources of data and databases (business, process, design, maintenance, etc.). To be able to achieve the level of financial benefits stated in this article, APM must first integrate all these many disparate reliability data sources.

Much of the reliability data for a process plant resides in the company's computer maintenance management or enterprise asset management systems. These types of systems record maintenance-related information such as when failures occur, the repairs that were made to the equipment and the likely causes of the failures.

However, there can be many other sources of reliability-related data in a plant such as plant real-time information and design systems. In addition, plant engineers often maintain their own reliability data in spreadsheets or other electronic mediums.

Another source of reliability data is from handheld devices. APM software has the ability to define, manage, route and report on a large volume of equipment condition data that are typically collected as part of an operator's shift assignments.

One goal of APM is to integrate all these data sources in a state-of-the-art software package so that all plant personnel can access it (Fig. 2). Significant savings can be achieved when all the

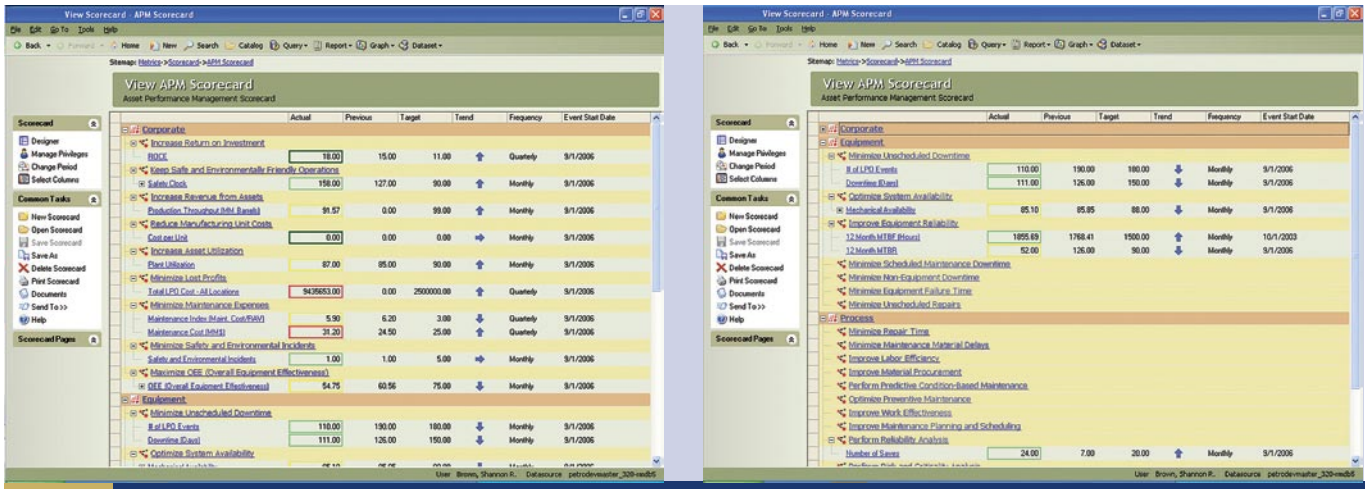

FIG. 3 Scorecard reports are used as management reporting and analysis tools.

data and functions are available enterprise-wide. For example, when an engineer at one plant completes a root-cause analysis (RCA), that information is available to engineers at other plants so they do not have to recreate it.

If you don't measure it, you can't manage it. Integrated data allow the ability to calculate and display plant metrics. Scorecard reports (Fig. 3) are used as management reporting and analysis tools to track the progress and attainment of business objectives. These show at a glance the critical information relative to each perspective, objective and measure. Action plans are then formulated to achieve these strategic objectives.

However, integrated data are not useful unless they are used to improve the decisions that are ultimately made in a plant. Thus, the next goal of APM is to use the integrated data with proven reliability methodologies. These methodologies consist of reliability engineering tools and changes in work practices that are often necessary to be able to take advantage of these tools.

Typical reliability engineering tools include:

- Graphical failure/lost production cost analysis tools
- RCM
- Risk-based inspection (RBI)
- Inspection management
- RCA
- Equipment failure mode characterization
- Process unit reliability modeling
- Thickness monitoring.

These tools are normally part of an APM software system.

Graphical failure/lost production cost analysis tools. Many process plants do not fully understand their reliability and maintenance cost structure. To clarify, they do not specifically calculate the amount of lost production caused by failure of particular equipment and typical failure modes (seal failure, bearing failure, etc.), the maintenance and lost production costs attributed to those failures, and the maintenance cost—both planned and unplanned. This is largely due to the fact that most process plants have never had access to the data in a structured format to be able to analyze data in this way.

Engineers and managers like to analyze the reliability performance of a particular plant from many different views. For example, they would like to know the number of failures, the failure and lost production costs, etc.

Those same engineers and managers like to analyze these reliability metrics in various ways. For example, perhaps first they want to understand these metrics by process unit, then by equipment tag number, then failure mode and then by repairable item. Or they might want to understand these metrics first by equipment manufacturer, plant location, time, etc. The more sophisticated APM technology solutions allow users the ability to "drill into" the data and query or "slice and dice" the data in whatever way makes sense for their particular operation as shown in Figs. 4, 5 and 6.

This ability to fully understand their reliability and maintenance cost structure is important because this allows engineers and managers the ability to understand where to focus their efforts.

Reliability-centered maintenance. RCM is the principal strategic portion of APM. RCM is to reliability what process safety initiatives were to process safety. RCM is one of the more important reasons that aircraft reliability and safety have achieved today's high levels.

All process units have many functions—many obvious and some that are more subtle. For example, the functions for a typical hydrotreater would include, but are not limited to:

- Reduce sulfur to .01 ppm
- Heat feed to 600°F
- Control separator level between 30–70%
- Maintain liquid in vessels.

RCM is an engineering process that allows engineers to define all the functions of a process unit. Then, through a series of steps, the engineer defines functional failures, failure modes, the consequences of those failures and ultimately recommendations on how to avoid those failures and maintain the defined functions. Through this process, RCM links the exact maintenance recommendations to maintain the defined functions.

Many think that RCM is solely a maintenance technique. However, it is more than that because if there is no maintenance task to avoid a failure, then a redesign may become necessary. In this sense, RCM transcends maintenance because it focuses on "maintaining the functions" of a process unit whether it be by maintenance activities or by design changes.

Failure modes and effects analysis (FMEA) is often heard in conjunction with RCM. That's because FMEA is a subset of RCM that focuses not on the functionality of a process but on

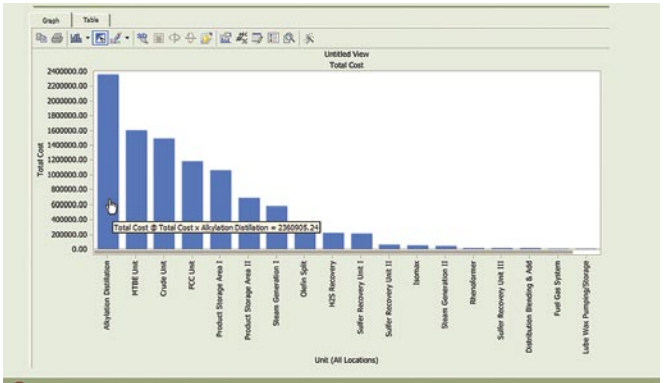

FIG. 4 First analyze data by process unit.

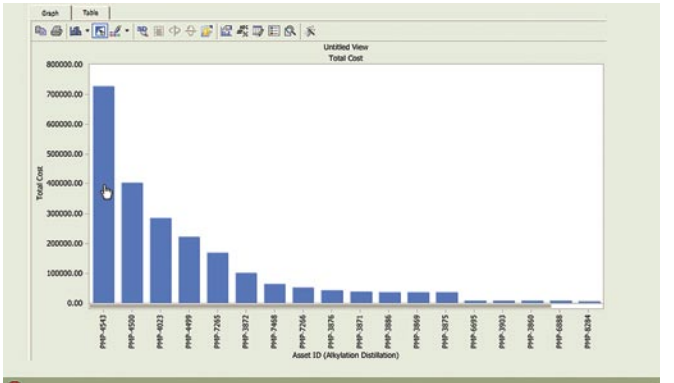

FIG. 5 Drill into asset ID for this process unit.

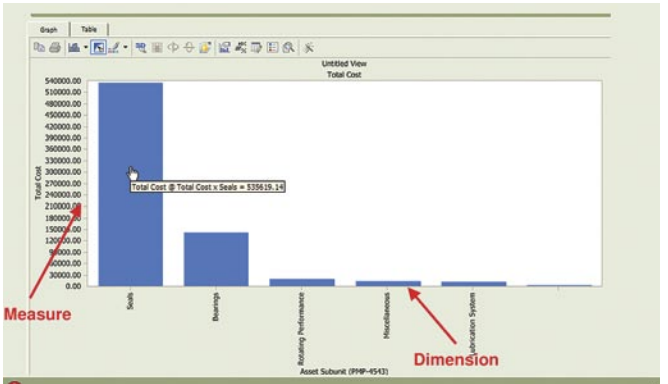

FIG. 6 Now drill down into asset subcomponent for this asset.

equipment failure modes. It is also a principal part of any strategic reliability initiative.

Risk-based inspection. RBI is an inspection optimization technique that allows process companies the ability to determine when to schedule inspections based on the probability that there will be a "material loss" from a pipe or vessel and the consequence of a fluid release (explosion, fire, toxic exposure, environmental impact or health-related issues). APM software tracks all the important parameters used to calculate both the probability and consequence of a material loss for each vessel or pipe.

Inspection management. Visual surveillance and inspection of equipment are critical to assessing its condition. In many industries, visual inspection programs are mandated by regulatory agencies that can levy significant fines for noncompliance. APM software provides functionality to manage large-scale inspection programs and provides a means of documenting as-found conditions.

A very important, yet underestimated, benefit of an inspection management program is tracking recommendations that result from inspections. In the past, when inspections were done, recommendations often were noted but rarely implemented. APM software solutions have made it much easier to implement recommendations than it was in the past.

Root-cause analysis. Maintenance and reliability studies in the process industries have shown that 20% of the equipment assets contribute to 80% of the maintenance and lost production costs. In other words, process plant maintenance and reliability follow the 80/20 rule as is the case in many other facets of life.

RCA is a work process that allows engineers the ability to analyze undesirable events so that faults can be documented and strategies can be established to prevent reoccurrence of the event. APM software facilitates gathering failure event data, assembling the RCA team, documenting failure modes and root causes, as well as tracking recommendations.

Unfortunately, many process plants are not fully positioned to take advantage of the power of RCA because they do not understand their cost structure adequately to be able to understand where to focus their efforts. That is why graphical failure/lost production cost analysis tools, as discussed earlier, are so important.

Characterization of equipment failure modes. It is important to be able to understand how long a part will last before it will likely fail. It is also important to understand what that typical failure pattern will be. Studies conducted in the airline industries, and similar studies in the process industries, showed that there are six typical failure patterns (Fig. 7).

Using failure data, APM software allows engineers the ability to calculate the failure pattern of an equipment failure mode and typical failure times. This functionality allows users the ability to perform "what-if" analyses and estimate costs for repair vs. replace decisions, acquisition vs. lease decisions and vendor-to-vendor comparisons.

Process unit reliability modeling. Process unit reliability modeling, based on Monte Carlo mathematical principles, allows the user to model how an individual piece of equipment's reliability and maintainability characteristics can impact overall availability of a process unit, the total number of expected failures and total failure costs including lost production costs. This analysis technique identifies the largest contributors to unavailability, which allows the plant to focus effort on eliminating that unavailability source.

These techniques allow plants the ability to evaluate different "what-if" scenarios and ultimately lead to better cost/benefit decisions. This analysis technique is increasingly being used to determine the optimal turnaround timing and what equipment should be optimally repaired during a given turnaround.

Thickness monitoring. An important step in determining the stationary equipment condition is monitoring the wall thickness of the process plant piping, vessels, heat exchangers, tanks and boilers. APM software provides industry-standard

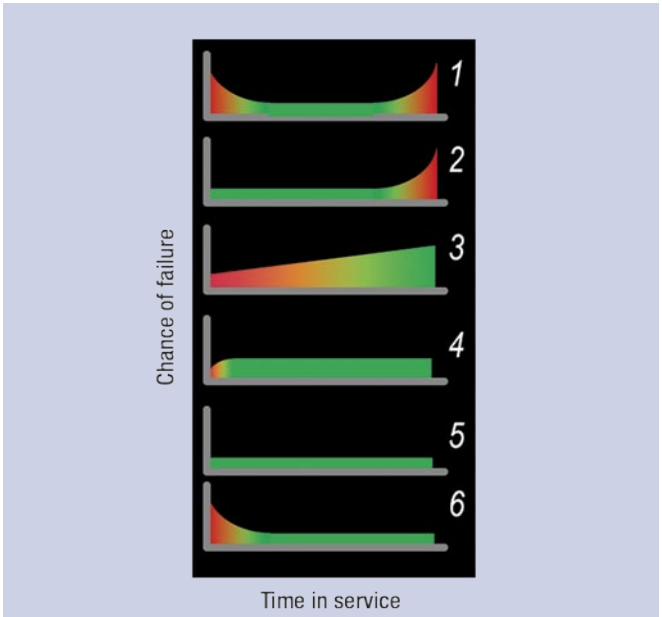

FIG. 7 There are six typical failure patterns.

API calculations and measurement management capabilities to determine and monitor stationary equipment condition. Specific calculations include minimum wall thickness, current and historical corrosion rate, next inspection date and retirement date. Also, a key aspect of managing stationary equipment condition is by monitoring corrosion through an ongoing ultrasonic thickness (UT) testing program. Seamless integration with many UT field testing devices is also provided by the APM software.

Benefit of an integrated approach to asset management. Applying any of the aforementioned technologies by itself will result in benefits. For example, applying RCM almost always results in an initial large reduction in maintenance costs because often a number of unneeded tasks are eliminated.

However, over time most RCM initiatives become stale. That is, their benefits fade over time.

As we know, process plants are dynamic. Over time plant feed rates and compositions, process unit operating conditions and production demands change.

The dynamic nature of our plants has reliability consequences. Failures start to occur in places that were originally unanticipated. The corrosion rate of certain equipment increases, while others decrease. Based on these changes, it may make sense to change turnaround plans—both what equipment is included in a turnaround or the turnaround frequency.

One would expect that our plant maintenance and reliability programs would be as dynamic as our plants. However, until the advent of APM, this has rarely been the case. One of the largest benefits of an integrated technology software solution is that plants can now react much more dynamically than was possible in the past.

For example, for RCM applications advanced technology solutions can track the number of failures for a given RCM failure mode and alert users when an abnormally high number of failures for that failure mode have occurred. This gives engineers the ability to alter maintenance tactics and frequencies in real time, thus maintaining the original benefits.

The same applies to RCA. If the company has gone to the expense of conducting an RCA, it would most certainly want to track if any subsequent failures had occurred on that equipment to understand the effectiveness of the recommendations from that RCA. APM software is able to track the failures in real time and alert users via e-mail when a certain number of failures had occurred on a piece of equipment.

Another example where this dynamic capability is important is in RBI programs. As process conditions change, the probability of a loss of containment may change. For a vessel that normally was inspected at 10-year intervals, this may mean that it now needs to be inspected at a five-year interval. On the other hand, another vessel that had been inspected at 10-year intervals may now only need to be inspected every 15 years. Advanced APM techniques can now track process variables and "optimize" inspection intervals in real time.

Thus, advanced APM technology solutions have become a major factor in transitioning our maintenance and reliability to dynamic solutions, like our process plant themselves, rather than static solutions that have been normal practice for many years. **HP**

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Corporate Fact Sheet

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COMPANY OVERVIEW

Meridium, Inc. is the leader in asset performance management solutions for process, power, mining and discrete manufacturing industries. With Meridium software and services, companies can improve profitability by increasing reliability and improving the performance of their production assets while optimizing maintenance costs, driving regulatory compliance and decreasing the potential for undesirable incidents. Industry leaders such as Chevron, Lyondell, Marathon Petroleum and Southern California Edison rely on Meridium for enterprise wide asset performance. Meridium is headquartered in Roanoke, VA, USA, with regional offices in Houston, TX, USA; Dubai, UAE; Walldorf, Germany; and Perth, Australia.

Quick Facts:

- 500+ licensed sites
- Founded in 1993
- 25+ countries
- Privately held

Meridium APM

Meridium's Asset Performance Management (APM) enterprise solution is not just reliability software but a comprehensive set of business processes, workflows and data capture that enables rigorous analysis to help you define strategies based on best practices, plant history and fact-based decision support. Meridium APM software has performance-driven, goal-oriented applications tied to key performance indicators. It provides analyses to decision makers about their production assets on an enterprise, plant, asset or equipment level.

Meridium's APM solution delivers enterprise reliability software and a work process that:

- Leverages critical asset performance data from enterprise and local sources (ERP, CMMS, DCS, and other discrete systems)
- Publishes key performance indicators enabling identification of improvement opportunities
- Automates technical data analysis to identify and predict failure occurrence and cause
- Supports continuous improvement of operational, surveillance, maintenance and design strategies based upon best practices, operational history and fact-based decision support
- Drives strategies back to execution systems to close the loop and continuously improve asset performance across the enterprise.

With demonstrated low capital intensity and rapid payback, Meridium provides an excellent investment option for improving capacity utilization, safety, process stability and environmental compliance.

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