THE ELEMENTS OF A WINNING FORMULA

Beware the ineffective PdM Program

By Burt Hurlock, CEO, Azima DLI

When it comes to predictive maintenance (PdM) programs, as with all human endeavors, there are winners and losers. What makes the difference? And why do successful PdM programs collapse as quickly as they form (a phenomenon well documented by vendors and customers alike). A recent industry survey conducted by Plant Services magazine offers clues.

The survey results are shocking given how long PdM has been in use. Less than 20% of respondents representing several hundred US plants thought their PdM programs were effective or very effective. The vast majority however, about 66%, thought their PdM programs were ineffective or needed improvement. With *that* success rate how has PdM survived? Respondents attributed their lack of success to the following obstacles: undefined financial benefits, undefined operational benefits, and lack of support/resources (executive, IT, engineering and budget).

Is it fair to say that the failure of PdM programs could be a self-inflicted wound? Maybe. PdM's wide rate of adoption in the face of such low success rates and in the absence of defined benefits is at least a conundrum.

If you don't know where you're going, any road will take you there

Metrics and KPIs are as old as management itself. It's easy to forget that all meaningful metrics have cultural origins. Imagine launching a start-up airline. Would it stress low cost (like Southwest), entertainment (like JetBlue), niceties (like Virgin Atlantic), or attitude (like Delta)?

Choices have to be made and winners don't win by accident. They set out to win. They make conscious commitments to certain objectives with targeted metrics and deliberate organizational design. As the airline industry suggests, a number of winners can co-exist with widely varying formulas that offer different but well *defined benefits*.

The false promise of generic and widely used metrics like ROI (return on investment) is that one size fits all. But what does first class passenger yield mean to Southwest, or turnaround time mean to Delta? Not much. KPIs have to be relevant to the organization. Managers and staff must know why they exist and how to influence them. Without *defined benefits*, it's hard to know where you're going.

A baseline for PdM today

Costs are the best understood and most carefully monitored enterprise performance metric. Unplanned maintenance and unplanned capital expenditures (capex) account for the lion's share of "manageable" direct production environment costs. Managers should also consider indirect costs like lost production, spoilage, and opportunity cost, among others.

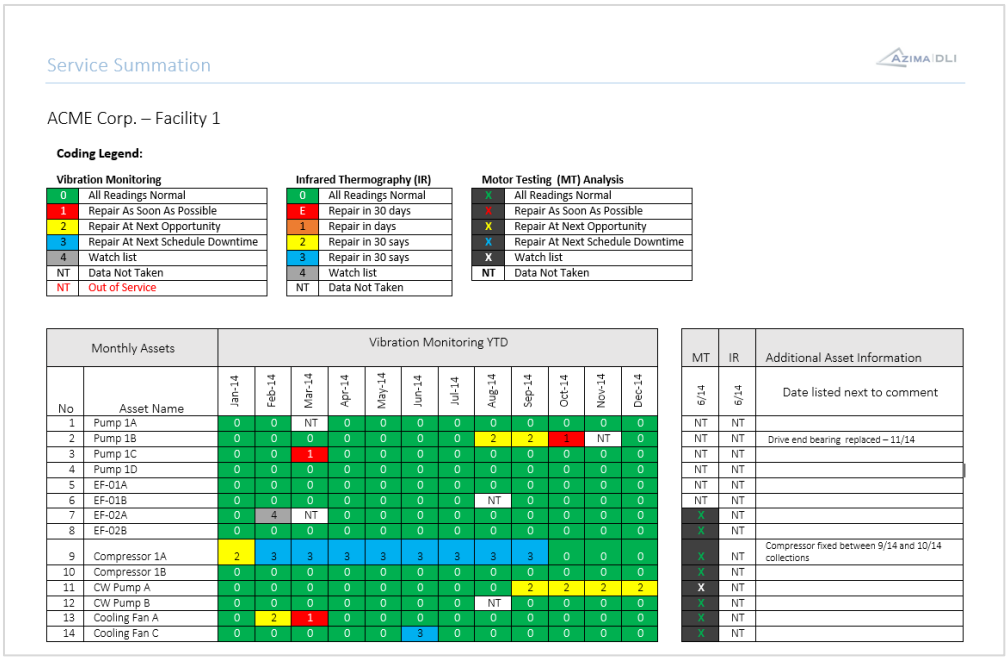
Unplanned maintenance and unplanned capex are exceedingly easy to measure. Those two numbers are the low hanging fruit—the definable financial benefit for even the most rudimentary PdM programs. Reducing and/or eliminating them can achieve double digit ROIs. That is, those costs (unplanned maintenance + unplanned capex) can be ten or more times higher than the actual cost of your PdM program. Those are the facts. They are undisputed. Call the accounting department and put the debate to rest.

The root of all (unplanned) costs

Unplanned maintenance and capex costs have natural precursors that well-conceived PdM programs identify. In the simplest scenario early detection of an emerging mechanical fault allows you to schedule an inexpensive repair during a planned outage rather than waiting for a catastrophe to bring the plant down at exponentially higher cost.

The simple mechanical fault detection that avoided a catastrophe with a scheduled, inexpensive repair is the building block of PdM. Fault detections vary by degree from slight to extreme. In very few cases do slight and moderate faults come with recommended actions. They are very early warnings of change that bear closer monitoring.

Serious and extreme fault detections include both a time frame and recommended action; and only in the case of extreme faults is the action recommended immediately. The purpose of grading faults by severity is to give managers time – time to plan and time to budget. Most production environments can live with a material number of machines operating with slight and moderate faults without serious risk of failure. Does that mean the risk of failure is higher than operating fault free? Of course, but the cost of addressing all detected faults immediately is much higher, too.



Service Summation

ACME Corp. – Facility 1

Coding Legend:

Vibration Monitoring

0	All Readings Normal
1	Repair As Soon As Possible
2	Repair At Next Opportunity
3	Repair At Next Schedule Downtime
4	Watch list
NT	Data Not Taken
NT	Out of Service

Infrared Thermography (IR)

0	All Readings Normal
E	Repair in 30 days
1	Repair in days
2	Repair in 30 says
3	Repair in 30 says
4	Watch list
NT	Data Not Taken

Motor Testing (MT) Analysis

X	All Readings Normal
X	Repair As Soon As Possible
X	Repair At Next Opportunity
X	Repair At Next Schedule Downtime
X	Watch list
NT	Data Not Taken

Monthly Assets		Vibration Monitoring YTD												MT	IR	Additional Asset Information
No	Asset Name	Jan-14	Feb-14	Mar-14	Apr-14	May-14	Jun-14	Jul-14	Aug-14	Sep-14	Oct-14	Nov-14	Dec-14	6/14	6/14	Date listed next to comment
1	Pump 1A	0	0	NT	0	0	0	0	0	0	0	0	0	NT	NT	
2	Pump 1B	0	0	0	0	0	0	0	2	2	1	NT	0	NT	NT	Drive end bearing replaced – 11/14
3	Pump 1C	0	0	1	0	0	0	0	0	0	0	0	0	NT	NT	
4	Pump 1D	0	0	0	0	0	0	0	0	0	0	0	0	NT	NT	
5	EF-01A	0	0	0	0	0	0	0	0	0	0	0	0	NT	NT	
6	EF-01B	0	0	0	0	0	0	0	NT	0	0	0	0	NT	NT	
7	EF-02A	0	4	NT	0	0	0	0	0	0	0	0	0	X	NT	
8	EF-02B	0	0	0	0	0	0	0	0	0	0	0	0	X	NT	
9	Compressor 1A	2	3	3	3	3	3	3	3	3	0	0	0	X	NT	Compressor fixed between 9/14 and 10/14 collections
10	Compressor 1B	0	0	0	0	0	0	0	0	0	0	0	0	X	NT	
11	CW Pump A	0	0	0	0	0	0	0	0	2	2	2	2	X	NT	
12	CW Pump B	0	0	0	0	0	0	0	NT	0	0	0	0	X	NT	
13	Cooling Fan A	0	2	1	0	0	0	0	0	0	0	0	0	X	NT	
14	Cooling Fan C	0	0	0	0	0	3	0	0	0	0	0	0	X	NT	

Figure 1: Example of plant PdM service summary. Total plant and individual machine health can be assessed at a glance.

When a PdM program delivers a comprehensive picture of machine health across a plant with fault detections presented by severity it's like having a whole plant MRI. Areas of high risk, low risk, and no risk are immediately apparent. The information gives maintenance managers the luxury of time and the chance to anticipate and head off failures.

Without the tools to foresee failures and plan and budget for repairs, budgets are prescriptive and myopic guesses at best. And because failures swing the budget far more than planned maintenance, incorrect assumptions are costly and painful. Forgoing well established methods for predicting maintenance spending is like driving by the rearview mirror. Fortunately, the age of Big Data is upon us, and with it comes the power to anticipate and head off unfavorable scenarios.

Committing to visibility

Even though a clear view of machine health supports more nuanced and accurate budgeting, it also encounters resistance. The knee jerk reaction to visibility can be fear that it may be used to second guess maintenance strategies or expose poor performance. That resistance fades when maintenance teams permanently reduce both maintenance and capex spending, and start coming in on budget year after year.

Resistance or not, visibility in production environments is here to stay. For decades mechanical faults detected by condition monitoring programs have made local heroes of individual plant managers and their maintenance teams. Well run onsite PdM programs—with onsite diagnostic

expertise, on time data collection and analysis, and careful planning and budgeting—often achieved exceptional results and reduced if not eliminated unplanned maintenance and capex spending. Until recently, however, such success was intermittent and localized.

That's because replicating success with PdM across an enterprise, and even sustaining it locally, depended on preserving and/or duplicating the same chemistry of people, expertise, measurement and management, which made locally exceptional performance a rarity.

The internet may be changing the local PdM paradigm by making goals and the behaviors required to achieve them more accessible, and the results more transparent. The internet can be used to illuminate the islands of strength in the sea of PdM mediocrity, which should translate into faster learning, better awareness, and rapid response. To management it will look like opportunity. To line workers it may mean the days of hiding bad news are numbered. Either way the decision to use data still has to be made, as does the decision to manage to it.

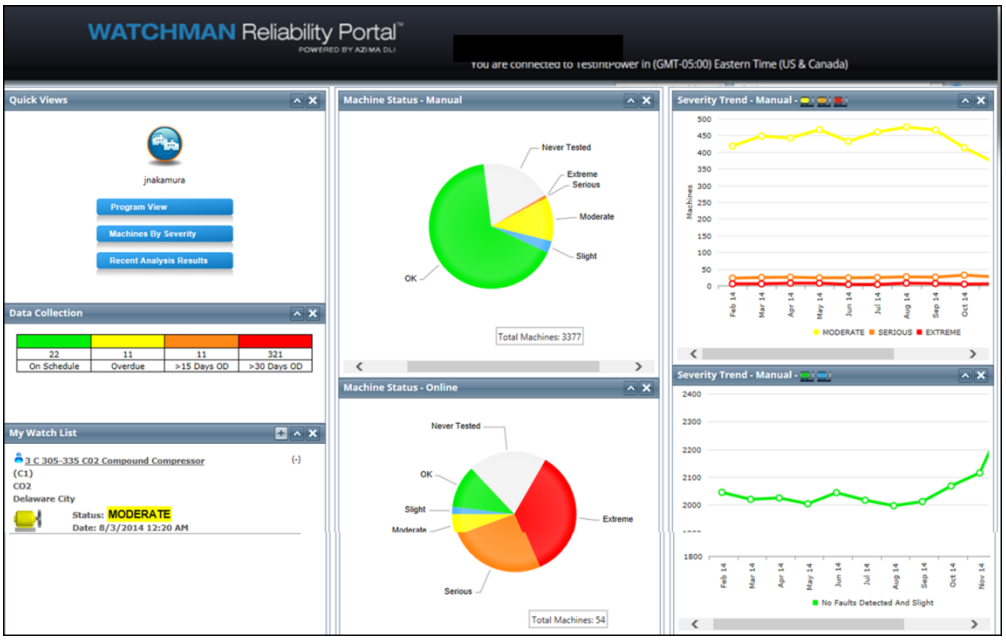


Figure 2: Example of a web-based platform that allows multiparty access to PdM information.

Winners measure

The benefit of working with established winners is both discovering the things they measure and helping them measure in new ways. Winners know what they want, and think about how to get it, which makes designing measurement systems for them rewarding. Another way to expose winning formulas is by subjecting both winners and losers with similar operations to common measures. The results can be surprising, if not counterintuitive, and present learning opportunities.

In the following example of performance benchmarking, five company sites were compared to each other, to their industry peers, and to plants outside their industry to understand how well they responded to mechanical fault detections. The results show that the fifth plant, while the best among its company peers, and far better than industry average, still only places in the third quartile relative to all plants in the sample set. The results suggest that opportunities abound for plant six to improve performance and squeeze more value out of its PdM program.

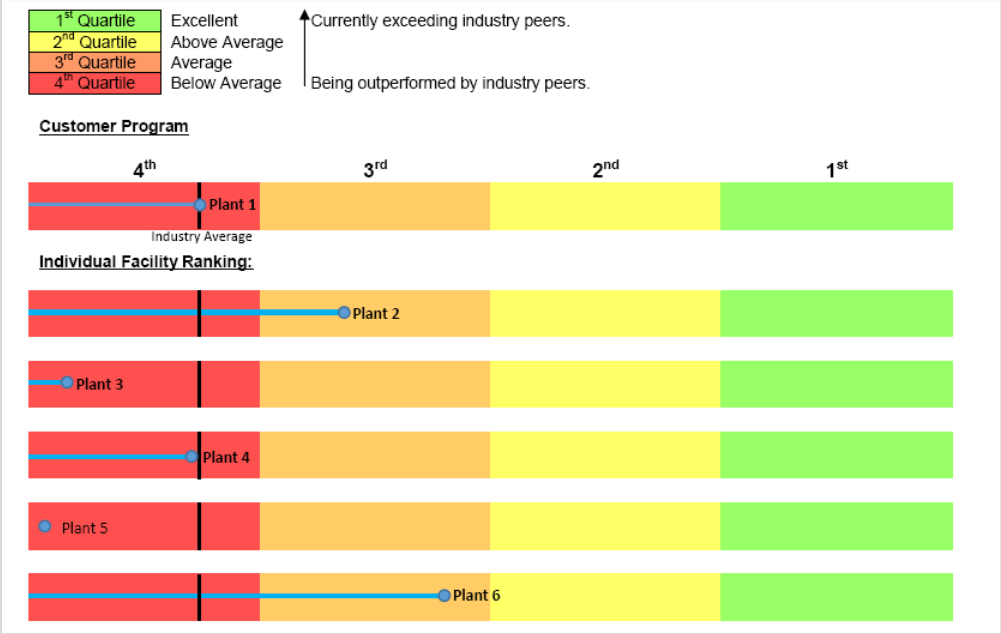


Figure 3: Ranking of PdM responsiveness across facilities

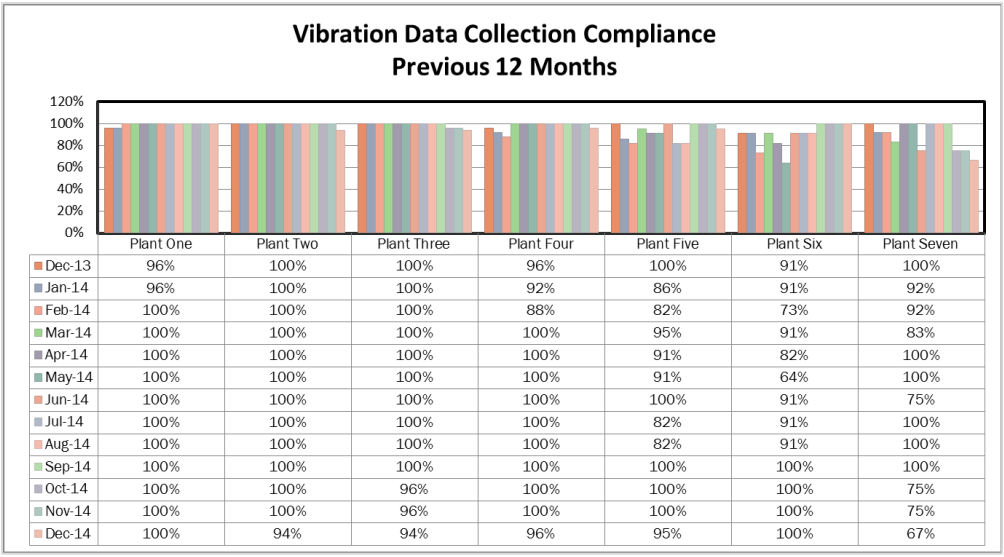
At the same time, one plant's success can be another's failure. For instance, one plant may win by eliminating risk even though eliminating risk costs many times more than managing it. In organizations where capital efficiency is more important than eliminating risk (because margins are tight and capital scarce), winning may mean reducing risk as much as possible within established cost constraints.

PdM as a means to an end

The benefit of serving a large number of customers over a dozen vertical markets is observing the range of behaviors and practices. The most common refrain is "we're unique." While that's sometimes true, some common rules apply: for instance, it's harder to improve without measuring, and measuring without acting is pointless.

Predictive maintenance is sufficiently alluring that most manufacturers suspect they should practice it. The number that actually embrace it and do it well, however, is low because PdM is only a means to an end. Without that end in sight, and commitment to measurable behaviors

and objectives, PdM can be a wasted investment. The correlation between winners and commitment to measurable goals is hard to ignore. While the commitment is not the same as a winning formula, it's an expression of the desire to find one.



	Plant One	Plant Two	Plant Three	Plant Four	Plant Five	Plant Six	Plant Seven
Dec-13	96%	100%	100%	96%	100%	91%	100%
Jan-14	96%	100%	100%	92%	86%	91%	92%
Feb-14	100%	100%	100%	88%	82%	73%	92%
Mar-14	100%	100%	100%	100%	95%	91%	83%
Apr-14	100%	100%	100%	100%	91%	82%	100%
May-14	100%	100%	100%	100%	91%	64%	100%
Jun-14	100%	100%	100%	100%	100%	91%	75%
Jul-14	100%	100%	100%	100%	82%	91%	100%
Aug-14	100%	100%	100%	100%	82%	91%	100%
Sep-14	100%	100%	100%	100%	100%	100%	100%
Oct-14	100%	100%	96%	100%	100%	100%	75%
Nov-14	100%	100%	96%	100%	100%	100%	75%
Dec-14	100%	94%	94%	96%	95%	100%	67%

Figure 4: Example of a winning company. This particular company's objective was company-wide compliance with on-time data collection schedules.

When companies go in search of winning formulas they seem to feed on heightened awareness, and to value accurate information. Intuition and experience no longer suffice. They want accurate data captured over time that connects action to performance. They are betting that winning formulas will take shape as they move towards their objectives.

Defining success

Southwest, JetBlue, Virgin Atlantic and Delta are all successful airlines. Even with different winning formulas success in the airline industry has some common attributes, like the ability to finance and maintain airplanes, sufficient customer retention to sustain a long-term franchise, and making enough money to keep employees and investors happy.

Production environments are no different. Low cost, low risk, high uptime and a good safety record would satisfy most manufacturers. The path to that success is well worn, which is why PdM survives, but it can't thrive without goals and systems to measure progress. If the solution is as simple as setting goals, then why doesn't PdM meet with more success? The answer is even simpler: communication. Great information is meaningless unless it improves awareness.

Communication with key stakeholders, scheduled reporting, accessible media, and defined response protocols are the critical precursors to modifying processes and procedures. If we can't see what's wrong, how can we change it?

Managing change

Changing old ways can be the most challenging of undertakings, and the challenge becomes insurmountable without clear communication, which means clearly communicated expectations, and clearly communicated results. The cited obstacles to success—*undefined financial and operational benefits, and lack of support/resources (executive, IT, engineering and budget)*—are symptoms, not the disease. How do we know? Because the financial and operating benefits of PdM are so easy to measure and have been demonstrated over decades by innumerable winners. PdM persists because the value is so easily captured.

The problem is not want of benefits, the problem is failure to pursue and support change with well communicated metrics and reporting. These are cultural issues based on deeply rooted beliefs that have to be confronted before the easy work of measuring and improving begins. Without commitment to building awareness, setting goals, and encouraging action, benefits will remain elusive.

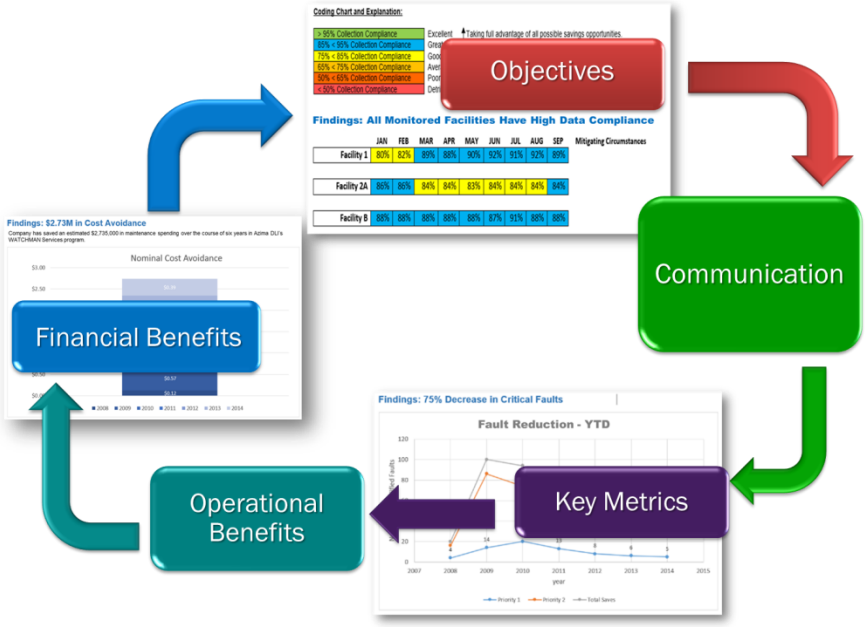


Figure 5: Example of how commitment to measurement can help track COMPANY OBJECTIVES (behavioral compliance), OPERATIONAL BENEFITS (steady reduction in serious and extreme machine faults) and FINANCIAL BENEFITS (savings via reduced unplanned maintenance, capex, and production loss).

Embracing change

Winners seem to live by Andy Grove's famous title, *Only the Paranoid Survive*. In perpetual search of better winning formulas, they will measure almost anything if they think improvement will follow. Similar kinds of behavior can infect production environments as well. When managers clear the way for PdM programs to work, change is immediate and dramatic. Positive results reward the first tentative initiatives and inspire more new ideas for change. The result is

a profusion of measurement systems that will be more and less useful, but without exception improve awareness.

The metrics and KPIs on which enterprises settle invariably address their vulnerabilities because they are designed to expose and strengthen weak links. Once proven, a standard set of metrics and KPIs can be applied to broadly similar settings and reveal similar weak links very quickly. The potential for scalable PdM systems to quantify exposures and institutionalize best practices across the enterprise is only just being realized, with cost avoidance and operating efficiency compounding with the size and scale of operations.

Beyond best practices

PdM programs can be uncanny barometers of culture. The more pervasive and consistent the PdM, the more accurately it reflects the enterprise (and its cultural nuances and back eddies). Seeing where your organization captures the most value from PdM may be the easiest way to expose your own winning formulas.

Like success, failure has common attributes. For PdM, those attributes include failure to comply with PMs, including data collection, and ignoring alerts without response or resolution. These are symptoms of poor leadership and management – cultural weak links. PdM programs can also fail by focusing on the wrong metrics, a mistake even the best leaders and managers can make. In a profit rich but risk sensitive industry like oil and gas, for instance, exploration platforms should care less about cost than risk. Ironically they tend to default to ROI because, perhaps, ROI is the benchmark for oil field development.

Measures of risk, cost, compliance and response can all be derived from basic PdM data. They can expose big opportunities and effective management practices as well as missed opportunities to avoid substantial costs that lurk almost everywhere in far flung production operations. The machine level fault detection that avoids catastrophe is barely a stitch in the rich tapestry of information about management practices, and planned and unplanned maintenance and capital spending. The less than 20% that rate their PdM programs *effective* and *very effective* have figured this out, and extend their leads daily over lesser competitors still on the hunt for defined benefits.

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Contact us for a demonstration or more information:
Azima DLI | 300 Tradecenter #4610 | Woburn MA 01801 | 781.938.0707

Azima DLI is the leader and premier provider of predictive maintenance analytical services and products that align with customers' high standards for reliability, availability and uptime. Azima DLI's WATCHMAN™ Solutions utilize flexible deployment models, proven vibration diagnostic software and unmatched analytical expertise to deliver sustainable, scalable and cost-effective condition-based maintenance programs.