5th Edition

From the Reliability Professionals at Allied Reliability

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New! Expanded Content Based on YOUR Feedback!

PdM SECRETS REVEALED

How to Improve Your PdM Program Or Start One from Scratch

Bonus Section Included

A Must-Read Guide for Maintenance and Reliability Leaders

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Table of Contents

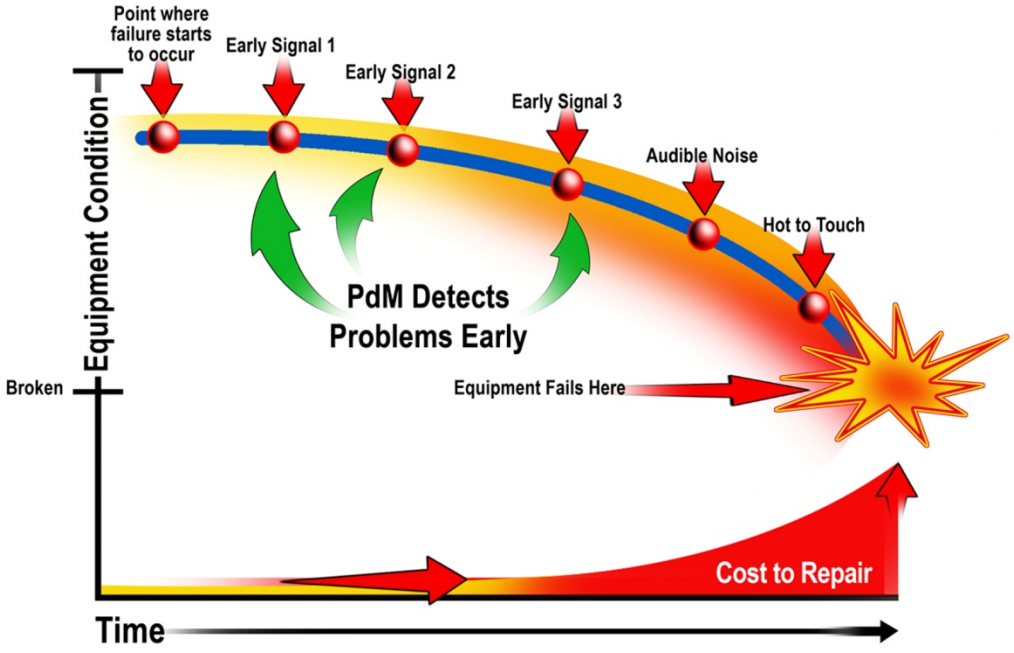
The Basic Concept of Predictive Maintenance

Although the Predictive Maintenance technologies themselves can get quite complicated, the basic concept of PdM is simple enough:

Most industrial equipment does not suddenly break down and stop working. The truth is, equipment breaks down gradually – over a period of weeks or months. Furthermore, it gives off numerous warning signals along the way.

These early warning signs – for instance, slight changes in temperature, vibration or sound – can be detected by PdM technologies. As a result, PdM gives you time to plan, schedule and make repairs – before the equipment fails.

The following graph illustrates this concept:



The bottom line is, when it comes to maintenance, time is money.

The difference in repair costs between the time a PdM specialist can detect an equipment problem until the time an operator notices it can be huge.

In fact, one study showed that the cost of PdM-driven, proactive maintenance is half as much as emergency, breakdown maintenance.

No other maintenance strategy gives you more time for advanced planning and scheduling than PdM. That's why PdM should be your number one source of planned maintenance.

Studies have proven that a well-planned repair job typically takes only half as much time as an unplanned job. Planned work is always more efficient and less costly than unplanned work.

Reader Larry asked if we use PdM and it warns us of potential failure or detects a defect, how can we tell when it is going to fail?

The exact time of failure cannot be know for certain. There are PdM Technologies that can give you a longer warning time, but no technology can tell you exactly when it is going to fail. The real challenge is integrating this knowledge of an impending failure into the daily work stream and correcting it before it interrupts your schedule.

The Top 6 Benefits of Predictive Maintenance

In his book, Plant Engineer's Handbook, Keith Mobley links the following benefits to PdM:

- Maintenance costs - down by 50%
- Unexpected failures - reduced by 55%
- Repair and overhaul time - down by 60%
- Spare parts inventory - reduced by 30%
- 30% increase in machinery mean time between failures (MTBF)
- 30% increase in uptime

Now these numbers may seem high. But even if you take only a fraction of these benefits, the financial impact of an effective PdM program at most plants can easily reach into millions of dollars.

And, for the typical manufacturing plant, a 10% reduction in maintenance costs has the same bottom line benefit as a 40% increase in sales.

Another advantage of predictive maintenance is this:

Studies have shown that with a properly-engineered PdM program, you can replace up to 30% of your Preventive Maintenance tasks (PMs). Find out more about right-sizing your PM program with our latest free report:

"Are You Doing Too Much PM? 16 Ways to Save Time and Money on Preventive Maintenance"

This report is another must-read for maintenance and reliability leaders.
It is available for free from the professionals at GP*Allied* and you can request it by e-mailing: info@gpallied.com.

Reader Mike asked if PdM can really produce these kinds of savings then why don't more companies make PdM a priority?

Exactly! It is mainly a lack of education about the benefits and the culture of "this is how we've always done it" which are actually to blame for PdM program successes not being sustained. That is why you should look into attending the Asset Health Assurance Training series.

To view abstracts and more information, go to:

www.alliedreliability.com/training/schedule.asp

The Hidden Benefit of Predictive Maintenance

For at least the last 40 years, the financial benefits of Predictive Maintenance have been proven over and over again.

However, if you actually talk to Maintenance and Reliability professionals who have seen the change from the "reactive" to the "proactive" world, chances are you will hear something different.

Here are just a few examples of what they are saying:

"I like to fish and hunt and play with my kids. I'm definitely not a maintenance geek. Man, I don't want to get called out in the middle of the night. I'm just telling you that if you don't do this [Predictive Maintenance], God bless your soul. And you better like coming in and doing maintenance, because you're going to do it a lot. I don't like maintenance. I like my free time."

"Now that we are down the road quite a ways in predictive technologies and implementing the overall proactive maintenance model, we are seeing the results of it. It's made my job easier. There are less call outs than what we had in the past. That reduces my shop level and improves my employee's morale and the overall relationship between operations and maintenance."

"We've been able to demonstrate to the operations group the validity of PdM technologies and where we can plan scheduled outages around the PdM work that's been identified. That's less stressful to me. It's safer because I can plan out that activity instead of working on it at midnight on Saturday night. It's reduced my stress level."

"I hardly ever get called in at night anymore. We don't need as many people here every day. We are at a 70 or 80% proactive work level. The quality of life is a big improvement. A big improvement for the worker."

"When you start implementing a [PdM] program like this there is always some push back. 'What's in it for me?' 'Why are we doing this?' Basically for a guy that likes a lot of overtime at the end of the day - his paycheck is less. But on the flip side of that is they're not working as hard and you're not fighting as many fires and you get more time off. About 5 years ago we'd have an estimated 120 calls in a year's time. Now we are running the plant 24-7 and are down to about 12-20 calls."

"My life has gotten much simpler. I'm not involved in the emergencies because typically we don't have that many and they are usually not catastrophic. Not as many phone calls in the middle of the night – a lot fewer."

So there you have it -- the "hidden" benefits of successful Predictive Maintenance:

Less stress. More peace of mind.

An easier job. More free time.

Now let's go behind the scenes and look at some of the secrets of highly successful PdM programs.

The First Job of Your PdM Program

Despite what you may have heard, the foundation of a successful PdM program is a simple list: A detailed, accurate equipment list.

Why? Because your equipment list is the foundation for all of the key steps that follow. For example, a good list is essential for:

- Identifying how your equipment can fail
- Choosing the right PdM technologies to apply to the asset
- Determining the ideal amount of PdM coverage for your plant
- Ranking the criticality of each piece of equipment
- Building databases for each PdM technology
- Determining PdM staffing levels

Readers John, Joseph, Richard and Roland all asked for the specifics of how to design and develop comprehensive PdM Programs.

These specifics are far too detailed to be covered in this report. There are a series of courses designed to answer these and many other questions related to Asset Health Assurance, PM/PdM Best Practices and program development.

The Asset Health Assurance Overview, Mechanical, Electrical and Stationary courses are designed to provide the framework you need to reach best practices in PM and PdM, in the shortest possible time, at the lowest overall cost.

To learn more about the Asset Health Assurance Training Series, go online to: http://www.alliedreliability.com/Training/schedule.asp

So, if your list is incomplete or incorrect, everything that's built from it will be flawed. Any shortcuts or inaccuracies will be exposed as big problems later.

What makes a good list? For starters:

- Equipment number
- Equipment description
- Equipment type
- Area / location of the equipment

Surprisingly enough, most plants do not have a good equipment list, unless the data was captured when the plant was built. So if you don't have this information, or if it's less than 75% accurate, here are two options:

1. The manual, paper-based approach

In the past, the conventional method was to walk up to each piece of equipment with a clipboard, write down the key information, and then have the data transcribed and entered into a database.

Now, depending on the size of your plant and the number of pieces of equipment, this process can be extremely time-consuming and prone to error. The other option is,

2. Using a software tool

Equipment lists can be created much faster and easier with a tablet PC or other hand held electronic device and software. Here's how it works.

First, you import your existing equipment data from your Enterprise Resource Planning (ERP) or CMMS into the software application. Then, data is gathered in the field and entered directly into the tool. Finally, it's a matter of exporting the compiled data to the appropriate databases and CMMS.

This speeds up the process tremendously and greatly reduces effort compared to the manual, paper-based approach.

However you decide to do it, don't be tempted into shortcutting this step. A good equipment list is one of the most overlooked and underappreciated elements of a successful reliability initiative.

Allied Reliability's **walk down** software application is just one several tools that enable fundamental processes such as;

- Asset Cataloging
- BOM Development
- Asset Criticality Analysis
- Equipment Maintenance Plan Development
- Developing Effective Work Procedures
- Planning
- Scheduling
- Work Execution

- RCM
- Scorecarding/KPI Management
- Integrated Condition Monitoring Reporting
- Operator or Maintenance Rounds Logging
- Work Order Prioritization
- Process Reliability Statistics

All tools and applications can be purchases as a Software as a Service (SaaS), stand-alone single user or network version. Stand-Alone software applications and other modules are also available through GP*Allied*'s training curriculum. For further details, please contact us at 888-414-5760 or e-mail us at: info@alliedreliability.com.

How to Choose the Right PdM Technologies

Many companies begin a Predictive Maintenance program by first choosing one of the most common technologies – like Vibration, Infrared or Ultrasound. After they get some basic training and experiment for awhile, they start applying the technology to their most critical equipment.

Makes sense, right?

Wrong. Let's go back to the basic concept of predictive maintenance.

Almost all equipment gives off early warning signals – such as changes in temperature, vibration or sound – before it fails. These warning signals, or failure modes, can be detected with certain condition monitoring technologies.

The problem is that one or two technologies alone can't detect the majority of the warning signals in your plant. As a result, a single-technology PdM program will miss far more faults than it catches.

So the key to a successful PdM program is to make sure it is highly sensitive to the failure modes of your equipment. That's why you need to apply multiple technologies, so you can detect the majority of failure modes in your plant.

Ultimately, it's your equipment's failure modes and criticality that determine which technologies you apply. Not the other way around.

The concept is simple. But you'd be surprised how many companies get this backwards.

Also, a multi-technology approach lets you double-check and confirm "fault findings" between technologies. Plus, it allows you to catch problems with one technology that might be missed by another.

But the biggest reason to apply multiple technologies is this: There is little, if any, payback from using just one or two PdM technologies. You will miss most of the early warning signals that occur, so the equipment will fail anyway.

The payback comes from integrating a full range of technologies across a high percentage of your asset base. That's why the fundamental starting point for a PdM program is:

- Understanding all the failure modes in your plant, and
- Applying the technologies that will detect them.

Recommended Resource

If you don't have the time or expertise to determine the failure modes for all your equipment and map them to the appropriate PdM technologies, here's a software driven-process that can help.

Using a database with several hundred equipment types already mapped to the appropriate technologies, now you can:

- Take the equipment on your equipment list
- Identify the possible failure modes for each, and
- Confirm which PdM technologies and inspections to apply

Here's a sample of recommended technologies by equipment type for a specified environment:

Equipment Type Versus Technology Application(s)	MECHANICAL				ELECTRICAL				STATIONARY			
	Vibration	Ultrasound	Infrared	Oil Analysis	MCA Online	MCA Offline	Infrared	Ultrasound	Visual Inspection	Ultrasonic Thickness	Dye Penetrant Testing	Eddy Current
Chiller	X	X	X		X	X		X	X			X
Centrifugal Pump	X	X	X	X	X	X	X		X	X	X	
Air Compressor	X	X	X	X	X	X	X	X	X			
Tank			X						X	X		
Evaporator			X				X		X			

This tells you which PdM technologies are required to cover your equipment. Best of all, the whole process takes hours - rather than weeks or months - to complete.

Find out more, e-mail us at: training@alliedreliability.com.

Readers Larry G., Tony, and Ahmad all asked a variation on the question of - what PdM Technology should you choose if you are only able to choose one?

Think of what you do now without Infrared, Ultrasound, Vibration etc… You probably use your visual inspection or your other senses right? What you want the PdM technologies to do is, enhance your senses and in many cases compensate for what you cannot humanly see, hear or feel etc….

The first sense you want to enhance should be your vision. Infrared is a very useful tool for that. It's applicable for Mechanical and Electrical faults finding and is used to quickly scan lots of equipment. Plus, when it comes to quick "wins", one thermographer can spend 3 days scanning equipment and find more work than your planning and scheduling can address in a month's time.

It is an excellent tool for prevention of fires/explosions. Because it is very visual, it is quickly understood, making it easy to point out changes in heat signatures and trend changes in your equipment health. *Remember: Training is important, just because a person can switch on a camera and see what is hot and what is not - does not make it a silver bullet. It is important to know the normal temperature ranges of your equipment and understand the common traps and limitations of the technology. If your equipment should run hot but is cold, you don't want to assume it is operating normally or without defect.

More detail on IR and other PdM technologies' applications to equipment types etc…can be found in the Asset Health Assurance Overview class. For more on this course go to: www.alliedreliability.com/training/schedule to view abstracts and registration details.

Which Equipment to Monitor with PdM

If you have a detailed criticality ranking of your asset list, you can determine your maintenance strategy, prioritize work and make better risk management decisions. Criticality rankings should be a single score based on collective agreement from:

- Production
- Maintenance
- Purchasing and Logistics
- Environmental, Health and Safety
- Accounting
- Sales, Marketing, and Customer Service

The problem is that a lot of companies use the ABC approach – where equipment is given an A, B or C priority. However, what happens is that most equipment falls somewhere in the middle and gets a "B" rating. So when it comes to priorities, which one are you going to work on first? You can't address all of them at once, so which "B" rating has priority?

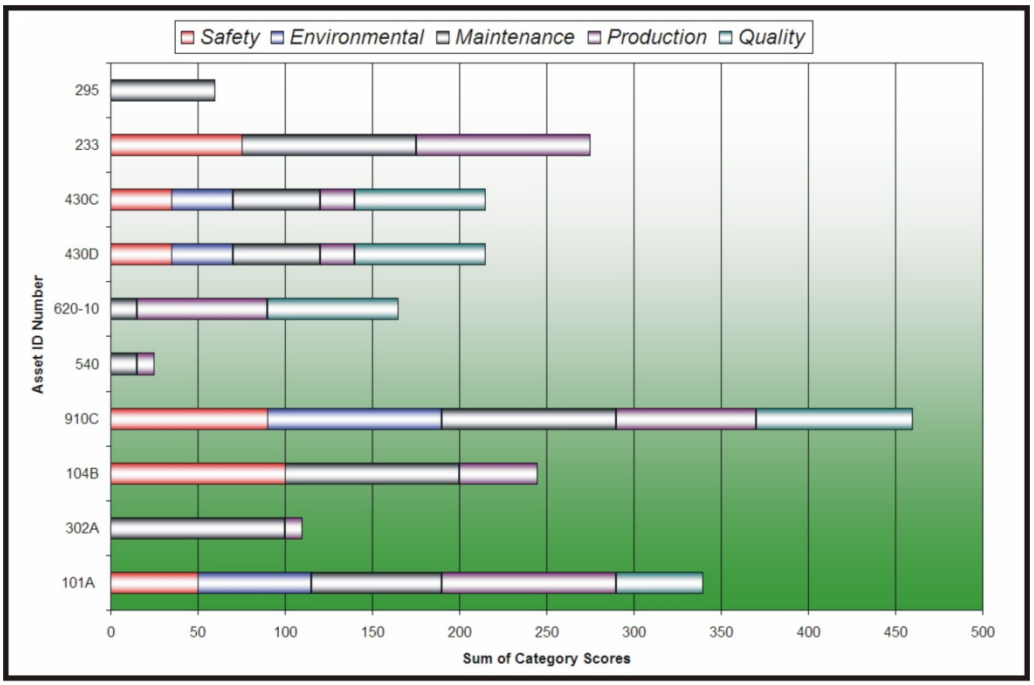
That's why you need a single score and overall ranking for each asset, so you can focus your PdM resources on equipment that has the biggest impact on plant performance.

A sample criticality ranking for a single piece of equipment is shown on the following page.

Notice how each asset has a single, composite score based on 5 key criticality factors

- Safety
- Environmental
- Maintenance
- Production
- Quality

Sample Criticality Ranking



Reader Andre asked us when he should use any RCM Analysis?

The Key to implementing any PdM analysis tasks that are both applicable in detecting potential failure and effective in mitigating the consequences of your failures, is to have a thorough understanding of your failure modes. The best way to build a failure modes driven maintenance strategy is to apply RCM Blitz™ to your critical assets! PdM complements RCM it does not replace it…you should use RCM for any failure mode associated with the operating context of the equipment.

Reader Mark asked about the cost effectiveness of Predictive Maintenance Inspections.

The value of PdM inspections should be judged against the criticality of the component being inspected ie: the cost of catastrophic failure of the cost of unplanned downtime. The actual cost of the component is usually of little concern.

To find out more about RCM Blitz™, contact us at: info@alliedreliability.com.

Choosing the Right Level of PdM Coverage

For most industries, benchmark data is available describing how much PdM coverage is considered “best practice” for that industry. For example:

Coverage by Technology	Vibration	Mech UE	Elect IR	MCA Offline	MCA Online	Oil Analysis	Mech IR	Elect UE
100% Theoretical	3,400	3,078	5,016	2,939	2,939	2,869	4,179	5,016
1st Quartile	2,720	2,155	4,815	1,470	1,470	1,492	2,925	4,815
2nd Quartile	2,312	1,693	4,364	1,176	1,176	1,090	2,298	4,364
3rd Quartile	1,530	1,077	3,862	882	882	717	1,463	3,862
4th Quartile	680	369	3,260	588	588	344	501	3,260
Existing Coverage	220	0	0	0	0	135	0	0

Mech – Mechanical UE – Ultrasound IR – Infrared Thermography
Elect – Electrical MCA – Motor Circuit Analysis

As you can see, the data compares existing coverage for each technology to 1st, 2nd, 3rd and 4th quartile performers. This is extremely useful information to determine how your current coverage ranks versus best practices in your industry.

Reader Bon asked for more explanation about the PdM Coverage Model.

Theoretically, if there is a failure mode that a particular PdM technology could detect, it should be applied to that asset. 100% Theoretical Coverage is not necessarily 100% coverage of a specific asset type, because the technology may not be appropriate for all failure modes. There will be some failure modes that NO PdM technology can detect and those should be assigned a PM task.

In the previous graphic, you can see that the row with 100% Theoretical shows the total number of assets at this facility that could ‘theoretically” be covered by a given technology in the green header; because the technology above it in the green header is known to be effective at detecting failure modes on those assets. Each yellow cell is broken down to show you just how many pieces of equipment could be covered by the technologies above in the green. In the 100% Theoretical example, those numbers would show that we could cover 3,400 pieces of equipment where Vibration has application to help to detect/identify a failure mode on that equipment.

**Remember the statement from above and assume that there are other assets not included in this 3,400 because there may be NO PdM technology known to detect failure modes in that asset. The same holds true in the other columns for the other PdM Technologies, 3,078 could potentially be covered by Mechanical UE, 5,016 by Electrical IR and so on. The likelihood that you could cover 100% of equipment with applicable technologies is not high; however, a 1st Quartile performer could cover 2,720 pieces out of 3,400 with Vibration and still have a tremendously successful PdM Program.

In our example, this plant covered only 220 pieces of the available 3,400 that would have benefitted from Vibration Analysis. This company isn't even at the lowest performing Quartile or 4th Quartile coverage of 680….the remainder of the red row shows many zeros, revealing that several of the PdM Technologies are not being used at all. In fact, this facility is using only Vibration and Oil Analysis and on far fewer pieces of equipment than they could actually be. This facility has some opportunity to drive more returns from its current "level" of activity but must be done with a systematic approach.

When designing or enhancing a PdM program, the 100% Theoretical Model gives the facility a "glimpse" of what the maturation stages look like. Factors such as workflow maturity, criticality, craft skills and knowledge/acceptance need to be taken into consideration when deciding to implement the right PdM program for your business. Ideally, a site should select the technologies that will generate the quickest return on investment while demonstrating some vital momentum to build upon. Technologies should complement your business processes, not overwhelm them.

Reader Andre asked us to define Failure Modes.

Simply put, Failure Modes define the part, what's wrong with it and why. One such example may show a failure mode for a bearing defined as: bearings, fatigued, due to misalignment. **Remember, the list of failure modes to be analyzed should represent those that have failed or are likely to fail.

Reader Tad asked us about time based maintenance frequency.

Referencing the original RCM report by Nolan and Heap and subsequent studies by the US Navy Submarine fleet, we learned that time based maintenance is only appropriate for 11% of the failure modes. These failures had a strong wear out mechanism. The other 89% of the time, the failures required an inspection to detect incipient failure. Therefore, time based maintenance strategies are less than effective for 89% of our failures in a plant.

Reader Jerry asked about the power of different PdM Technologies.

There is no "ONE all-powerful" PdM Technology. Each one of them detects different failure modes..so think of it as, which ones can I use to detect failure modes that are likely in my machinery.

Engineering Your Program At-a-Glance

Now that you know what technologies to apply, which equipment to apply them to, and what level of coverage is considered best practice, this allows you to:

- See different program scenarios based on the criticality of your equipment
- Compare your coverage vs. best practice performers
- See what equipment would be included if your technology coverage is increased to the next quartile

Essentially, this is the information you need to engineer a PdM program, evaluate your "best investment" and compare it to best practices based on 1st, 2nd, 3rd and 4th quartiles of industry coverage.

This information is displayed in the following Asset Health Matrix.

					MECHANICAL				ELECTRICAL				STATIONARY			
CRITICALITY	ASSET COUNT	ASSET DESCRIPTION	CMMS #	ASSET TYPE	Vibration	Ultrasound	Infrared	Oil Analysis	MCA Online	MCA Offline	Infrared	Ultrasound	Visual Inspection	Ultrasonic Thickness	Liquid Penetrant Testing	Eddy Current
	561				273	276	300	263	269	269	406	137	203	199	50	0
1650		#1 GERM DRYER REC. CYCLONE B	SP03009B	CYCLONE									X	X		
1650		1200 AMP LOAD SWITCH FOR MCC 354	FL03009D	SWITCHGEAR			X					X				
1500		1200 AMP LOAD SWITCH FOR MCC 355	FL03009E	SWITCHGEAR			X					X				
1500		2ND STAGE RC B SET	SP03014B2	TANK									X	X		
1400		3RD STAGE RC B SET	SP03014B3	TANK									X	X		
1300		4TH STAGE RC B SET	SP03014B4	TANK									X	X		
1200		GAS TURBINE/GENERATOR	SP03009C	GENERATOR	X	X	X	X	X	X	X		X			
1000		#1 PREDRYER CYCLONE FAN	SP03009D	CENTRIFUGAL	X	X	X	X	X	X	X		X	X	X	

Reader Edi asked how this stuff works at a power plant.

The mechanical and electrical failure modes identified with PdM are a function of machine design not industry vertical. The rolling element bearing works the same whether you are pumping water or crushing rocks and everything in between. The concepts of alignment, balance and tolerances are universal.

What to Measure – 11 Key PdM Metrics

There are many ways to measure the results and impact of a PdM program. So it's important to consider carefully which metrics to use. Here are some guidelines and suggestions.

If you don't measure it, you can't prove that it ever happened.

You may have heard, "In God we trust. Everybody else brings data." So if you want to prove the success of your program to upper management, you need to have the data to back it up.

The less you know, the more you have to measure.

For any process, if you know little or nothing about it, everything appears to be random. So you have to measure it until you understand it. The less you know the more you have to measure.

What gets measured gets improved.

Measurements are a great way to drive positive behavior changes.

With that said, the number 1 PdM metric to consider is this:

What percent of your total maintenance man-hours is driven by PdM?

That's the single most important metric to track. Because on average, best practice reliability programs generate an average of 50% of their work from PdM inspections and corrective work.

So if PdM and the results of PdM aren't generating at least half of your work total, you've got room for improvement.

Look, predictive maintenance is proven to be more cost-effective than preventive maintenance or emergency maintenance. So shouldn't it account for at least half of your work?

Surprisingly enough, most companies don't know how much PdM work they do. That's because they mix PM and PdM together, so they can't break out a true PdM number.

However, we've found that the majority of plants in North America generate less than 10% of their maintenance workflow from PdM.

What Else To Track

Depending on the maturity of your program, here's a list of the other 10 metrics to track the success of your efforts:

1. PdM effectiveness – hours of corrective work identified by PdM divided by hours spent on PdM inspections
2. Percent of PdM recommendations completed within 30 and 90 days
3. Percent of work flow that is planned maintenance (target is 80%+)
4. Total planned work in planner's backlog
5. Adherence to PdM schedule
6. Wrench time
7. Mean time between failure
8. Maintenance costs as a percent of asset base
9. Maintenance costs and as percent of sales
10. Overall equipment effectiveness and asset utilization

Reader Jason asked what is the number 1 think you should track?

Percent of work flow that is planned maintenance (target is 80%+) - you'll know if your current maintenance is effective.

What Not to Measure

Some organizations spend a lot of time tracking cost avoidance. In other words, "If we hadn't caught this problem early, it would have cost us X dollars in emergency repairs later." But here's the problem: You will never find cost avoidance on your company's financial statements. So it has little real value to your management.

What's important to measure are those things that lead to:

- Lower labor costs
- Reduced energy consumption
- Lower spare parts inventory
- Improved product quality
- Better safety performance
- More throughput capacity

These are the key factors that directly impact financial performance.

Reader Hasmukh asked whether instrumentation alarms can be used as a good PdM indicator.

Process instrumentation alarms are excellent indicators of when things have changed. Whether or not they are considered PdM is determined by the status of the problem they are indicating. If it is an impending loss of function, then it can be considered Pd. If the loss of function has already occurred, then it is not considered PdM. You can refer to the PF Curve for the graphic illustration of this point.

Four Reasons Why PdM Doesn't Work

After applying PdM technologies, many people expect that a more reliable plant will magically appear. This idea is attractive, appealing – and wrong.

You see, it's one thing to identify equipment problems with the technologies. But it's another thing to plan and schedule the corrective work, get the craftsperson out there and get the repairs done in a timely, disciplined, orderly manner.

That's why the heart of a successful Predictive Maintenance program is a sound work order system. Because ultimately, it's your work order process that lets you leverage the power of PdM.

Remember, the true return on your investment in PdM comes from eliminating defects – not just identifying them. So you must be able to plan, schedule and execute the corrective work that results from PdM inspections. Otherwise, there's very little value associated with condition monitoring technologies.

A good work order system doesn't have to be highly sophisticated. But you must have a process in place that will turn PdM work requests into work orders.

Sounds easy, right? Yet here are the 4 most common things that go wrong with a PdM work request:

1. PdM corrective work is identified, but the work request never gets to planning.
2. The corrective work gets planned but never scheduled.
3. The work gets on the schedule, but when it's time to perform the job, the parts aren't available.
4. The work gets planned and scheduled. The parts are available. But then emergency work takes precedence and the PdM corrective work never gets executed.

That's why the specific PdM work processes must be outlined and mapped for your facility. For example:

- How the PdM schedule will be managed
- How the reports will flow
- How special analysis requests will be managed
- How PdM corrective work will be performed

Reader Stan asked about the use PdM as a prognostics tool.

The name predictive maintenance was never intended to mean that one could use it to predict the life of a component. The "predictive" came from the fact one could know which machine was going to fail next but not necessarily when it was going to fail. The proper name for these inspection methods is Condition Monitoring. And, in all cases this is all that can be done. One can monitor the condition of components, but fault progression is still speculative work based on a given set of conditions.

Another key consideration is the routing and approval process for PdM work.

Some companies want all PdM work requests reviewed and approved before converting them to work orders. The problem is that very few Maintenance Managers, Reliability Engineers and Planners are well-grounded in PdM technologies. As a result, they can't always make the best decisions about the work requested.

So we believe that if you have qualified PdM technicians, they should be able to put in their own work requests. Then, as soon as the job gets planned, it gets turned into a work order.

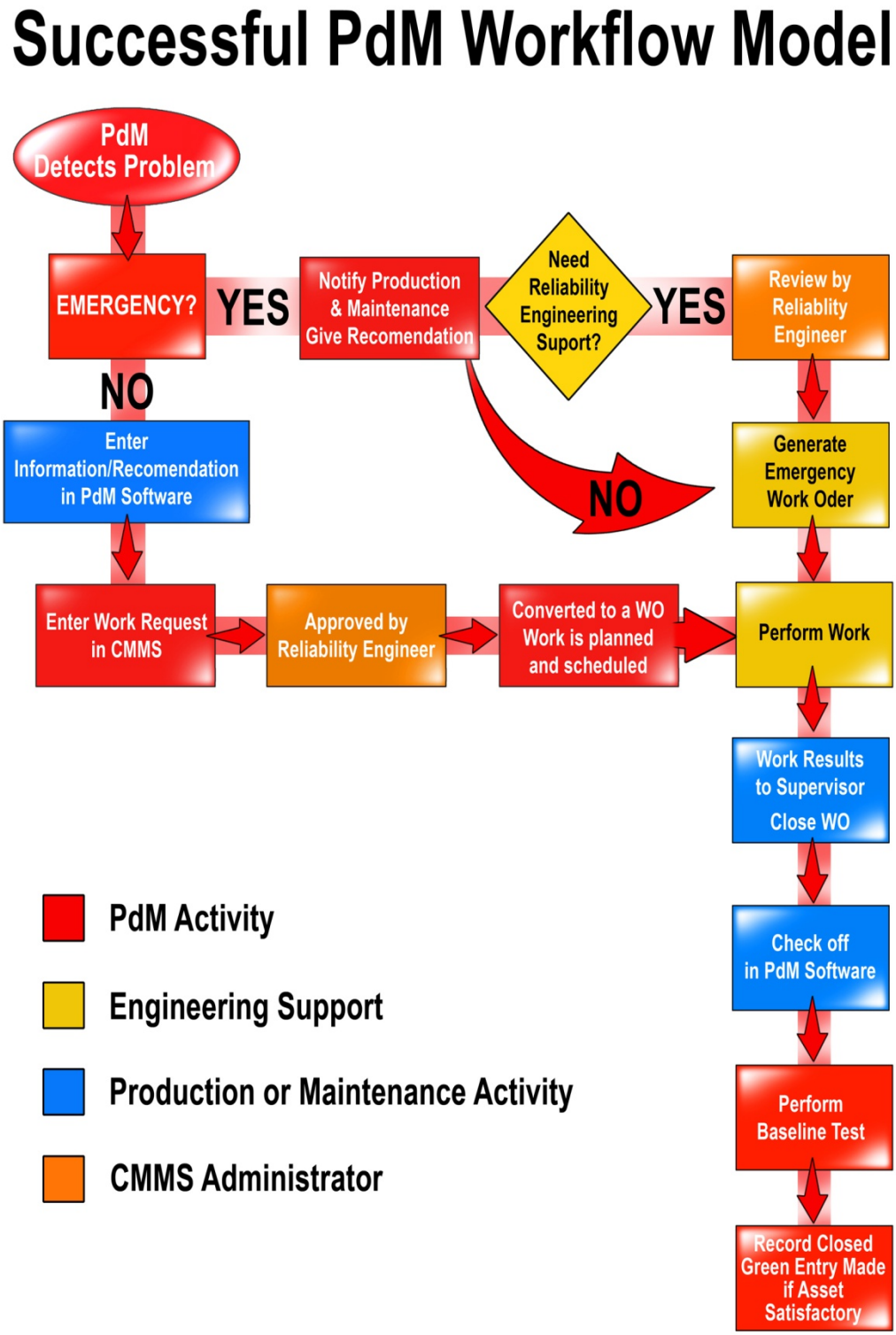
But that's not always acceptable to some organizations. So if you want to have someone reviewing and approving PdM work requests, make sure they are well-educated in the PdM technologies.

One final point: Increasing your PdM inspections will increase the amount of work in your system.

So the question is: How much additional PdM work can your plant absorb?

You must factor that into the equation when you are designing or expanding a PdM program. The goal is to take full advantage of the technologies without overwhelming the capacity and limitations of your work management system.

The following diagram is an example of a successful PdM work management model:


Successful PdM Workflow Model
PdM Detects Problem
EMERGENCY?
YES
Notify Production & Maintenance Give Recomendation
Need Reliability Engineering Suport?
YES
Review by Reliablity Engineer
NO
Enter Information/Recomendation in PdM Software
NO
Generate Emergency Work Oder
Enter Work Request in CMMS
Approved by Reliability Engineer
Converted to a WO Work is planned and scheduled
Perform Work
Work Results to Supervisor Close WO
Check off in PdM Software
Perform Baseline Test
Record Closed Green Entry Made if Asset Satisfactory
PdM Activity
Engineering Support
Production or Maintenance Activity
CMMS Administrator

Are You Collecting The Right Data?

In essence, Predictive Maintenance is a data-driven process. It's all about collecting and analyzing data to determine what corrective work needs to be done. The key is to make sure your PdM team is looking at the right data.

Unfortunately, a lot of companies spend a lot of time looking at the wrong data, because the data collection specifications were set up incorrectly to begin with. So the data can't do what it's supposed to do: Identify equipment problems.

That's why setting up the PdM technology databases is such an important step. Done right, these databases let you trust your alarms to catch impending problems. Then you can look at exception reports, see what equipment is in alarm, and only analyze that equipment.

But if you can't trust your data and the alarms, analysts must look at all data from all equipment and all collection points.

The difference is huge. For example, with the right database, a vibration analyst can collect and analyze data on 400 – 450 pieces of equipment per month.

Without it, productivity drops by 50% to 200 – 225 pieces of equipment per month per technician.

So having the right database has a direct impact on the productivity of your team and the success of your program.

Depending on the size of the plant, setting up these databases can take a lot of time and effort. But it's well worth it, because the payback is enormous.

Reader Muhammad asked about the usefulness of fault frequency in your PdM Program

The collection of fault frequency information such as bearing type, full load amps, insulation class and lubricant type, can make analysis more rapid, more certain, and in some cases, more accurate.

The Number 1 Question to Ask

When setting up PdM databases, the main question to ask is this:

What data do we need to collect, so that if there's a problem with this equipment, it shows up and we see it?

The answer requires understanding:

- The failure modes of the equipment
- The capability of each PdM technology to detect them
- What points on the equipment to look for the failure modes
- The theory behind the PdM technology
- How to present the data for analysis
- How the individual hardware and software package works
- What the alarm limits should be

Granted, that's a lot to know. And it doesn't come from a one-week training class.

That's why setting up PdM databases is best handled by analysts who hold a level 3 certification with several years of experience in that specific technology.

What Kind of PdM Program – the 4 Options

At this point you know:

- What equipment you have in your plant
- Which PdM technologies should be applied
- Which equipment to apply the technologies
- How to manage the PdM workflow
- What metrics to use to measure the success of your program
- How to set up the PdM databases

Now it's time to make a sound, strategic business decision on the right PdM sourcing model. Here are the four options:

1. Internal

- The PdM program is managed entirely in-house: including all data collection, interpretation, analysis, and recommendations.

2. Contract

- All key functions are outsourced to a professional, third-party PdM service organization.

3. Hybrid

- Part of the work is done in-house and part of it is outsourced. For example, data collection is handled internally, and analysis and recommendations are outsourced.

4. Remote Diagnostics

- The collected data is then sent directly to a world class analyst for analysis and recommendations.

How to decide? It's simply a matter of "running the numbers" to see which type of program makes the most sense. Here are some of the key factors to consider:

- Labor costs
- Training and development
- Coaching and mentoring
- Recruiting and staffing
- Hardware and software
- Timeline for implementation
- Remote diagnostics and supplemental support
- Union vs. non-union environment
- Career development opportunities

In addition, here are five unique situations that tend to favor outsourcing:

1. When you need the PdM expertise right away

- Some companies can't wait years to develop the PdM capabilities in-house; they need the improvements now.
- So you can accelerate the process by bringing in qualified analysts who are already trained and certified, have the right tools and understand the capability of the predictive technologies.

2. If PdM is not a core competency

- For many companies, PdM is not a core competency within their maintenance organization. They don't have properly-trained analysts. They don't have the right tools and equipment. And they don't have the time to get up to speed.
- So if your team lacks an in-depth understanding of the full range PdM technologies, their capabilities, and how to apply them, outsourcing makes a lot of sense.

3. For companies with multiple sites

- Multiple sites mean each facility has to learn PdM on their own and at their own pace.
- Thus, partnering with a third-party provider allows you to quickly implement standardized methods across many facilities. Each site gets immediate support in the areas where they need it most. That means they can focus on the results of the PdM program rather than on developing the program itself.

4. If there are opportunities to improve other areas of Reliability

- There are plenty of other aspects to Reliability that offer big payback, such as improvements in leadership, planning and scheduling, precision craft skills, root cause analysis, RCM analysis, etc.
- These are essential elements that, for the most part, you have to do yourself. If these represent major opportunities for improvement, consider focusing on them instead of PdM.

5. For a true picture of the health of your equipment

- Typically, internal Predictive Maintenance programs are overly optimistic about the health of their equipment. Why? Because there's internal pressure to make assets look better than they really are.
- Having a third-party provider of predictive services means you'll get a better, clearer picture of the condition of your assets.

How to Choose a PdM Service Provider

When you look at the range of PdM service providers, you'll find a mind-boggling range of companies - from local motor shops and machine shops to large oil companies, bearing manufacturers, and compressor manufacturers.

Here are 3 keys to look for in a service provider:

1. The ability to integrate multiple technologies

- Most service providers only focus on 1 or 2 predictive maintenance technologies. But as you know, an effective PdM program requires a multi-technology approach to detect all the possible failure modes for your equipment.
- Therefore, the provider should have the ability to bring in 8-12 of the key PdM technologies that comprise 15-20 specific PdM applications under one integrated approach.

2. PdM is a core competency

- Different companies have different core competencies. For motor rewind shops, data collector manufacturers, bearing manufacturers, oil refiners – those are their core competencies.
- To think they reach outside their core competencies and effectively deploy motor circuit analysis, ultrasound, vibration – and all of the other PdM technologies – simply isn't realistic.

3. Qualified analysts in each technology

- It's critical to have qualified analysts who can identify the root causes of equipment problems. Otherwise you will constantly be fixing symptoms rather than the root cause.
- For example, if you have an alignment problem on equipment that is causing bearing failures, you can spend a lot of time and money replacing bearings. Or you can address the root cause and fix the misalignment problem.

That's why it's so important to have PdM analysts who can make the right recommendations. At a minimum, the service provider should employ analysts with:

- Training and certification in the technology
- Desire, motivation and passion for the job
- A technical background in the field
- 1-2 years of experience under a mentor

Putting It All Together -- The PdM Design and Scope

Your PdM program will be most effective when the scope of the program is clear and well-defined. A design and scope document provides your team with the information necessary to clarify and fully understand the program.

Basically, a design and scope document is a blueprint that helps plan, schedule and control the implementation of the project. Some of the information that should be included:

- Targeted equipment for applying PdM technologies
- Resource requirements to deploy the PdM program
- The resource model to be used – internal, external or hybrid program
- Costs involved for ongoing support
- Workforce training and individual development plans
- Written standards for personnel certifications and qualifications
- Written standards for inspection procedures and technology standards
- PdM workflows and work management processes
- Performance metrics and targets for each category
- A 2-year Gant chart with implementation timelines

In addition, it should also include the business case – an objective financial analysis of current and expected benefits of the Predictive Maintenance process. The business case can be broken down into maintenance cost components such as:

- Parts/materials
- External labor
- Internal labor
- Tools and rental equipment
- Production improvements
- Other reliability related results
- Capital expenditures

Having all of this information compiled and published in one final document is a powerful way to lay out your plans.

Why go through the trouble of preparing a design/scope document?

First off, it serves as a reference guide that justifies the investment in the program.

Plus, let's face it, in a lot of companies, managers turn over every 2-3 years. So when a new manager comes in and starts asking questions, you can pull out this document and show exactly what you're doing and why.

An anonymous reader asked about how to position a PdM and asset reliability initiative with maintenance crews.

The easiest way is to allow them to participate in the process. PdM helps them troubleshoot; however, this will be difficult if management has never listened to them on the other things the crafts people have told them in the past. The more you involve them, the more likely you are to have find success. Don't involve them, and you are destined to fail.

Conclusion

To sum it all up, there are two ways to do maintenance on equipment. You can either wait until it breaks down, and then fix it. Or you can use Predictive technologies to monitor equipment, diagnose conditions and anticipate failures before they occur.

The choice is yours.

“We've known for a long time, both intuitively and through RCM studies, that a condition based approach, when combined with effective work management, planning and scheduling, and a proactive, defect elimination mindset, is the most cost effective means of maintaining a plant."

Ron Moore, author of Making Common Sense Common Practice

Bonus Section: Key Facts, Figures and Trends You Should Know About the PdM Industry

How big is the predictive maintenance industry? What are the key trends?

Simple questions. But surprisingly enough, few facts and figures have ever been published about the PdM industry.

So that's why we sat down recently with industry consultant Michael Vann. We turned to Michael because his company (The Vann Group, http://www.vann-group.com) has published one of the few known studies on the PdM industry. And he's done extensive interviews and research on this sector.

Please read on as Michael reveals key facts, figures and trends about the business side of predictive maintenance in this special bonus section to "PdM Secrets Revealed".

Q: Michael, can you give us a quick history of predictive maintenance?

A: PdM is really a creation of the last fifty years. Before World War II, maintenance wasn't even considered an important part of equipment design. The machines were very basic compared to today.

After World War II, equipment became more complex, and more breakdowns started to occur. That's when preventive and planned maintenance techniques emerged.

Then in the 1950's, the basic concepts of reliability mathematics were developed by statisticians at the U.S. Defense Department. And that paved the way for the early use of PdM technologies.

In the 1960's, the aerospace and defense industries recognized the tremendous value of PdM for reducing the risk of failures. Later, PdM technologies were adopted by the civil aviation and nuclear industries.

Finally, as the Cold War came to a close, a lot of defense and aerospace workers migrated into commercial industry, and they took their PdM knowledge with them. Many struck out on their own and formed new companies to provide PdM services.

So it wasn't until the late 1980's and early 1990's that predictive maintenance services became mainstream.

Q: Overall, how much do companies actually spend on industrial maintenance?

A: In our studies, we focused specifically on the U.S. industrial market for maintaining rotating equipment. That's estimated to be at least $200 billion a year.

Q: How much of that is spent with maintenance contractors?

A: There was a survey done in 2001 which indicated companies spend about one-third of their maintenance budgets with contractors.

Q: How big is the predictive maintenance market?

A: It's almost impossible to say exactly, because the market is so fragmented. But it's safe to assume there's a multi-billion dollar market for PdM equipment and services. So it's pretty sizeable - and it's been growing at double-digit rates for years.

Q: What's causing the growth?

A: It's simply because PdM has become more cost-effective. The equipment is smaller, portable and more user-friendly. The technologies are easier to use, and it's easier to interpret the information.

Plus, equipment costs have dropped, and that's reduced the barrier to getting into PdM.

So now it's easier and more cost-effective to let PdM technologies make the first assessment if an equipment problem exists or not.

Q: Who are the biggest users of PdM services and equipment?

A: Certainly those industries that are asset-intensive, like food & beverage, pharmaceutical, refining, petrochemicals, power generation ... the ones that own and operate a lot of valuable, expensive equipment.

Q: What is the profile of the typical PdM service provider?

A: As I said, it's a very fragmented industry ... there are thousands of companies involved. But we know that most PdM service companies are small, and they are focused on a local market. There are only a handful of companies that have a national footprint.

For example, when we interviewed thermography companies, if they had 4-5 guys that's considered a big shop. That was a big service company. There's only so much work that 4 guys can do.

Q: What about revenues?

A: It varies by technology, but we generally found that the average PdM service provider had revenues in the $1 - $2.5 million range.

Also, out of hundreds of companies we researched, very few offer more than one or two technologies. Most are limited to one - maybe two - technologies such as vibration and infrared.

Q: What about the PdM equipment manufacturers?

A: Some of them offer services too - as a value-add for their customers. But services are a very small percentage of their overall revenues.

Q: What trends do you see in the future?

A: I think the market is definitely going toward fully integrated solutions. Companies are realizing that one or two technologies can't solve the majority of reliability problems that exist in their production processes.

Until recently, an integrated solution may have been a little premature. It wasn't quite at that tipping point yet. Now I see it becoming more mainstream.

Q: What's going to happen to the small, local service providers?

A: I think they'll always be around. But for large-scale corporations who want to build strategic, competitive advantages - that's tough to accomplish through dozens of local PdM service providers. Big companies want consistent services and standards delivered across all their plants.

So that's good news for service companies who can bring a total, integrated PdM solution to the customer's sites.

Q: What about information systems?

A: Managers now want to see data from all the PdM technologies integrated into a single database. Before, it wasn't easy to view information from the different technologies in a useful format.

Now decision-makers can see accurate, real-time information - the kind of information they've always dreamed about. By drilling down into key performance trends and historical data, they can make better-informed decisions about maintenance and production.

Q: What about finding skilled PdM technicians?

A: There's definitely a shortage of skilled manpower - especially in remote areas where it's hard to attract workers.

That - plus the retirement of PdM professionals - is reducing the available labor pool. Just trying to find employees is a challenge, so that's another reason why outsourcing has become popular.

The good news is the jobs being created are good jobs, like planners and schedulers, PdM technicians and analysts, reliability engineers, trainers ... people who work both with their hands and their theoretical knowledge. These are not the typical blue-collar jobs traditionally associated with industrial maintenance.

Reader Victor, Mike, Paul, William and Tom all asked for case histories. *We have included a list of case studies below.*

Case Study Results Pharmaceuticals

Prior to Reliability Initiative

Patented product going off patent

After Reliability Initiative

Reactive Maintenance 71% → 7%

Overtime 22% → 5%

Maintenance Employees (FTEs) 350 → 250

Added 9 Planners, 7 PdM Technicians and 8 Reliability Engineers

Availability → 12% increase

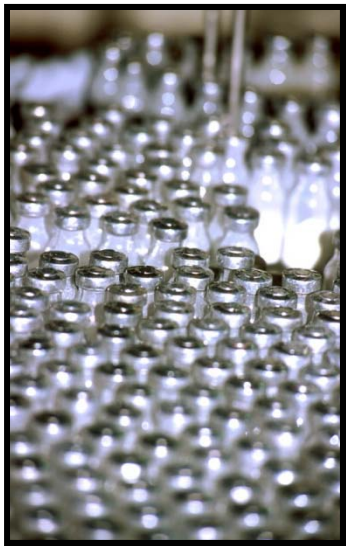
Healthy Assets 35% → 85%

Production Deviations → 1/10th of previous levels

Maintenance Budget → Reduced 40%

Inventory → Reduced to 33% of previous level

Insurance Premiums → Reduced 30%



Case Study Results Steel

Prior to Reliability Initiative

On verge of bankruptcy

After Reliability Initiative

Reactive Maintenance 70% → 20%

Availability 78% → 91% (based on 8,760 hours)

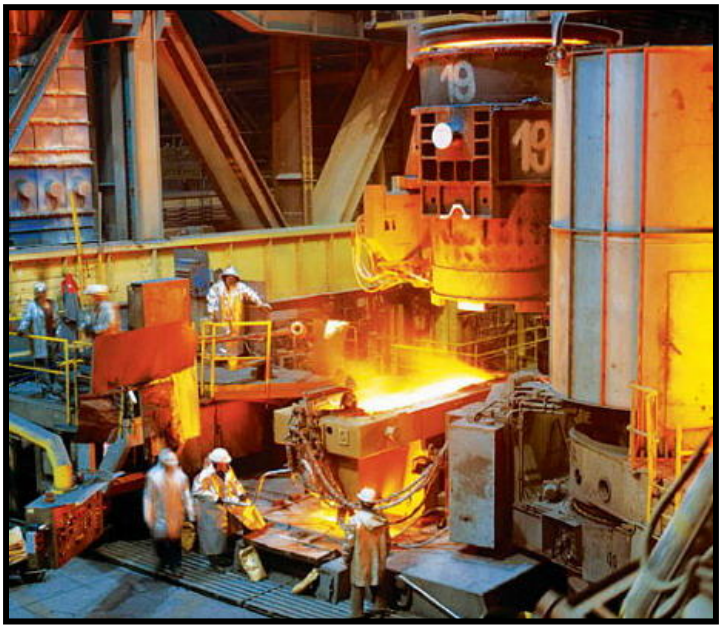
Product Quality (yield) 76% → 91%

Inventory Reduction → $40,000,000

Maintenance Costs → 50% reduction

Most Profitable Steel Producer 1999

Ranked as #1 Steel Maker in the World by Dow Jones



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Recommended Resources

Asset Health Assurance Training Series Workshops

Here's your chance to transform your preventive and predictive maintenance programs into best practices with a new series of workshops from GPAllied.

No matter where you are on the road to reliability, now you can learn and apply the secrets from some of the most successful programs -- and program managers -- in the world.

Plus, in each of these classes, Overview, Mechanical, Electrical and Stationary, you'll get access to the powerful, proprietary software tools to help you put new knowledge into practice:

There's a roadmap tool, an equipment walkdown tool, a criticality analysis tool, asset health matrix tool, PM evaluation tool and a self assessment tool...each with a storehouse of knowledge inside.

So now there's no excuse not to have a successful PM and PdM program. You get comprehensive training in all the technologies, designed around your own equipment, packaged together with the software tools you need to make the job faster and easier.

Asset Health Assurance Training Series is designed for people with little or no formal training in predictive maintenance and condition monitoring technologies. This includes maintenance technicians, supervisors, planners and schedulers, reliability engineers and plant managers.

Reserve your spot at: http://www.alliedreliability.com/training/schedule.asp For information on private classes held at your location, send an email to training@alliedreliability.com.

Maintenance Planning and Scheduling

To go from reactive to proactive maintenance, you must have an effective planning system in place. Why? Because proactive maintenance is planned maintenance.

Without good planning and scheduling, maintenance is haphazard at best, chaotic at worst. Left alone, maintenance tends toward emergency work and fire-fighting – with no time left for the preventive and predictive work.

The result? Higher material costs, more overtime and higher repair costs.

Oddly enough, one-third of all companies have a maintenance planner, yet less than 10% of these planners are used effectively. That's why training is critical if you want planning to run efficiently and effectively and avoid bad work practices.

Discover the keys to successful planning and how to unlock its tremendous power in this course. Classes include instruction on best practices from experts in the field. For more information, e-mail us at: training@gpallied.com.

Phase I PM / PdM Evaluation

What's the fastest, easiest way to improve your maintenance program?

Get a third-party evaluation of your preventive and predictive maintenance program and an assessment of your use of the 5 major technologies.

You'll find out exactly what you need to do to improve PM / PdM, lower your maintenance costs and improve the reliability of your plant.

After designing, operating and managing over 200 PdM programs, we've taken everything we know and packed it into this analysis tool. You'll get more work done in days than you could do in months on your own.

"I believe that Allied's Phase I PdM analysis is an excellent addition to the Reliability process we have implemented and will add significant value to the bottom line of our company. I'm excited about the results of the analysis... and I am a guy that is not very easily excited!"

-- Gary Johnson, Reliability & Maintenance Manager
Alcoa Primary Metals Business Unit

It's a tremendous time-saver. Ready to start? Call 888-414-5760. Or send an email to info@alliedreliability.com.

About Allied Reliability

Founded in 1997, Allied Reliability and Allied Services Group have quickly become one of the largest maintenance and reliability engineering firm specializing in Predictive Maintenance and Condition Monitoring services.

Today, Allied Reliability serves clients in over 200 plants and facilities in 40 states in the U.S., 3 provinces in Canada, plus countries in Europe and Latin America.

Our technicians routinely monitor over 150,000 pieces of equipment with a full range of PdM technologies.

For more information about our offerings in:

PM / PdM Program Design

- Criticality Analysis
- PM Evaluation
- Asset Health Matrix
- PdM Technologies Evaluation
- Work Management Evaluation
- Contract PdM
- Remote Diagnostics
- Coaching and Mentoring

For details, e-mail us at info@alliedreliability.com or call 888-414-5760.

Legal Notice

"This is a quick read, worthy of the time spent on it by those responsible for equipment reliability and maintenance cost effectiveness. PdM represents one of the best tools for increasing profits and improving competitiveness in the global marketplace. Decision makers should pay attention to this subject as it represents one of the last frontiers for improvement in quality and capacity for delivery of products and services at the lowest cost."

-- Jack R. Nicholas, Jr., MBA, P.E., CMRP, CEO Maintenance Quality Systems LLC

"I read through this report several times and my conclusion is - The "Content" is in perfect harmony with the "Title". Indeed, this report is a must-read practical guide for all maintenance and reliability practitioners regardless of the maturity or success of their PdM Programs.

I highly appreciate the logical flow as well as simplicity and yet comprehensive nature of the material. I find it difficult to place a price tag on it for I deem it invaluable to any maintenance organization. However, I will reluctantly recommend a minimum of $100 per copy.

This is a job worthy of commendation. I say a big thank you to Allied Reliability for reaching out to and educating maintenance and reliability practitioners globally in an ever evolving field where we are faced with the challenge of achieving excellence in the light of harsh economic situations."

-- Victor Itulua E., DML Lab, Mechanical Engineering Dept, Tennessee State University

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"Thanks for the report. Great information! Your information makes me look like a genius to the rest of the management group! I liked the straight forward, no nonsense approach. I don't have a lot of spare time to try to sort through questionable advertising fluff. This report has the information I was looking for and tells me where to find the answers. I just want to thank you for the concise information in a great format. This report articulates the things I all ready know, but need to be better at passing along to my superiors in order to improve our plant's program."

-- Craig Pindell, Maintenance Program Specialist, Dyno Nobel Inc.

"Thanks for the information; this has become invaluable in my goal of pushing a sound PdM program here. Although we are still far away, we are making some progress. We finally had our reliability forum with the site leadership team, and I presented the last paper you sent me."

-- John Roach, Reliability Engineer, Huntsman Corp.

"It's hard to put a price value on the information you have in the *PdM Secrets Revealed: How to Improve Your PdM Program Or Start One from Scratch* report. We have been in the process of developing a successful PdM Process for three years. Our down time has been reduced from 15% to an average of 4%. Unexpected failures are rarely happening, compared to 8-10 times a month or more. We have reduced our maintenance budget by 20% and are using a lot of the funds in upgrades to equipment."

-- Byron H., Maintenance Manager, Mining and Metals industry

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