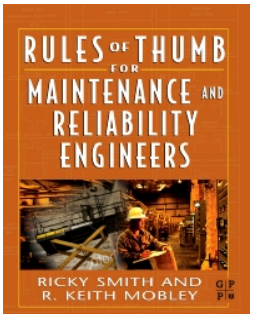


Lean Reliability

By Ricky Smith CMRP/ Keith Mobley

Lean thinking has been widely adopted in manufacturing operations. Toyota set the standard in discrete manufacturing industries for producing products in the quickest and most efficient way. Other leading companies have also adopted productivity-enhancing manufacturing techniques.

Yet in highly capital-intensive industries, including mining, metals, pulp and paper, and power generation, equipment reliability plays a far more critical role in business success because degradation in equipment condition results in reduced equipment capability. Equipment downtime, quality problems and the potential for safety and/or environmental incidents are the result of poor performing equipment. All of these can negatively impact plant output.

This whitepaper explains how traditional Lean thinking and principles can be applied specifically to the equipment reliability process to achieve breakthrough performance improvement. This business process focuses people on managing physical asset reliability to meet the business goals of the company. Lean Reliability brings together Maintenance and Operations personnel to manage the equipment reliability process in a way that reduces waste and continuously improves the process. Lean Reliability focuses on managing asset health to achieve optimal performance at optimal cost.

The Evolution from Lean Manufacturing to Lean Maintenance to Lean Reliability

Lean Manufacturing has been implemented in many organizations to optimize the production process. Lean improvement efforts have successfully reduced manufacturing lead times, reduced work in process, and generally improved the work environment and manufacturing operation. Yet many companies continue to face major issues due to poor performing capital assets (either not meeting capacity requirements or overspending in Maintenance to achieve required performance levels). These companies have not seen the full benefits of Lean. The reason for this underachievement is the lack of integration of Maintenance as a true partner of Manufacturing in achieving optimal performance of the physical assets that contribute to achieving company goals. Maintenance needs to “join the lean team” and contribute as a partner to the operation.

For some companies, the old way of thinking about Lean within Maintenance simply meant cutting the Maintenance budget by 20 to 30%, sometimes by even 50%, then demanding that Maintenance do more with less. This approach was known as the “slash and dash” approach. As a result, plant performance suffered while management struggled to cope with acute reliability issues and a disgruntled workforce.

For other companies, Maintenance was simply a necessary evil, and a creeping Maintenance budget was the result - spending too much money for the required uptime or equipment availability. As Ron Moore, author of “Making Common Sense Common Practice” defined it, “(companies have) too much maintenance in their reliability”. If your maintenance budget continues to rise and reliability either stays the same or decreases, your maintenance program is the problem.

And for yet others, reliability and maintenance issues remain a hidden problem – even though they are the root cause of the company losing large amounts of money by the minute. When we compare maintenance costs within a typical company to world-class (see chart below), we recognize that there is a huge opportunity to improve. In the U.S, alone, billions of dollars are spent unnecessarily on maintenance expenditures due to lack of control, lack of process.

Metric	"Typical"	"World Class"
Maintenance Cost / Replacement Asset Value (RAV) ***Maintenance cost*** must include labor (including overtime), material, contract maintenance and capital replacements / maintenance (replacing worn out assets because they were never properly maintained).	**3.5% – 9%**	**2.0% - 3.0%**
Maintenance Material Cost / Replacement Asset Value (RAV) ***Maintenance material*** cost must include material in storeroom stock, plus material in other storage locations (maintenance shop, plant floor, etc.).	**1.0% - 3.5%**	**.25% - .75**

Table 7.2.1

Many companies have shut their doors and used many excuses including not being able to compete with cheaper labor overseas. We, in maintenance and operations, can either improve our plant operational performance and control our destiny or someone else will, by closing the plant.

Managing Asset Performance to Meet Customer Needs

Customer expectations are normally defined in terms of product quality, competitive pricing, service levels, on-time delivery, and overall solution delivery. Within our organization, we can determine, measure and control the performance requirements of our physical assets to meet business goals and market demand. (e.g. quality, availability and Overall Equipment Effectiveness (OEE), cost/unit, safety and environmental integrity). To achieve our asset performance requirements, we must manage three inputs; process technology, standard operating practices and asset care practices. See graphic below, Figure 7.2.2.

Figure 7.2.2

The first input is process technology that simply delivers the inherent capability of the equipment "by design" to meet the equipment performance requirements. The second input is the operating practices that make use of the inherent capability of process equipment. The documentation of standard operating practices assures the consistent and correct operation of equipment to maximize performance. The third input is the asset care practices that maintain the inherent capability of the equipment. Deterioration begins to take place as soon as equipment is commissioned. In addition to normal wear and deterioration, other failures occur. Failures happens when equipment is pushed beyond the limitations of its design or operational errors occur. Degradation in equipment condition results in reduced equipment capability.

Equipment downtime, quality problems or the potential for accidents and/or environmental incidents are the visible outcome. In Lean, one of the goals is to reduce the losses associated with product quality, plant capacity and safety.

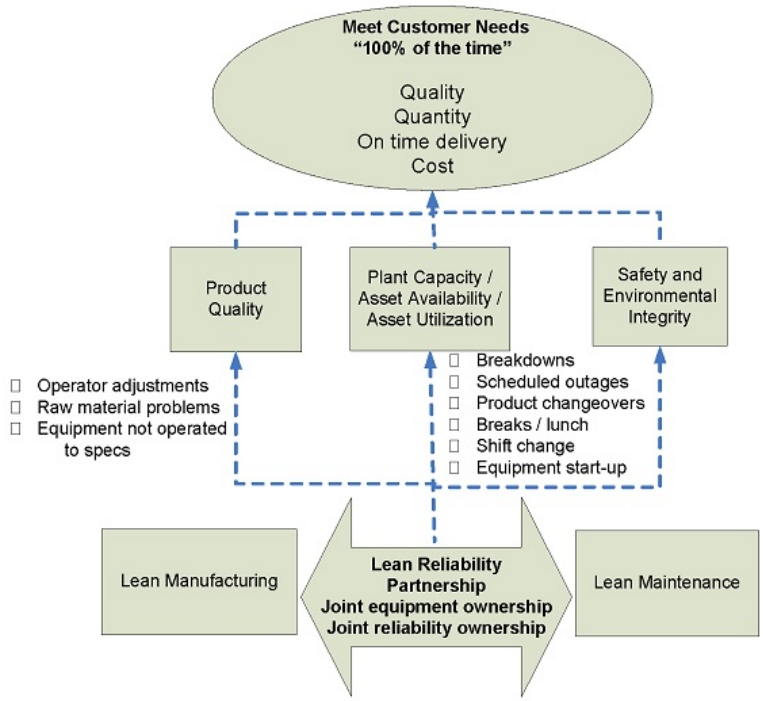


Figure 7.2.3 A Lean Reliability Partnership is Key to Meeting Customer Needs

Plant capacity, asset availability and asset utilization losses are affected by scheduled and unscheduled downtime. This downtime includes equipment breakdowns, scheduled outages, product changeovers, breaks / lunch, shift changeovers and equipment start-up. Product quality losses can be affected by both maintenance and operations but are the responsibility of both parties. Quality losses include operator adjustments/errors which or as a result of equipment reliability issues; raw material problems could be caused by the supplier (low chance), storage or transfer issues which could be operations or equipment reliability problems. Safety and environmental integrity losses can affect the health of the plant workers and health of the community. This category is difficult to place a specific hard value to but the results nonetheless can be measured.

Everyone in an operation from senior management to floor level personnel must understand that these losses can cause a plant to lay off employees or worst - shutdown. In most cases plant layoffs and shutdowns could have been avoided if addressed jointly in a lean reliability initiative (because of the huge financial impact increased reliability provides). The specific financial value of the initiative must be determined in terms of addressing the major losses. Jointly the plant leadership team, along with the comptroller, can determine the opportunity in the short and long term.

The New Lean Team

To achieve and sustain Lean Reliability, there is a joint responsibility between Maintenance and Operations. Ownership of equipment and reliability is a shared responsibility which must be demonstrated and proven through reduction in cost and risk to the business. Working together at all levels (from the plant floor to management), Maintenance and Operations are the new "Lean Team", providing a solution to address the major losses that can be caused by equipment reliability issues. This new team needs to drive reliability from the floor level and monitor progress of reliability by establishing targets for improvements and measure progress with KPIs (Key Performance Indicators). Only then can this team leverage a sense of shared ownership in Lean Reliability to achieve breakthrough performance.

Lean Reliability requires a business process to manage asset reliability. This process needs to be jointly managed by Maintenance and Operations working together to optimize asset reliability at optimal cost.

A Proactive Asset Reliability Process

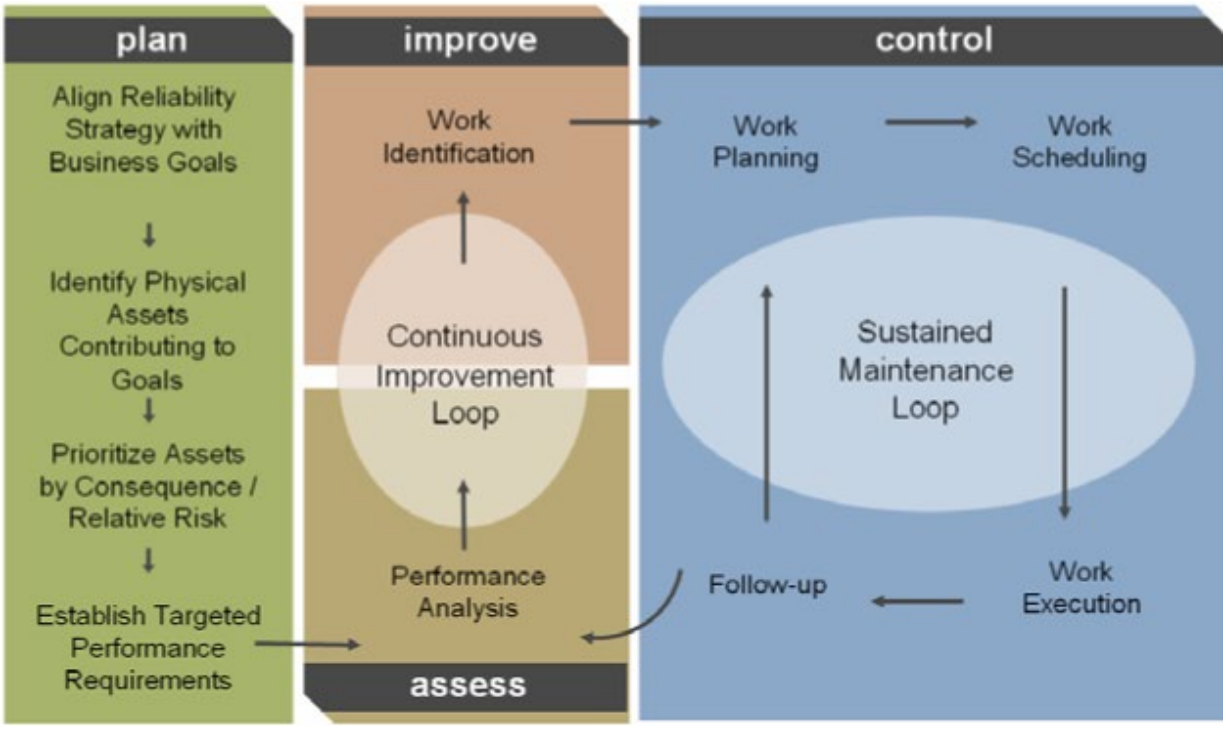
Evolving from Lean Manufacturing to Lean Reliability requires the development of a Lean Asset Reliability Process. The output of this proactive process is optimal asset reliability at optimal cost. The core concept in a Lean Asset Reliability Process is providing a sound technical basis to focus on the right work at the right time – regardless of who is conducting the work (the operator or tradesperson).

In most plants with high maintenance costs (excluding perhaps nuclear power generation plants), we find reactive activities. By our very nature, we resist change and are trapped in this reactive environment, We become such good fire fighters, that we are rewarded for our reactive behavior – so we believe this reactive culture is a good thing, that is until the next time the equipment breaks down, causing a major downtime incident (hero one day, enemy the next).

Changing from a reactive culture to a proactive culture cannot happen overnight. It is a journey that starts with implementing a process for achieving reliability.

Companies that have been successful in transitioning to a proactive asset reliability focused culture all have one ingredient in common – they are following a formal business process to govern the work done to maintain their assets. The reason for this fact is that the reliability of assets is far more related to the things people do than it is to anything else. With the right process in place, we can ensure that people are doing the right things to maintain plant assets.

While most plants have in place a process to govern the work done in “An Asset Reliability Process”(Figure 7.2.4) maintenance, the typical process includes only the planning, scheduling, work execution and follow-up elements of the above process. These process elements, shown in the blue box of the process diagram, are necessary elements but they do not represent an effective, proactive process.



Asset Reliability Process” (Figure 7.2.4)

Before we discuss the other required elements of a reliability process, we should first understand the definition of “optimal asset reliability”. Optimal asset reliability means that for the least possible cost, we achieve the level of performance we need from our equipment to meet our business goals (plant or company level goals). Equipment performance in this case is not production output but should be described instead in terms of the required level of uptime (such as Mean Time Between Failure, or MTBF) and or in terms of the maintenance cost needed to assure the desired performance. Given that we need to understand the business goals to be supported by the equipment, the asset reliability process must include this connection to business goals, as shown in the green box of the process diagram. Next, we determine the assets that are most critical when they fail, and where the risk is highest in terms of impact on business performance. For these assets, we establish specific performance targets. This stage focuses maintenance reliability improvements on the performance targets of critical assets that contribute most to the company's success. The Assess stage then compares the asset performance targets to the maintained asset’s actual performance which is learned in the blue box as we execute work. This stage identifies and prioritizes gaps in performance by performing specific Performance Analyses.

In this process, functional failure is defined as the inability to meet performance requirements, and so a performance gap is really a functional failure. In the Improve stage, the team selects an appropriate Work Identification strategy to understand and address all causes of failure for the specific asset under consideration.

One of the toughest challenges on the road to improved asset reliability is to determine the prescription of proactive work that should be done to maintain the assets so that they deliver the reliability we need (at optimal cost). This topic is also known as “work identification”, and it represents the cornerstone of an effective asset reliability process. The resulting asset reliability program for an asset will include some mix of preventive maintenance, detective maintenance, predictive maintenance and some run-to-failure decisions. The outcome of the Work Identification element is the right work at the right time (the right work defined in terms of the tasks and the timing for conducting them). The process is self-sustaining, with opportunities to continuously improve and evaluate the overall effectiveness of the Asset Reliability Process as well as revisit reliability programs and continuously improve. These activities optimize the effectiveness of the Lean Team.

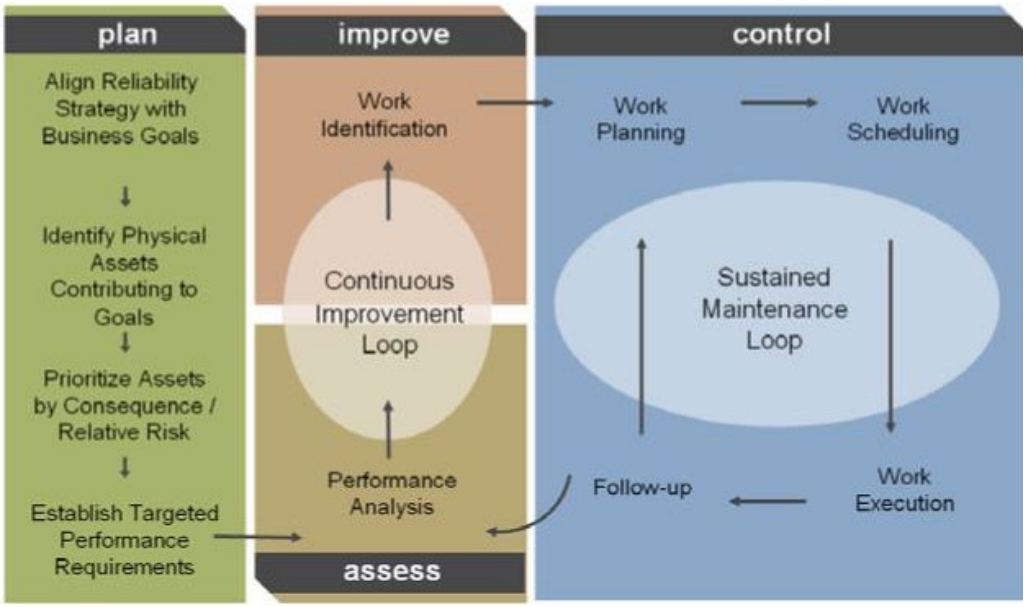


Figure 7.2.4 Asset Reliability Process

Supporting Reliability Practices and Technology

The new Asset Reliability Process creates an opportunity for maintainers, operators and management to learn new things and grow into new roles and responsibilities. Implementing one-system-at-a-time, you can gradually transform your maintenance and operations employees into experts in reliability. Much of the knowledge of the equipment and how to maintain it to ensure optimal reliability lies within your existing workforce. The knowledge from these equipment experts can be formalized and made available through the reliability process. This knowledge can be leveraged across all employees, assets and even across other plants.

The transition to a reliability focused approach to asset care will result in the need to manage an enormous amount of equipment health data. Successful Lean Reliability initiatives use technology to their advantage to capture the knowledge of equipment experts and to then manage plant assets from an online picture of the health. Rather than reacting to equipment failures, Operators and Maintainers proactively maintain optimal equipment health.

The Basic Principles of Lean Reliability

The three basic principles of Lean Reliability are:

1. **Eliminate waste**
2. **Continuously improve**
3. **Teaming Maintenance and Operations**

Eliminate Waste

There is a huge opportunity to eliminate waste when we implement a proactive asset reliability process. Fundamentally, people are, for the most part, doing the wrong work. The wrong work is a combination of work done that is too much too early, or too little too late. The classic example of the wrong work is justified as "we have always done it this way". There is a very significant financial opportunity associated with identifying the right work to do.

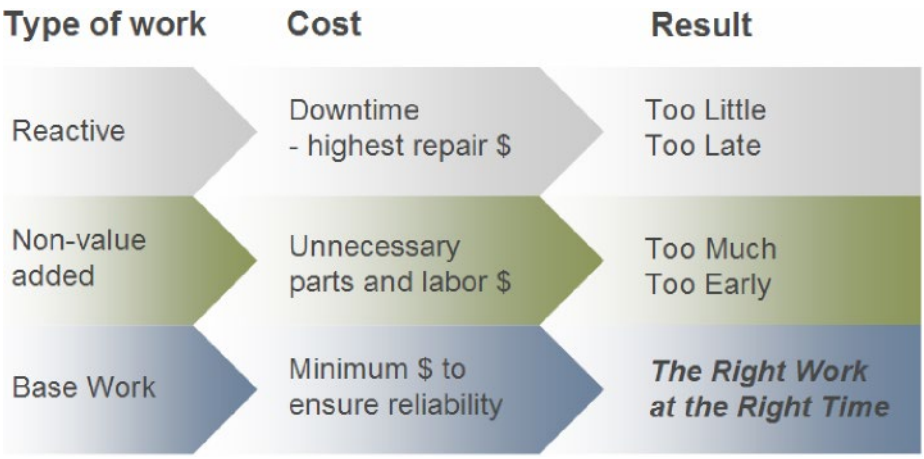


Figure 7.2.5 “The Right Work at the Right Time”

In a reactive environment, the focus of maintenance work is repairing failed equipment. In a fully proactive environment, the focus on maintenance work becomes inspections of asset heath to enable proactive intervention prior to failure. To transition to a proactive asset reliability program, you need effective work identification capabilities.

The right work is the minimum amount of work necessary to ensure the asset provides the necessary level of performance. Since most failures occur randomly, and are not related to age, other techniques such as asset heath monitoring are needed to allow us to intervene prior to loss of asset function. Work identification is the cornerstone of reliability improvement and represents the fundamental shift from conventional time-based maintenance to an asset reliability approach to maintenance.

Yet, the answer is not as simple as solely identifying the right work. In a reactive environment, a binder filled with proactive tasks is not a solution. The solution must be a proactive process for guiding people's activity. In addition, to successfully executing the process, employees must be trained on the latest reliability thinking and practices and equipped with tools to manage the data inherent in a proactive environment.

Finally, an appropriate change management implementation approach must be used. To implement a proactive solution in a reactive culture in a reactive culture requires unique approach, one that transforms culture, one asset at a time.

Determining the right reliability program for an asset is no easy task. It might seem that the longer a company has been around the more effective the asset maintenance programs would be. Unfortunately, this is not always true. The effectiveness of a reliability program has little to do with the number of years a company has been doing maintenance. Most companies are doing too much maintenance too soon, or too little too late, either of which has cost consequences to the organization.

To begin, we must first understand how equipment really fails.

Understand the New Definition of Failure

Reliability studies over the last 30 years say that 80% of asset failures are random. This is quite a departure from what we would expect, yet research has proven that for most components, there is no correlation between age and how likely they are to fail. However, with the right practices and technologies, you can detect early signs of random failure by monitoring the health indicators to determine whether asset health is degrading. The P-F interval is the time between the detection of a potential failure (P) and functional failure (F), as demonstrated in the diagram below, Figure 7.2.6. Proactive corrective action is scheduled before functional failure occurs.

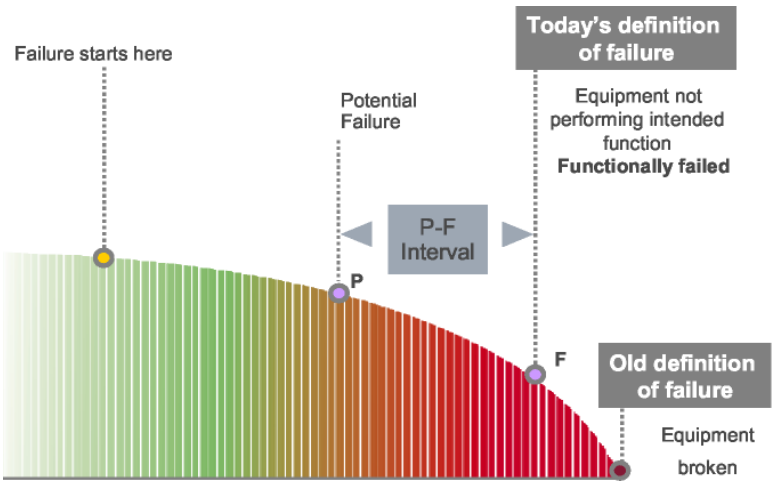


Figure 7.2.6 PF Curve

Take a step back and review the way you manage equipment performance. If equipment continues to fail after preventive maintenance or overhauls, then something must change. Rethink conservative time or age-based restorations and replacement decisions with asset health monitoring. If a PM task is not tied to a failure mode (root cause), question why you are doing it.

Make sure you understand the function of an asset and its operating context, otherwise, your efforts are wasted. Understanding the function of an asset and its performance requirements can have a profound effect on how that equipment is operated and maintained and hence can affect the overall reliability of the asset. This can be a challenging task, needs to involve the operators and maintainers of the asset because they know best what the asset must do to achieve the operating targets.

Capture the Knowledge of your Aging Workforce – Before they Retire

The imminent aging workforce issue has made asset reliability a hot topic at the executive level of most capital-intensive companies. Executives have recognized the challenge in retaining valuable maintenance and equipment reliability knowledge as their workforce retires.

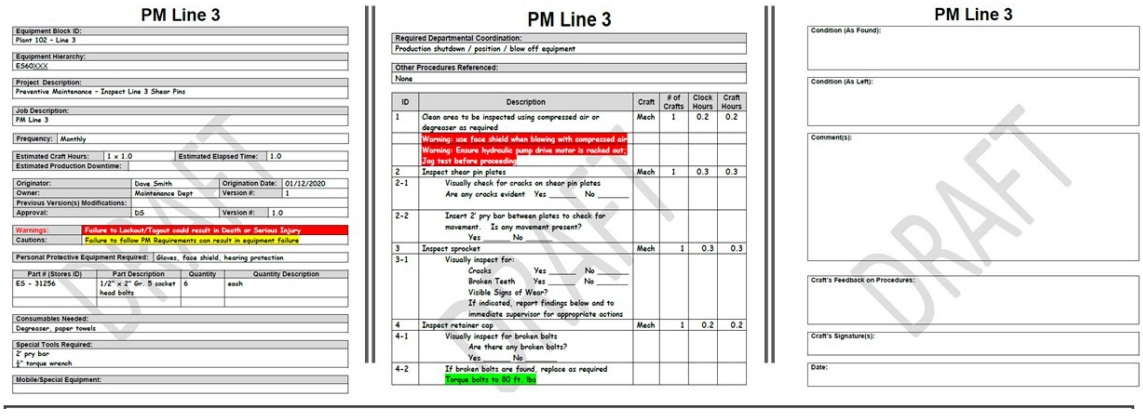
During their tenure, well-seasoned operators and maintenance veterans become intimate with their equipment and can quickly repair to avoid downtime. But this acquired knowledge is rarely documented or transferred to others and will be lost if companies do not systematically collect this important information employees perform their jobs, all of this knowledge will be lost upon retirement.

The reliability program captures the knowledge of the equipment experts, the operators and maintainers who know the equipment best. In many companies, these employees have worked with the equipment daily for decades, and so their knowledge is invaluable. The challenge is to find a way to store this information so that all employees can take advantage of it for their daily work. Reliability software captures this knowledge and makes it available.

During the development of the asset
reliability program, these maintainers and operators will be asked to contribute their knowledge of the ways the asset fails and the ways that have found to detect or prevent failure. In the context of a well-defined failure analysis, their knowledge is captured, formalized by linking proactive tasks to specific failure modes. The detail that was previously carried around in personal pocketbooks becomes readily available as the new Asset Reliability Program is defined and deployed.

It's not a matter of *if* the aging workforce issue will affect you & your organization but *when…* Don't waste this expertise, don't let it walk out the door. If we don't act now, the problem will worsen.

The best and most effective method to capture knowledge is to use repeatable procedures.



PM Line 3

Equipment Block ID:
Plant 102 - Line 3

Equipment Hierarchy:
ES60XXX

Project Description:
Preventive Maintenance - Inspect Line 3 Shear Pins

Job Description:
PM Line 3

Frequency: Monthly

Estimated Craft Hours:	1 x 1.0	Estimated Elapsed Time:	1.0
Estimated Production Downtime:			

Originator:	Dave Smith	Origination Date:	01/12/2020
Owner:	Maintenance Dept	Version #:	1
Previous Version(s) Modifications:			
Approval:	DS	Version #:	1.0

Warnings: Failure to Lockout/Tagout could result in Death or Serious Injury
Cautions: Failure to follow PM Requirements can result in equipment failure

Personal Protective Equipment Required: Gloves, face shield, hearing protection

Part # (Stores ID)	Part Description	Quantity	Quantity Description
ES - 31256	1/2" x 2" Gr. 5 socket head bolts	6	each

Consumables Needed:
Degreaser, paper towels

Special Tools Required:
2' pry bar
3" torque wrench

Mobile/Special Equipment:

PM Line 3

Required Departmental Coordination:
Production shutdown / position / blow off equipment

Other Procedures Referenced:
None

ID	Description	Craft	# of Crafts	Clock Hours	Craft Hours
1	Clean area to be inspected using compressed air or degreaser as required	Mech	1	0.2	0.2
	Warning: use face shield when blowing with compressed air				
	Warning: Ensure hydraulic pump drive motor is racked out; Jog test before proceeding				
2	Inspect shear pin plates	Mech	1	0.3	0.3
2-1	Visually check for cracks on shear pin plates Are any cracks evident Yes _____ No _____				
2-2	Insert 2' pry bar between plates to check for movement. Is any movement present? Yes No				
3	Inspect sprocket	Mech	1	0.3	0.3
3-1	Visually inspect for: Cracks Yes _____ No _____ Broken Teeth Yes _____ No _____ Visible Signs of Wear? If indicated, report findings below and to immediate supervisor for appropriate actions				
4	Inspect retainer cap	Mech	1	0.2	0.2
4-1	Visually inspect for broken bolts Are there any broken bolts? Yes _____ No _____				
4-2	If broken bolts are found, replace as required Torque bolts to 80 ft. lbs				

PM Line 3

Condition (As Found):

Condition (As Left):

Comment(s):

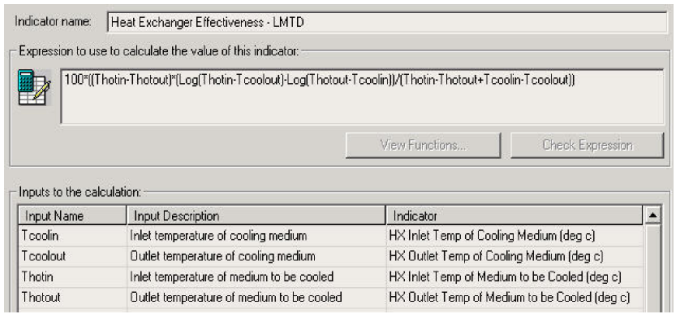
Craft's Feedback on Procedures:

Craft's Signature(s):

Date:

By capturing the knowledge of your experts within a system, you can also reduce the amount of time wasted each day manually calculating condition data. For example, the screen shown below.

Figure 7.2.8 captures the calculation to determine the effectiveness of a heat exchanger.



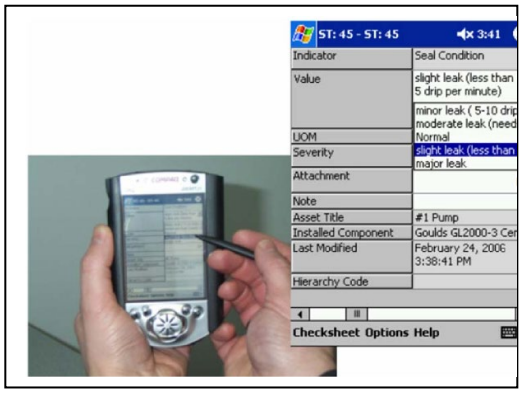
7.2.8 Reliability Software captures the knowledge of your maintenance experts and eliminates manual calculations.

You no longer need to remember the engineering calculation since software can store the expression, making it permanently available for all to use. Combine data from various indicators to determine the overall effectiveness of the heat exchanger and when a non-normal value is found, prompt the user with the predetermined corrective action (which was once only known by the expert). You can also consolidate islands of data from multiple sources within the plant to evaluate current asset health. This ensures you can get an accurate picture of asset health in a timely manner.

Automate paper check sheets

Most inspections involve rather subjective assessments of the equipment condition. Visual or other sensory inspections can be logged via hand-held data recorders (PDA's). Non-normal readings will trigger alarms And follow up work tasks to suggest more rigorous inspections or corrective work.

This also removes the subjectivity of the inspection by providing the inspector with the ability to choose a statement that corresponds to the observed condition, from a predefined list of such statements. This approach will enable each employee that conducts the inspection do so in a consistent manner.



Automating paper check sheets improves consistency and quality of data.

Figure 7.2. 9

There are many more opportunities to eliminate waste when a proactive asset reliability process is implemented. These ideas are just the tip of the iceberg.

Continuous Improvement

Continuous improvement in Lean Reliability has some very basic principles which must be met in order to be successful. Most companies never obtain true continuous improvement because one or more of these basic principles are not met and thus their Lean effort never provides all the rewards available in the way of lower total cost, higher asset reliability, higher asset availability, and higher capacity. These principles include:

1. Workflow processes based on known "best practices" and periodically reviewed.
2. Having the discipline to follow the established workflow processes. Defining clear roles and responsibilities as well as KPIs helps to ensure adherence to process.
3. Development of pre-planned job packages which have defined procedures, specifications, material, tools, safety and other items required to ensure repeatability of the maintenance work. These pre-planned work packages provide a means for maintenance work practices to be improved based on Subject Matter Experts (SM Es). With pre-panned work packages maintenance work can continue to improve and reduce the potential for lost time, lost knowledge, and maintenance induced failures.
4. Defining **"right work at the right time"** (preventive, predictive, detective maintenance) utilizing a technically sound process which is defined and managed by both maintenance and operations. Analyzing known failures and improving the reliability program (learn from mistakes). An automated system makes this a simple process.
5. Don't let the magnitude if failure data prevent you from succeeding. Monitoring and dissemination of asset health using PdM, visual inspections, PLC Data, etc. becomes more manageable once a system is in place.

You have the option to not follow all of these principles but with every principle that is not followed there comes with it a risk of Lean not meeting the goals you expect. Is it worth the risk? Most companies select the principles that are easiest to put in place or that they understand first.

Teaming Maintenance & Operations

The third and most important element of Lean Reliability is the teaming of Maintenance and Operations to manage the physical assets required to achieve the goals of the company. Asset management needs to be a shared responsibility between Operations and Maintenance. Together, this team can provide a solution to address the major losses caused by equipment reliability issues.

Lean Reliability can only be successful when maintenance and operations become true partners in managing assets. With a proactive process focusing on value-added functions required to produce optimal equipment reliability at optimal cost, Lean Reliability is about people and creating a permanent environment focused on reliability of equipment as a way of life in Maintenance and Operations. After all, it is the Operators and Maintainers that are the equipment experts – they know how the equipment can fail. They know how to detect early signs of failure. They need to understand whether it matters to the business if the asset fails.

This new team needs to drive reliability from the plant floor level and support it from the top to be successful.

How Lean Reliability Aligns with TPM, Kaizen, 5S and Six Sigma

Over the years, there has been a multitude of manufacturing improvement initiatives (eg. TPM, Six Sigma, 5S, Kaizen) to improve operational effectives and efficiency. Lean Reliability applies these concepts to the Equipment Reliability Process.

Total Productive Maintenance (TPM)

The basic principle of TPM is to empower employees to get involved with process improvement in order to prevent unplanned equipment downtime and minimize waste. With the objective to lower costs and improve return on assets, the basic asset care philosophy is about “autonomous maintenance” or “operator-driven maintenance”. While this concept of basic care is a valuable starting point towards optimizing asset performance at optimal cost, it falls short in the technical validity of the asset reliability program.

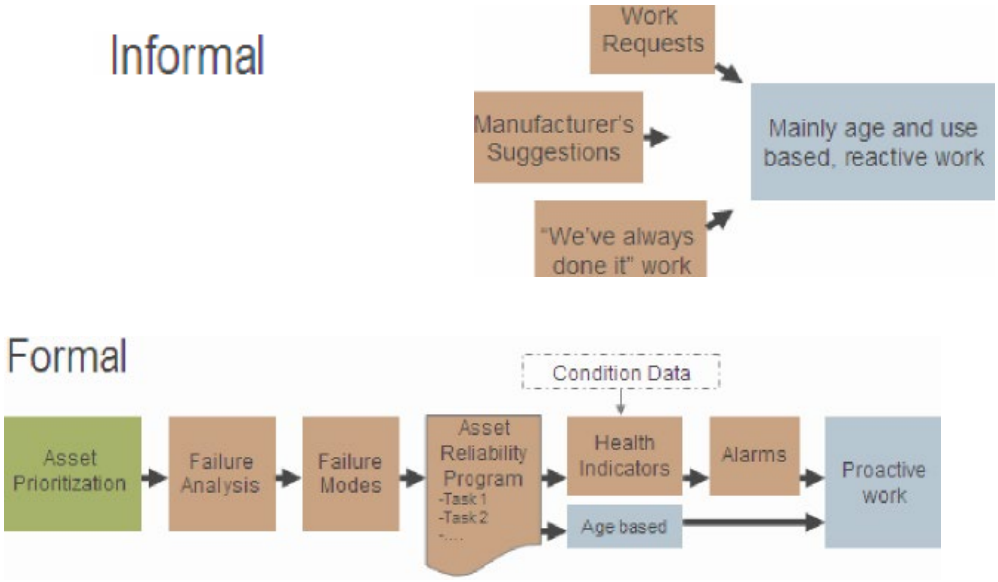


Figure 7.2.11

One of the ways that we transition from reactive to proactive is to enhance the work identification process. Rather than relying on our current program of reactive work requests, mostly time-based OEM suggestions, potentially unjustified work that work that we’ve always done, we create a process that is based on an understanding of the relative risk of the asset, followed by a technically sound failure analysis using a formal work identification methodology, to understand all of the asset’s failure modes.

Using one or more of these work identification methodologies, we then define, for those failure modes that will be managed through the maintenance function, the complete Asset Reliability Program, or the list of tasks that will be used to mitigate the consequences of those failures. About 80% of the Asset Reliability Program tasks will on average be health based, requiring that we define normal and non-normal values, and corresponding alarms. With this process we maximize the extent to which our maintenance function is proactive, and we therefore improve the bottom line through improved reliability.

Kaizen

Kaizen, like Lean, focuses on eliminating waste and continuous improvement. Kaizen is about empowering employees to get involved with their own work organization. With a Kaizen mindset, the employee that does a job is the expert of that job. Maintenance supervisors are typically encouraged to lead structured improvement efforts in their own work areas. Kaizen helps the supervisor to stimulate his employees’ creativity. While this philosophy has merit on its own, the missing element that would enable a sustainable change is a proactive asset reliability process supported by appropriate tools and practices. Nevertheless, the philosophy is a good one and guides the people responsible for creating and implementing Lean Reliability.

5S

5S in the traditional manufacturing world, is a methodology for organizing the workplace. It involves sorting, setting in order, shining, standardizing and sustaining the environment. 5S can be applied to Lean Reliability as follows:

SORT – Organize assets based on risk, allow maintenance and operations efforts to be jointly focused on the right targets for improved asset reliability and plant performance. When "sorting" is well implemented, communication between workers is improved.

SET IN ORDER – Organize the work - create sound asset reliability programs. Ensure you are doing "the right work at the right time". Use a work identification methodology that delivers a technically sound program. Involve operators and maintainers and create and implement the asset reliability programs one asset at a time.

SHINE – Take pride (and ownership) in the reliability of assets. Identify the health of an asset based on indicators.

STANDARDIZE – Focus on standardizing maintenance work. In pre-planned job packages, document everything needed to perform the maintenance work to save time and avoid the potential for a self-induced failure. Maintenance labor loss and precious production downtime is kept to a minimum. Orderliness and control is the core of "standardization".

SUSTAIN – Focus on discipline and commitment; without a focus on "sustaining" reliability, you can easily revert back. Crucial for your team to be trained on the process and equipped with supporting practices and tools. Employees empowered to make decisions.

Six Sigma

Six Sigma focuses on removing defects (failures) and reducing variation in a process. Six Sigma uses a variety of statistical analysis tools to analyze reliability data. The best application of Six Sigma in Lean Reliability is through Six Sigma's DMAIC Process. We can overlay the DMIAC Process on top of the Lean Reliability Process – a perfect fit.

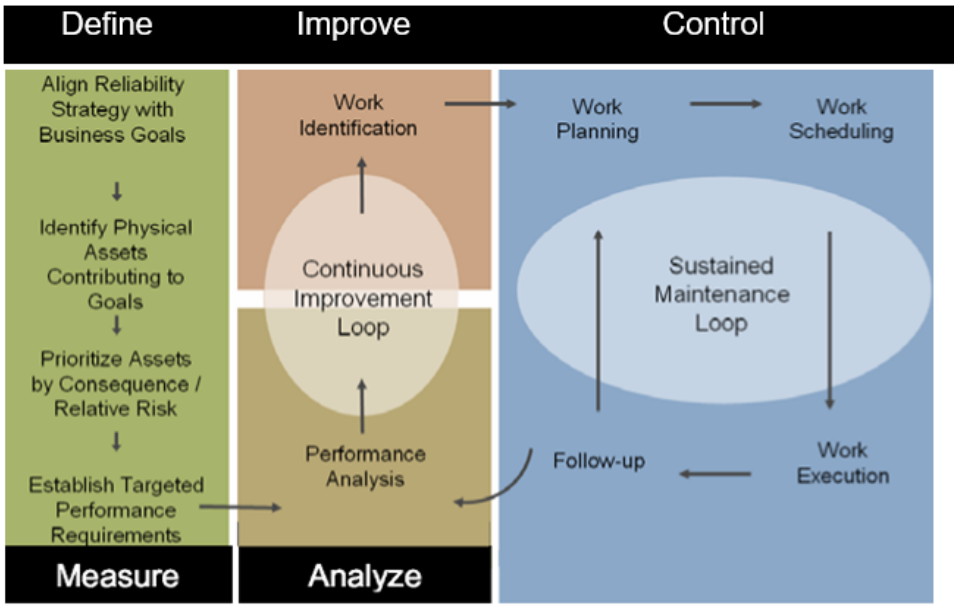


Figure 7.2.12 The DMAIC Asset Reliability Process

Step 1: **Define** a reliability strategy and plan aligned with the goals of the company. To define where to focus efforts, prioritize assets according to relative risk to the business. Relative risk must be calculated (consequence of failure multiplied by frequency or probability of failure).

Step 2: **Measure** the level of the reliability and performance for the highest priority assets. To measure asset utilization, ensure that availability is consistently measured and includes both planned and unplanned downtime).

Step 3: **Perform** an Analysis on the asset working with operators and maintenance together. Your goal in the early stages should be to put in place proactive asset reliability programs for your critical assets (starting with highest priority). Statistical methods like Weibull can be used to analyze the performance.

Step 4: Continuously i**mprove** the asset's reliability program using a formal work identification methodology. For example, you may choose to use Reliability Centered Maintenance, or Maintenance Task Analysis to get started quickly. The method of work identification you use for an asset should be determined by the level of knowledge and definition (documentation) of an asset's current reliability program and the relative risk of the asset to the business.

Step 5: Develop a **Control** plan for Maintenance and Operations. An asset's proactive asset reliability program dictates a new way of life for tradespeople and Operators – including a new sense of ownership and willingness to care for assets.

Six Sigma's DMAIC process can add quick value to a Lean Reliability initiative.

Key Elements to Implement and Sustain Lean

When implementing any Lean initiative, there are key elements to successfully implementing and sustaining the improvement. The elements are the areas which will bring true success to your initiative.

Education: Education is so important for personnel from senior management to floor level personnel to truly understand all aspects of Lean Reliability impacts the operation. Everyone in a plant should understand the definition of reliability and what it means to the success of the company. Operators and maintenance personnel need to understand the reality of how equipment fails and learn to manage asset health.

Getting Support from Senior Management: The easiest and fastest way to get support from Senior Management is to develop the business case. The business case must be developed with Plant Leadership Team identifying the opportunity based on the business goals of the company.

Business Plan Savings

	Year 1	Year 2	Year 3	Accumulated Savings
Maintenance labor savings	$800,000	$1,200,000	$2,000,000	$4,000,000
Maintenance materials savings	–$200,000	$300,000	$1,100,000	$1,200,000
Capacity net profit	$2,737,500	$5,475,000	$8,212,500	$16,425,000
Total savings	$3,337,500	$6,975,000	$11,312,500	$21,625,000
Reliability initiative cost	–$3,200,000	–$600,000	–$120,000	–$3,920,000
Net savings	$137,500	$6,375,000	$11,192,500	$17,705,000

It should include an assessment to determine gaps between current and future state and identify specific opportunities for improvement, both financial and non-quantifiable impacts. An action plan should also be included with cost and a return on investment before you will obtain senior management support. Without executive support, the entire project is a waste of time – it either won't get off the ground, will not succeed or will not be sustainable. When assessing the organization and setting the plan, ensure employees are involved so later they feel the ownership and are empowered to make decisions.

MAINTENANCE / RELIABILITY ASSESSMENT

The biggest challenge organizations face is to know the status of their current maintenance and reliability process and developing a plan to close the gap between current and desired performance.

In the next few pages, you will be given specific questions to answer in order to define the gap between your maintenance and reliability process current performance and what is defined as "Best Practices".

All answers should be a "yes" if not then this area may need to be explored in more depth. If you are unsure about the question or answer, then the question answer is a "no".

Remember this assessment is only used to help an organization determine its gaps between current and desired performance.

It is recommended this assessment is performed with representatives from all state holders. This includes plant manager, maintenance and engineering manager, production management, operators, maintenance personnel, maintenance planners, storeroom management, etc.

Score totals:

0 - 500 = Total Reactive / Reliability principles are not understood or applied

- Need to educate all management and engineering in reliability and develop a reliability strategy for serious change. Need to develop a business case to define the opportunity immediately. (attend training in Maintenance and Reliability Best Practices)

501 – 700 = Emerging (long way to go)

- Need to develop a business case and reliability strategy with timeline, targets, and objectives.

701 – 850 = Proactive (continue the journey, you are headed in the right direction)

- Need to ensure continuous improvement process is built into your asset reliability process. Identify gaps in the assessment and fill the gaps.

851 – 1000 = World Class

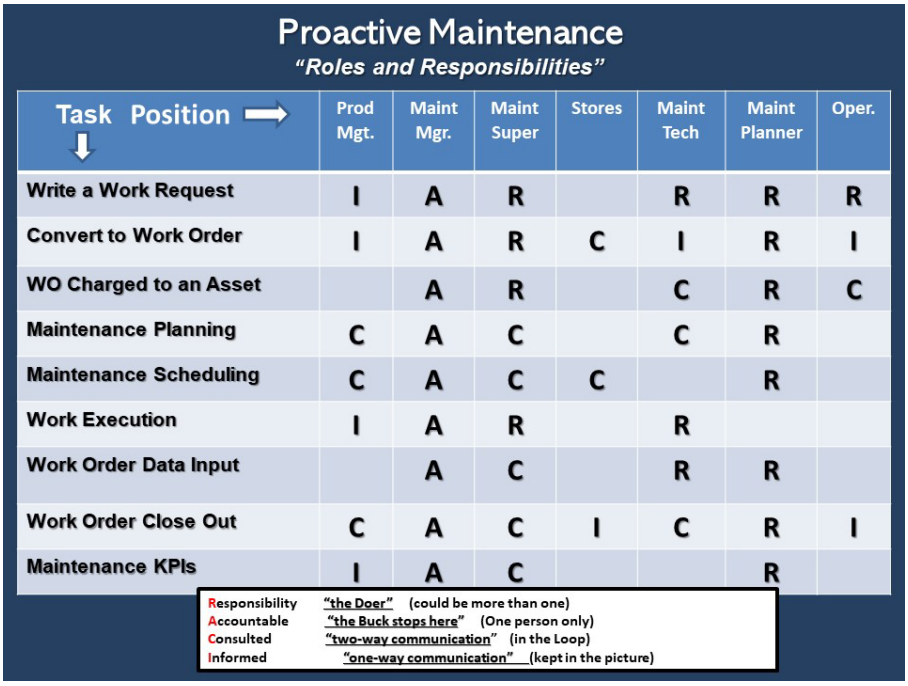
- Hire an outside reliability consulting firm to assess your current stated and make recommendations for any change required. Great job.

Effective Change Management: Implementing Lean Reliability is all about people. Changing the way people think - the culture of a company - is very difficult. Don't expect to change the culture within the plant overnight. Change happens gradually. With the right practices and tools to support a Lean project, you can implement one asset at a time and realize a significant ROI faster than you would expect. Remember the 5S and the DMAIC process and focus on one asset at a time. This will provide the change you need, and it will be sustainable change.

Technology Support: Technology can make a data intensive process easier to manage. Ensure the systems you choose can be integrated and work effectively together.

Value stream mapping: This mapping process is critical to the success of Lean. It is used to determine current work processes against future state eliminating non-value-added elements of the process. In manufacturing, this refers to workflow processes for product output. In reliability, **this refers to the workflow processes for reliability output such as asset criticality assessment, work identification, planning, scheduling, etc.**

Roles and Responsibilities defined: Map the tasks required to manage and execute the asset reliability process to the roles required in the organization and to the responsibilities of those people associated with equipment reliability. The goal is to ensure that improved equipment performance is achieved and sustained. The output of the workshop is clearly defined role descriptions with associated responsibilities. Everyone must focus on executing the asset reliability process. Start by analyzing the business process tasks, and then identify the duties required for each role to ensure that optimal equipment performance is sustained.



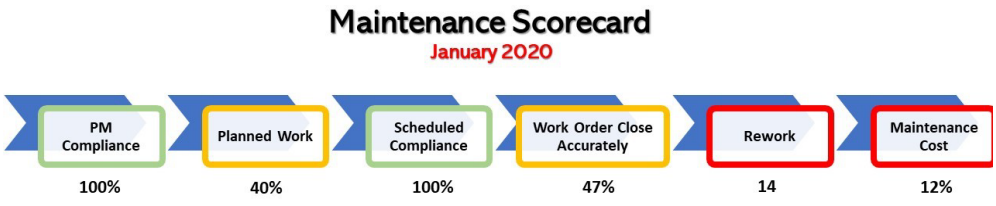
Proactive Maintenance

"Roles and Responsibilities"

Task ⇩ Position ⇨	Prod Mgt.	Maint Mgr.	Maint Super	Stores	Maint Tech	Maint Planner	Oper.
Write a Work Request	I	A	R		R	R	R
Convert to Work Order	I	A	R	C	I	R	I
WO Charged to an Asset		A	R		C	R	C
Maintenance Planning	C	A	C		C	R	
Maintenance Scheduling	C	A	C	C		R	
Work Execution	I	A	R		R		
Work Order Data Input		A	C		R	R	
Work Order Close Out	C	A	C	I	C	R	I
Maintenance KPIs	I	A	C			R	

Responsibility "the Doer" (could be more than one)
Accountable "the Buck stops here" (One person only)
Consulted "two-way communication" (in the Loop)
Informed "one-way communication" (kept in the picture)

Key Performance Indicators: KPIs in Lean begin with the manufacturing KPIs (quality, throughput, OEE, asset utilization, safety) and all other KPIs must align to them. KPIs should be defined as leading and lagging. The key lagging (or results) indicators for reliability are failures (MTBF is the recognized measure of reliability), downtime attributed to maintenance and cost. These KPIs will demonstrate everything done right, or wrong in a lean process. Lagging indicators cannot be managed because they are the results of everything done. Leading (or process) indicators provide an indication of where problems are occurring before they affect the lagging indicators. Leading indicators are what we manage. Reliability process metrics are identified to drive specific actions in the process.



There are many other valuable metrics that can be identified for the purpose of benchmarking, but we focus on the metrics that drive the execution of a successful reliability process and directly measure its impact. As an example, wrench time is a useful metric to benchmark maintenance efficiency, but it doesn't tell you what to do to improve it. However, by acting on process metrics for Planning, Scheduling and Execution, wrench time can be improved.

S u m m a r y

In today's competitive world Lean Reliability is key to a company's survival. Eliminating non-value-added tasks and continuously improving must be a part of everyone's daily life. As lean reliability progresses, reactivity begins to vanish, and a proactive Lean Asset Reliability becomes the focus. The hidden plant is finally found where the plant experiences more capacity and asset availability and lower cost than anyone ever imagined.

Do not think this journey is easy or without sacrifices because it is not. However, once you have traveled this journey you will never return.