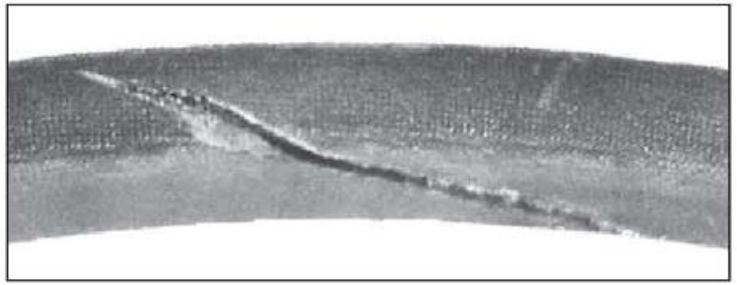
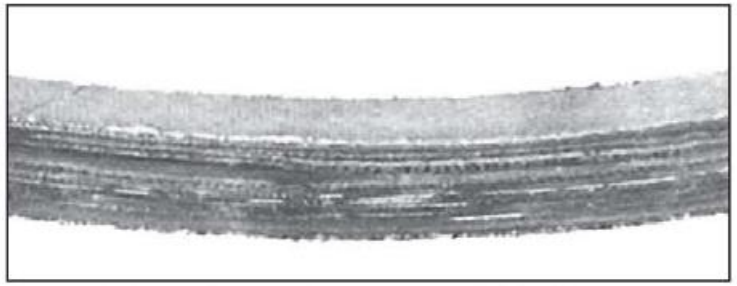
Preventive Maintenance Best Practices

By Ricky Smith CMRP

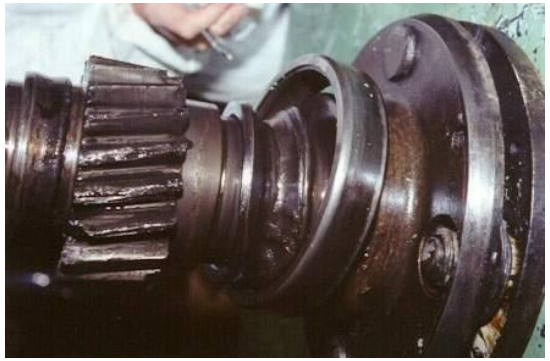
Insanity: “Performing Preventive Maintenance on equipment that continues to break down”



Cause of Failure — Cut bottom and sidewall indicate belt was pried over sheave and damaged during installation.
Correction — Be sure to use proper length belt and move tensioning all the way "in" when installing belt.



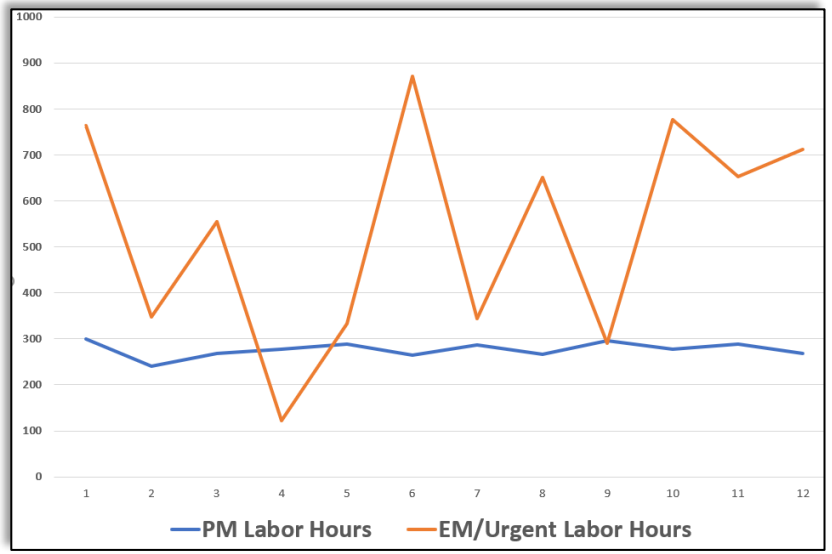
Cause of Failure — Constant slippage caused by insufficient tension in belt.
Correction — Tension drive in accordance with the recommendations of the equipment manufacturer and this manual.



Best Practices in Preventive Maintenance

The Fundamentals of Effective PMs

1. All Equipment PMs are focused on specific “Failure Modes”
2. All PM Procedures should have the following:
    - Step by Step Instructions (initial each step)
    - Specifications
    - Space available for extra information
        - Condition as found
        - Condition as left
        - Recommendation to changes to Procedure
3. When a PM Work Order is given to Maintenance Techs the following should be attached:
    - Equipment Failure history since last PM Executed
4. If a piece of critical equipment fails between PM cycles an RCA should be initiated
5. Post the following metric in Maintenance Shop on a line graph
    - PM Labor Hours vs EM/Urgent Labor Hours



“Measure what you Manage”

An Example of the Hawthorne Effect for Behavior Change in PM using this metric, PM vs EM /Urgent Labor Hrs.

Best Practices in Preventive Maintenance

A Best Practice is a method or technique that has been generally accepted as superior to any alternatives because it produces results that are superior to those achieved by other means or because it has become a standard way of doing things

What to do if Preventive Maintenance is not Meeting Expectations

Step 1: Acknowledge you have a problem with your PM Program not meeting expectations

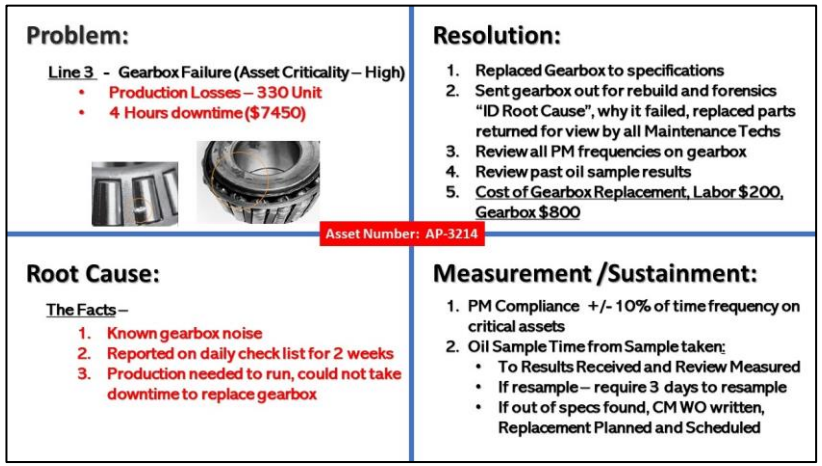
Step 2: Assemble a team of Maintenance Techs, Maintenance Supervisor and operators

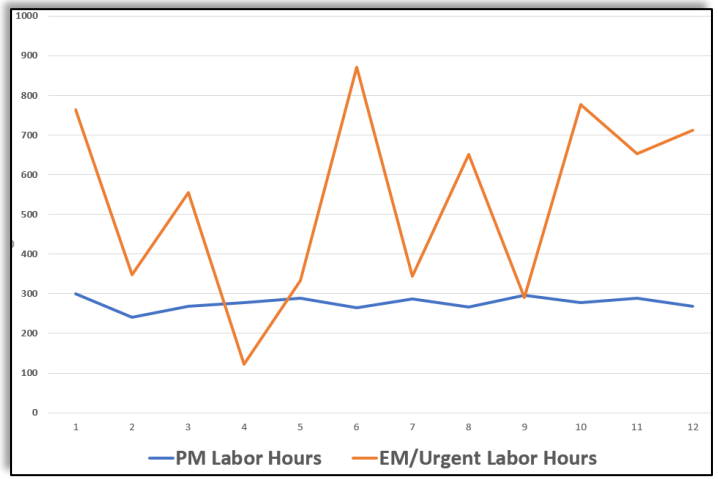
Step 3: The PM Optimization Team establishes their Vision, Mission, and Guiding Principles approved by Maintenance, Production and Plant Leadership and meet weekly for 30 minutes max (FOCUS)

Step 4: Identify the equipment have the most losses, ie. OEE, Production loss, EM/Urgent Labor hrs., etc.

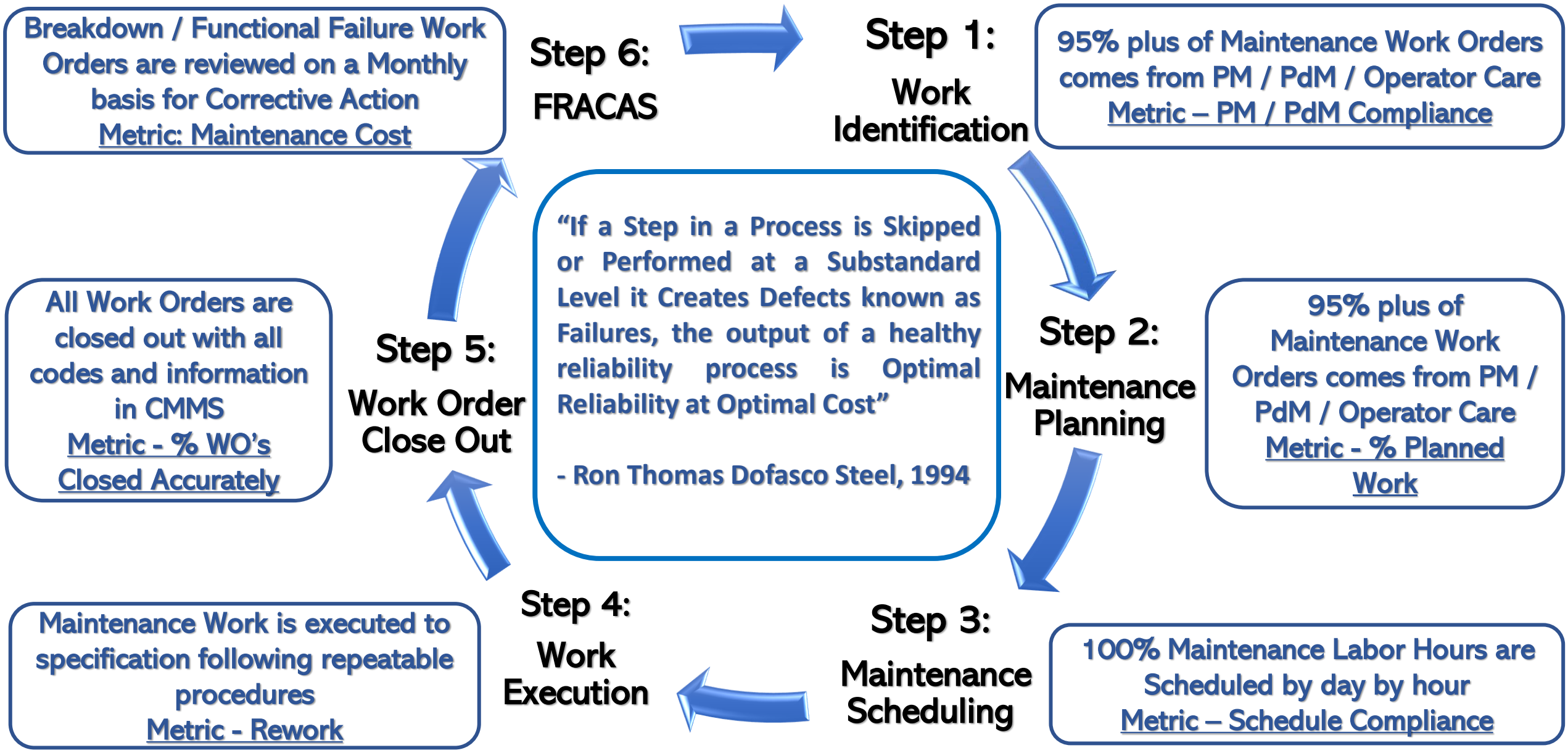
Step 5: Post a Dashboard to measure progress and effectiveness of this Program

Step 6: Create a PM Problem/Solutions Board using the A3 Approach to problem solving





Proactive Maintenance Continuous Improvement Loop



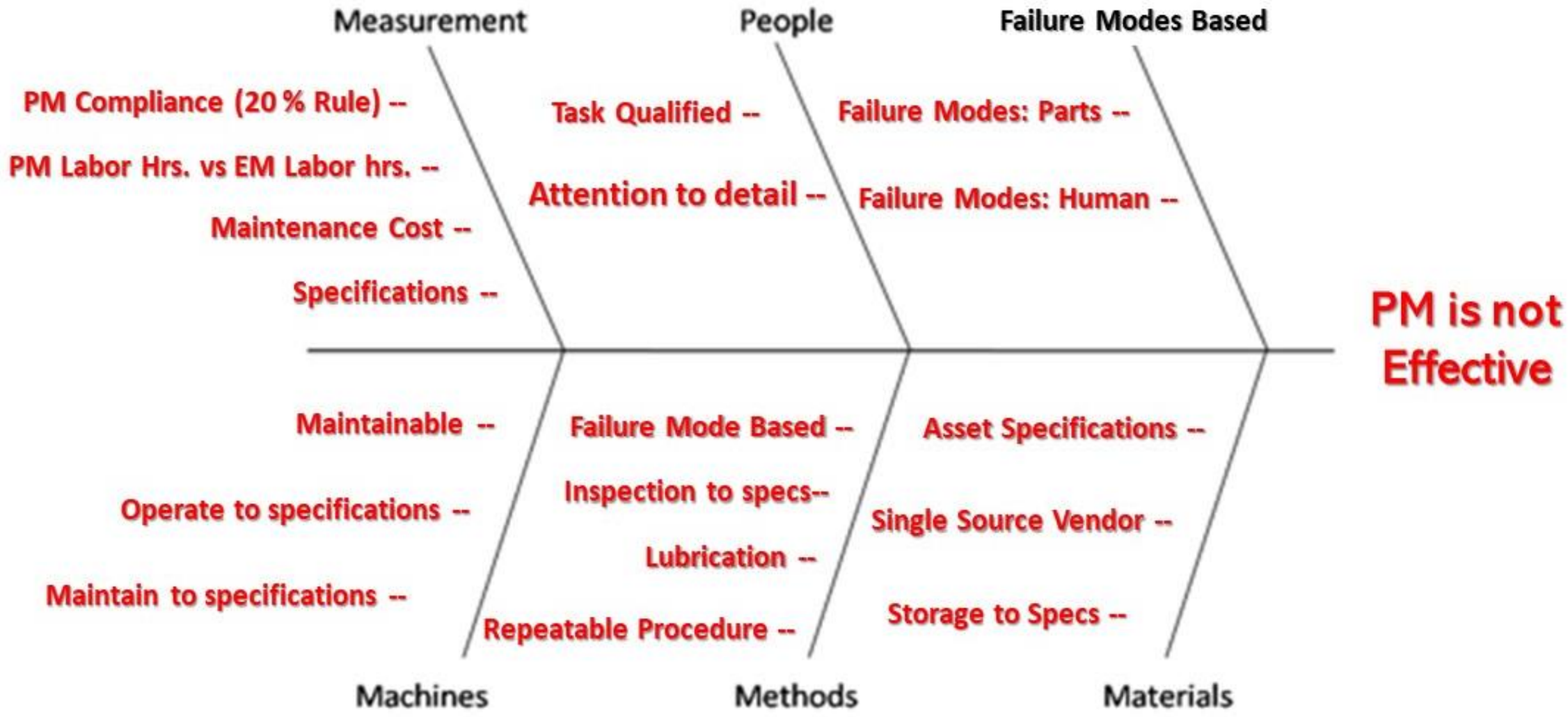
Reliability Dashboard by Asset – Gypsy Paper

Board Line

2019

Line Assets	# of Failures	Production Losses	EM/Urgent Labor Hrs.	PM Compliance
Board Infeed	127	1123	346	100%
Conveyor	21	489	469	100%
Press Unit	2	2312	18	98%
Hydraulics	47	324	110	95%
PLC / DCS	8	978	943	100%
DocArm Lift	64	1934	86	98%
Total	269	7160	1,999	99.8%

Preventive Maintenance Ishikawa (Fishbone)



Ishikawa diagrams are causal diagrams created that show the causes of a specific event or activity (Preventive Maintenance).
Common uses of the Ishikawa diagram are to identify potential factors causing an overall effect. Each cause or reason for imperfection is a source of variation.

Preventive Maintenance

- Preventive maintenance (PM) is an equipment maintenance strategy based on replacing or restoring an asset on a fixed interval regardless of its condition.
- Scheduled restoration and replacement tasks are examples of preventive maintenance.
- To inspect, adjust, lubricate are preventive maintenance task

“Without Definitions we have Chaos”

Operator Care

- **Operator Care is used to identify defects or problems conducted during their normal workday.**

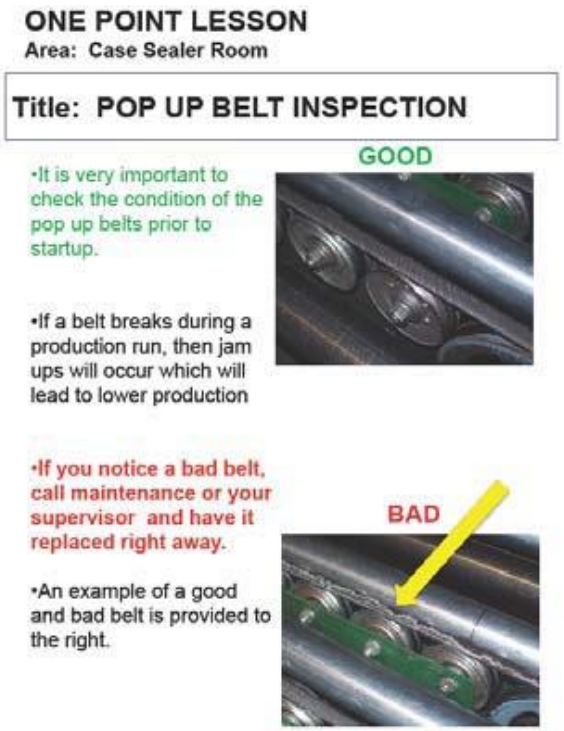
- **They must be simple, visual, and easy to identify as part of their normal activity.**

- **Operator care use of Visual Controls**

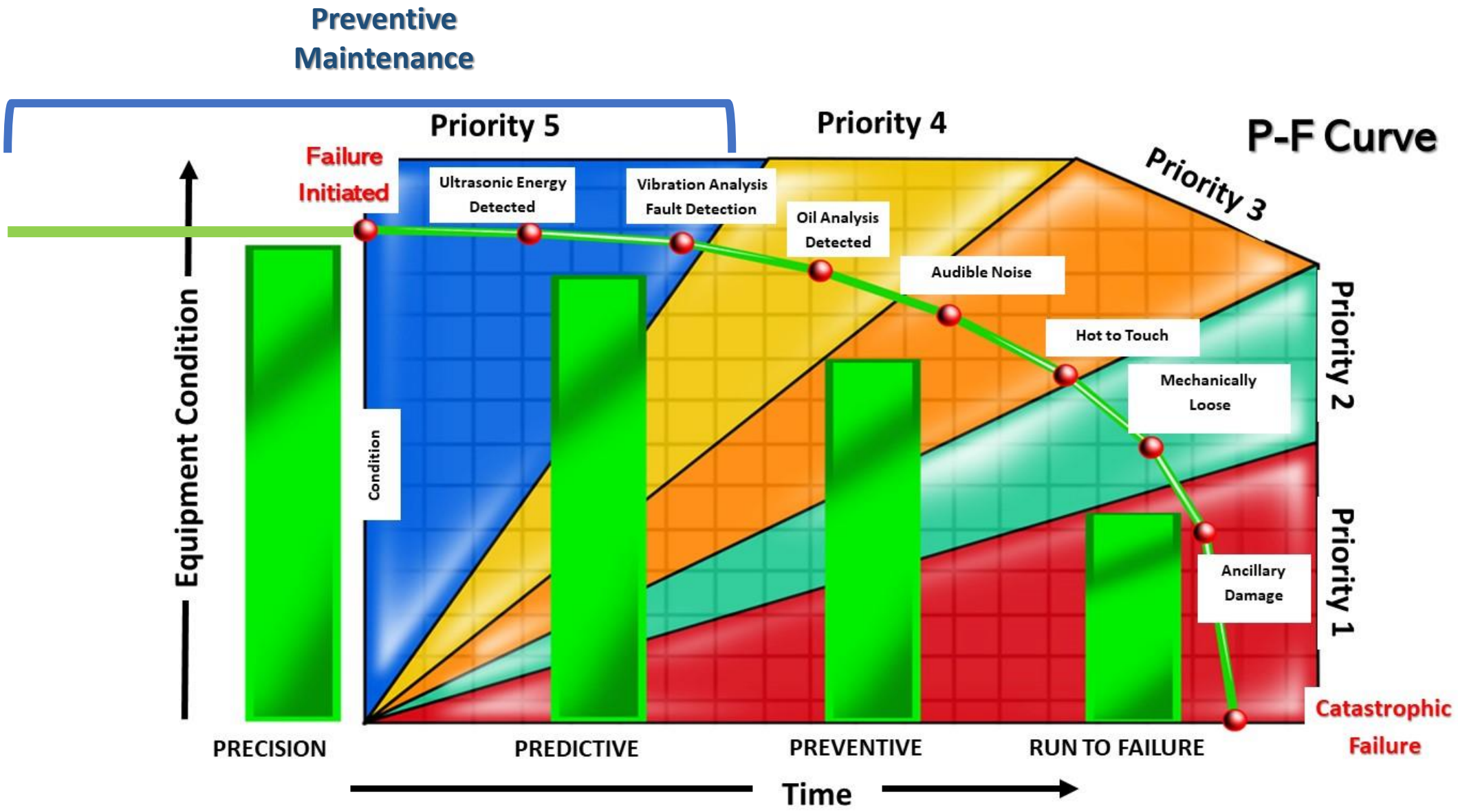
  <u>Visual controls can be used to:</u>

  - Improve the Speed and Accuracy of Inspection
  - Reduce Confusion
  - Ensure Consistency

Simple applications such as the marking of gauges and level indicators, match marking base bolts, or labeling equipment can greatly enhance inspection performance and engagement.



Preventive Maintenance and the PF Curve



Preventive Maintenance Definition

Source: SMRP Metrics

- Preventive maintenance (PM) is an equipment maintenance strategy based on replacing or restoring an asset on a fixed interval regardless of its condition.
- Scheduled restoration and replacement tasks are examples of preventive maintenance.
- Inspect, Adjust, and Lubricate

Preventive Maintenance Metrics

Source: SMRP Metrics

- PREVENTIVE MAINTENANCE HOURS

The maintenance labor hours to replace or restore an asset at a fixed interval, regardless of its condition. Scheduled restoration and replacement tasks are examples of preventive maintenance.

- PREVENTIVE MAINTENANCE COSTS

This metric is the maintenance cost that is used to perform fixed interval maintenance tasks, regardless of the equipment condition at the time. The result is expressed as a percentage of total maintenance costs.

- PREVENTIVE / PREDICTIVE MAINTENANCE YIELD

This metric measures the volume of corrective maintenance work that results directly from preventive maintenance (PM) and predictive maintenance (PdM) work orders.

The measure is the amount of repair and replacement work that is identified when performing PM or PdM work compared to the volume of PM or PdM work being done.

Preventive Maintenance Vision Statement

A Holistic Integrated Approach that Identifies and Mitigates Defects That Lead to Unscheduled Downtime and Reduces Total Cost of Ownership

Preventive Maintenance Mission Statement

High Integrity of Managing Assets to Become World Class:

“Optimal Asset Reliability at Optimal Cost”

enabling

“Optional Process Reliability at Optimal Cost”

Preventive Maintenance Guiding Principles

- **Preventive Maintenance is the most important routine function** that maintenance personnel must accomplish to specifications
- **Preventive Maintenance must meet expectations of Production** consistently (***Optimal Process Reliability***)
- **Preventive Maintenance must be measured and managed** using the right **Leading and Lagging KPIs**. ***(Leading KPIs lead to results, Lagging KPIs are the results)***
- **PMs must be evaluated for effectiveness** if equipment failures are occurring.
- **Maintenance Techs are involved in** PM Evaluation and Optimization

PM Optimization Process

1. Identify a cross functional team (Operator, Maintenance Tech, Reliability Engineer, Maintenance Planner)
2. Establish expectations from everyone engaged in this process
3. Define end goal of this process
4. Define how you will measure if the PM Optimization Process is effective or not
5. Present copies of PMs to all parties
6. Review equipment history for the past 30, 60, and 180 days
   - # of breakdowns
   - Causes of critical breakdowns based on a formal RCA
   - PM Labor Hours vs EM/Urgent Labor Hours
7. Review Current PMs and PdMs to identify:
   - PM procedure may need to be rewritten
   - Training which may be required
   - PM Frequency may be inaccurate and may need to be adjusted
   - If the equipment is in a "Maintainable Condition"
8. Rewrite PMs or write new PMs
9. Monitor and measure is these new PMs are effective

PM Task Action Recommendation	# of Tasks	% of Tasks	Man-Hours Represented
Non-Value Added (Delete)	1,640	8.2%	6,661
Reassign to Operator Care	1,380	6.9%	5,605
Reassign to Lube Route	2,856	14.3%	11,600
Replace with PdM	6,437	32.2%	28,222
Re-Engineer	5,200	26.0%	26,221
No Modifications Required	2,487	10.4%	8,987
Totals	20,000	100.0%	87,297

Preventive Maintenance Problems / Solutions

"Insanity: Performing PM on equipment that continues to break down"

PM Activities	PM Metrics	Possible Problem	Possible Solution
Inspection	PM Effectiveness (MTBF)	• PMs Not focused on Failure Modes • Ineffective measurements • No step by step procedure • No verification PM completed to specifications • Personnel not following procedure	• Engage Maintenance Techs in evaluating PMs • Post line graph: PM labor hrs. vs EM/Urgent labor hrs.
Lubrication	PM Compliance (Using the 10% Rule)	• Measurements with high variation • Lack of training in Best Practices • No oversight by Maintenance Leadership	• Determine type and amount of grease required • Inspect lubrication process
Time Based Change Out	Schedule Compliance (by day by hour)	• Asset unavailability • Maintenance Planning and Scheduling not effective	• Planning and Scheduling training for planners and leadership
Operator Care	PM Compliance (by shift) PM Effectiveness	• No specifications on PM • Lack of Reporting for corrective action • Lack of Management support	• Measure effectiveness of PM Compliance of Operator Care

Effective Procedure Execution

Written Procedures

NORIA STANDARD PROCEDURES

Sampling Procedure NSP-S-002.01

Drain Port Location

General Considerations

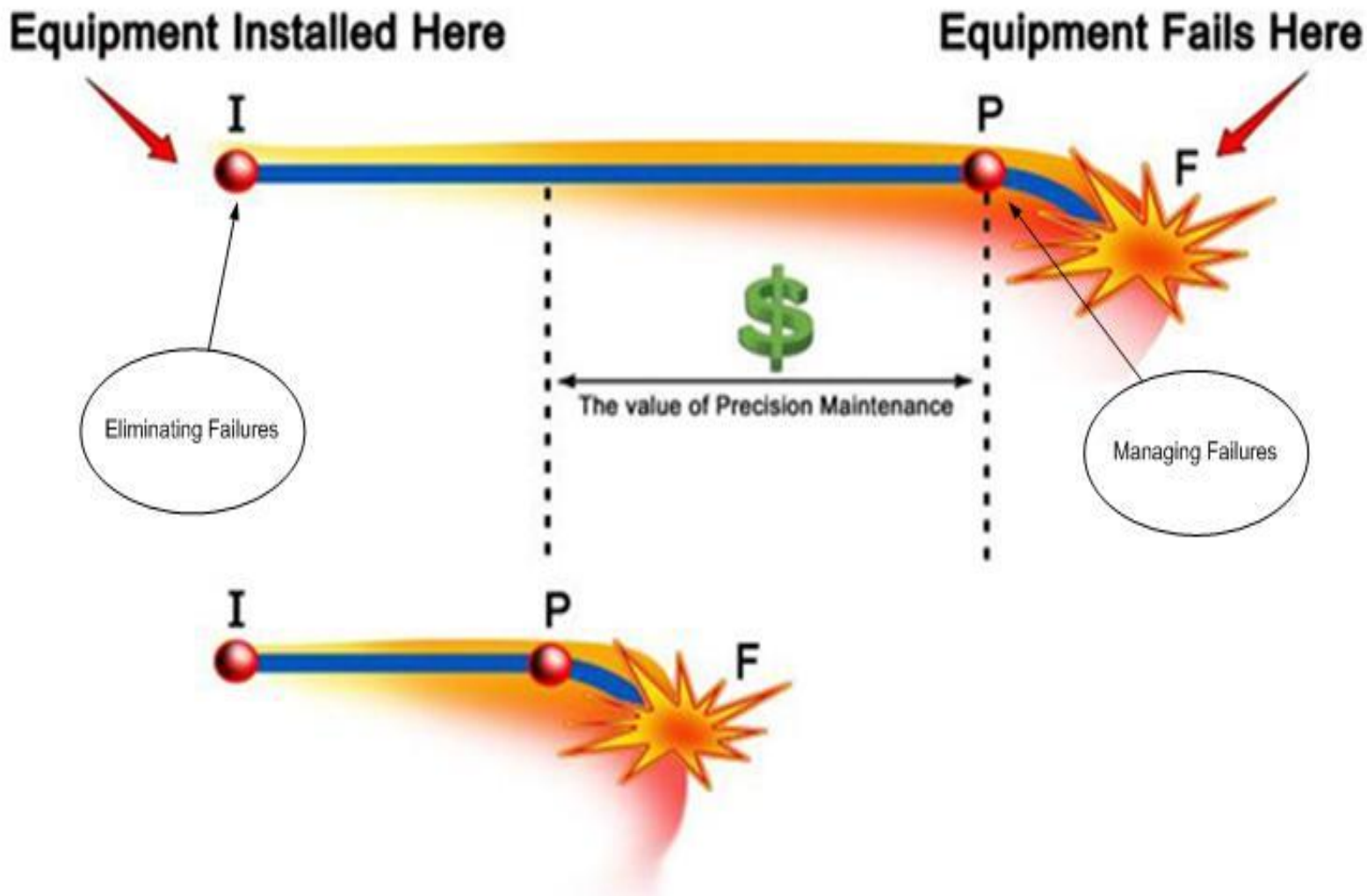
Sampling Procedure
Drain-Port Location

Material Requirements for Obtaining a Sample

Sampling Procedure

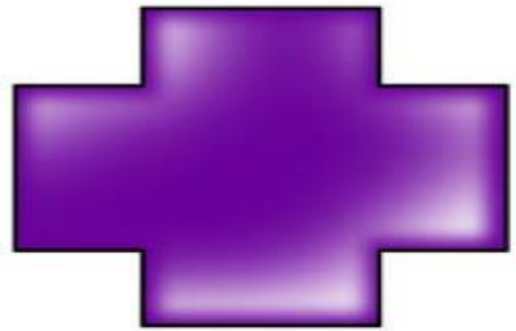
- **Clearly Define Best Practice**
- **Consistency and Continuity**
- **Reinforce Best Practice**
- **Define Training and Certification**
- **Enable Quality, Safety and Environmental Compliance**

Our Goal


Equipment Installed Here
Equipment Fails Here
I
P
F
Eliminating Failures
The value of Precision Maintenance
Managing Failures
I
P
F

PM Evaluation

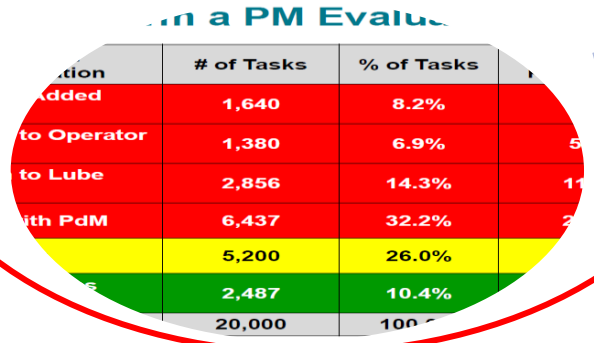
Break each Sample PM into Tasks



Total PM Tasks and Man-Hours

Categorize PM Task Recommendations

Use Template Provided



	# of Tasks	% of Tasks	
dded	1,640	8.2%	
to Operator	1,380	6.9%	5
to Lube	2,856	14.3%	11
ith PdM	6,437	32.2%	3
	5,200	26.0%	
	2,487	10.4%	
	20,000	100	

Break PMs into Task

Total PM Task and Labor Hrs

Categorize PMs into Task Recommendations

Identify Task by …

Eliminate Task based on Non-Valued added

Begin the Process

PM Task Action Recommendation	# of Tasks	% of Tasks	Man-Hours Represented
Non-Value Added (Delete)	1,640	8.2%	6,661
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Preventive Maintenance for Maintainable Equipment

"Roles and Responsibilities"

Position → / Task ↓	Maint Super	Rel Engr.	Maint Supervisor	Maint Techs	Maint Planner	Ops Line Manager	Plant Mgr.
ID Most Critical Asset	I	R	R	R	I	A	I
ID all Components	A	R	C	C	C		
How will each Component Fail	A	R		C	C	C	
Write PM Repeatable Procedure	A	R	C	R	C		
Measure PM Effectiveness	C	R	R	R	C	A	I
Equipment/Process Reliability	R	R	R	R	R	R	A

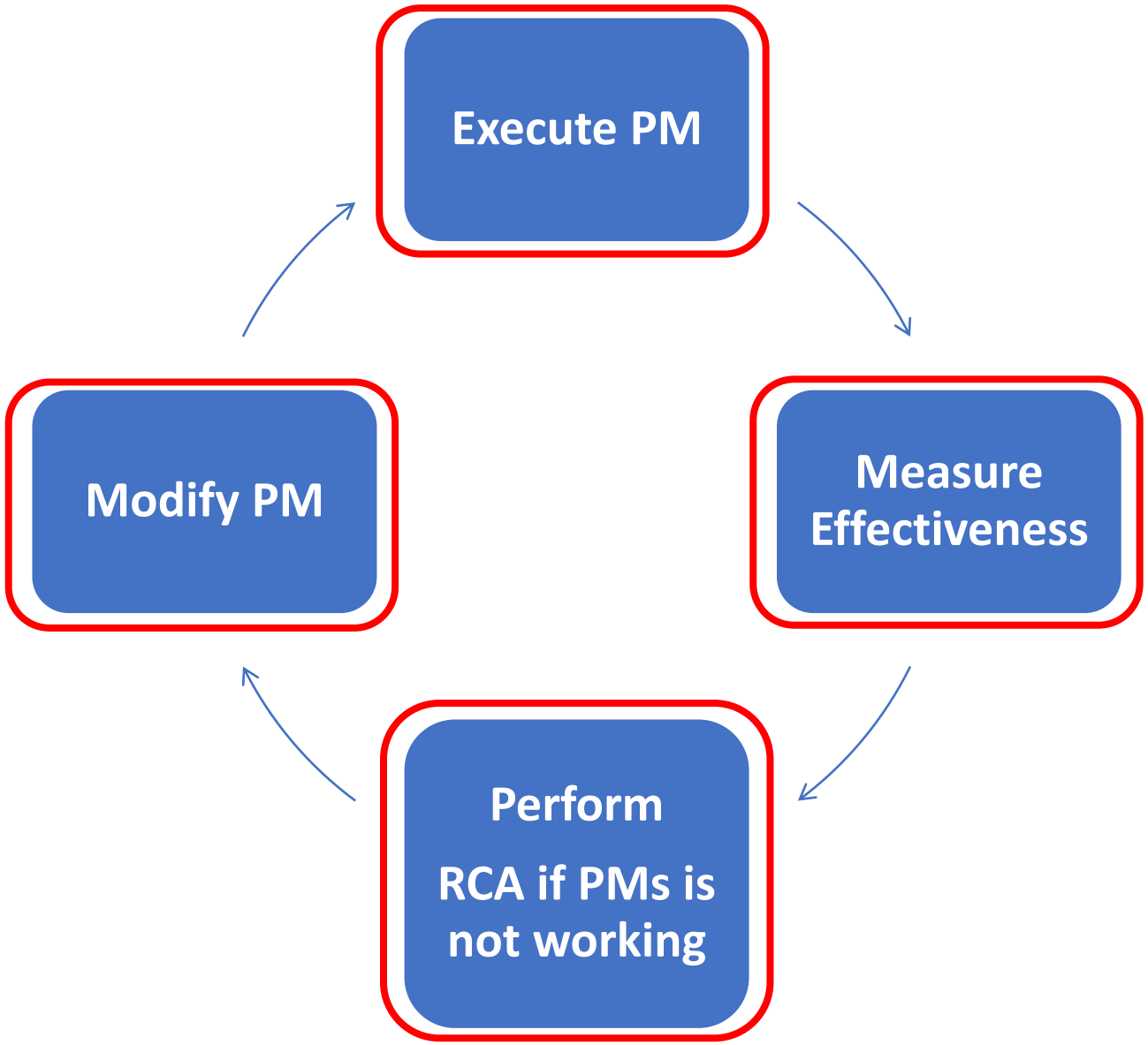
Responsibility	**"the Doer"**
Accountable	**"the Buck stops here"**
Consulted	**"in the Loop"**
Informed	**"kept in the picture"**

PM Metrics

- **Identify Metrics to measure:**

1. **# of PMs Schedule for week**
2. **# of breaks to schedule (break ins)**
3. **Schedule Compliance**
4. **% of Planned Work**
5. **Rework**

Implement, Measure, Manage and Adjust



Recommendations

1. Update Criticality Analysis on current assets
2. Perform PM Evaluation on the most critical assets first
3. Modify PMs based on PM Evaluation conducted with Maintenance Techs and Operators
4. Create a Preventive Maintenance Dashboard with 4-6 metrics
5. Hire outside source to identify why Maximo cannot meet the requirement of Managing Asset Management Effectively
6. Focus on Optimizing Process Reliability through increased equipment availability and performance with an effective PM Program
7. Repeatable Procedures are required for all Maintenance Activity

Questions?

Learn…

- Preventive Maintenance Known Best Practices
- Create an PM Dashboard
- The number of times a PM inspection should identify a defect or abnormality
- When to use a GEMBA Walk to Optimize Preventive Maintenance
- Definition of Preventive Maintenance
- Maintenance and Operator PM Alignment
- Top 10 Reasons why Preventive Maintenance does not meet expectations and what to do not about it
- How PM Compliance can be misleading
- Learn how write an Effective PM Procedure
- Learn how to know if a PM is effective or not
- Describe the Objective of Preventive Maintenance
- Execute in a group environment Preventive Maintenance "hands on" exercises (over 20 exercises)
- Learn how to Measure if a Preventive Maintenance Function is effective
- How to engage Production to execute simple PMs
- Create Leading and Lagging Preventive Maintenance Metrics
- Define how to transition from current state to a Proactive Preventive Maintenance
- Learn and Practice how to conduct a PM Optimization in your plant/facility