
# SMRP BEST PRACTICES METRICS WORKSHOP

# Safety Topic


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# Reliability and Safety

- Reliability is a stable, trouble free, operation
- Unreliability is unscheduled downtime
- A reliable site prevents upsets, equipment failures and Unscheduled Downtime = less exposure to injuries.
- Unscheduled downtime creates the potential for people to get hurt when the unit goes off-line, when it's being repaired and once again when it's restarted.

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# Best Practices Metrics Workshop Abstract

How do you know which metrics truly matter? The Society for Maintenance & Reliability Professionals (SMRP) Body of Knowledge and Best Practices, 5th Edition, are the basis for this workshop. In this workshop, you'll gain insights into the latest thinking on maintenance and reliability (M&R) metrics. Attendees will learn how to use the metric hierarchy for linking M&R activities to an organization's strategy. Using this proven process, M&R practitioners will be able to make the business case for reliability to operations and leadership. M&R best practices will be discussed, along with how the metrics align with SMRP's five pillars in the Body of Knowledge. This hands-on workshop reviews the standard definitions and application of common metrics developed by the SMRP Best Practices Committee. Attendees will understand how to measure performance consistently, make valid comparisons and provide guidance to their organization on how to use SMRP metrics. The workshop is interactive; attendees will participate in activities using specific examples to apply and calculate metrics.

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# Learning Objectives

1. Understand SMRP's metric development practice
2. Increase the understanding of M&R metrics
3. Transfer knowledge about the application of metrics
4. Understand standardized metric calculation
5. Discuss the application of metrics
6. Review leading and lagging metrics
7. Identify critical data and how it impacts performance

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# Today's Agenda

1. Introductions and Workshop Objectives
2. History of SMRP and Metric Development Process
3. Sample Metric Calculations
4. Why Use Maintenance and Reliability Metrics
5. Group Exercise; Speedy Mac Reliability Products (SMRP)
6. Selecting the Right Metrics
7. Benchmarking
8. Critical Information Needs
9. Data Quality
10. Summary

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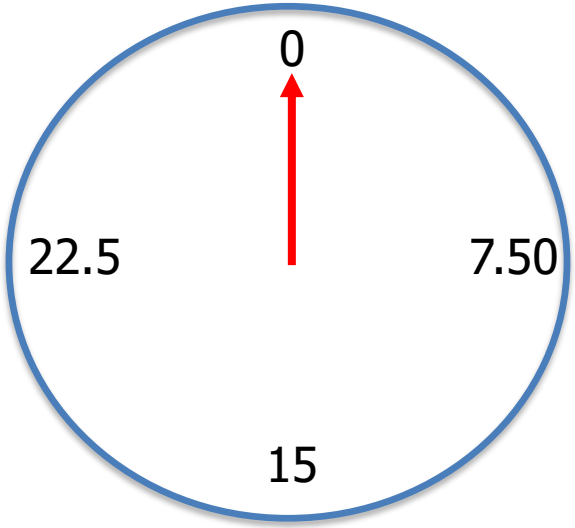
# Introductions

1. Your name and where do you live?
2. Who do you work for?
3. What's your job?
4. What is  your interest in reliability management?
5. What do you want to get from today's workshop?
6. Tell us an interesting fact about yourself

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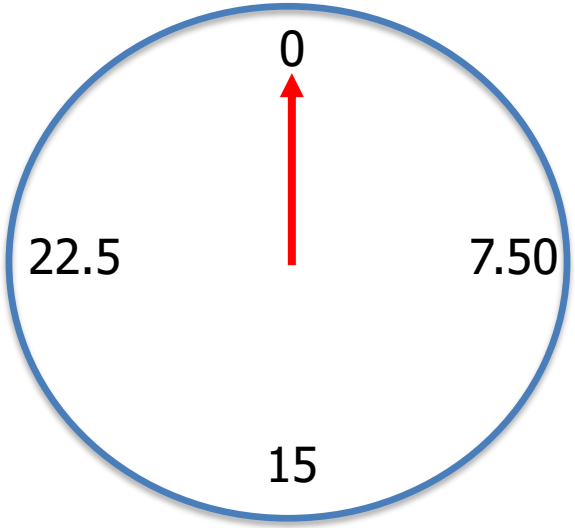


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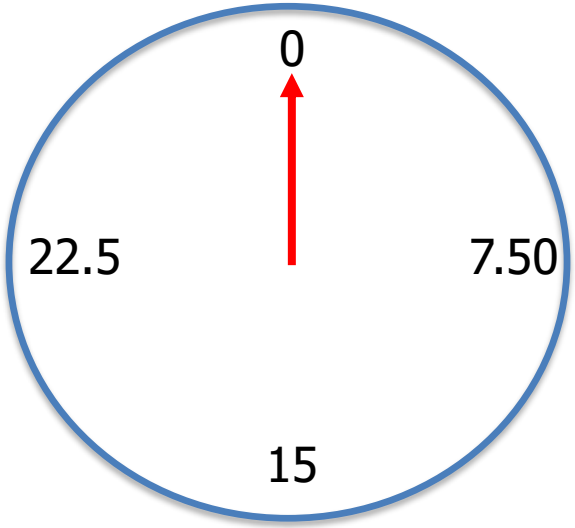


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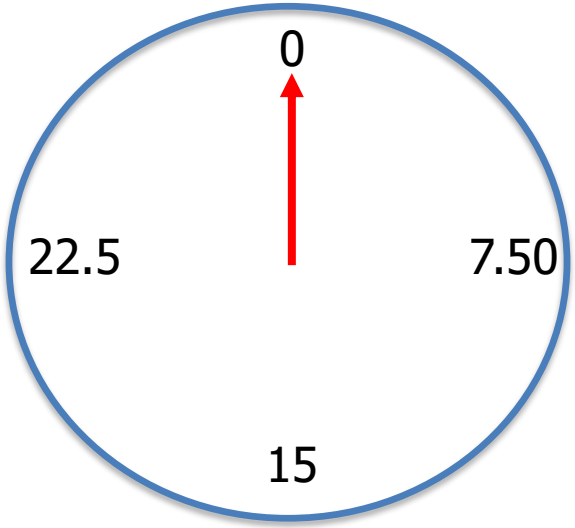


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# Instructor Biography

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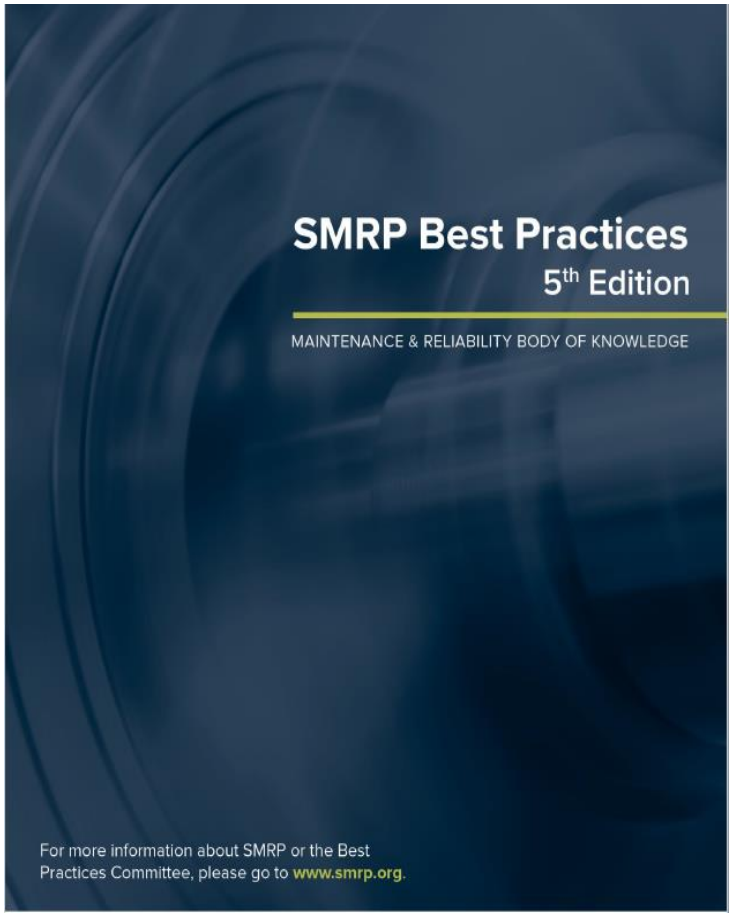
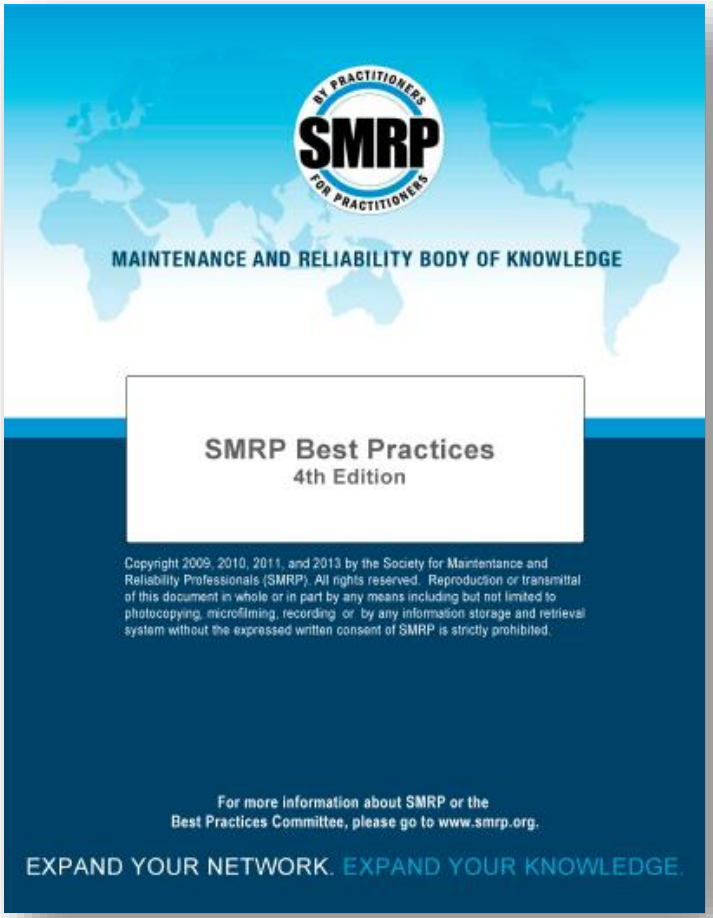
# Key SMRP BOK Documents

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# Today's Workshop is Interactive


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# Section 2:
# SMRP History and the Metric Development Process

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# Learning Objectives

1. Review History of SMRP
2. Understand the Metric Development Process
3. European Federation of National Maintenance Societies (ERNMS) and SMRP Harmonization Project

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# History of SMRP

- SMRP – Society for Maintenance & Reliability Professionals
- An organization “By Practitioners, for Practitioners”
- Formed and Chartered in 1992
- 6500+ members worldwide
- 210 Executive Company members
- SMRP’s certifying organization, SMRPCO, manages the certification program for M&R professionals

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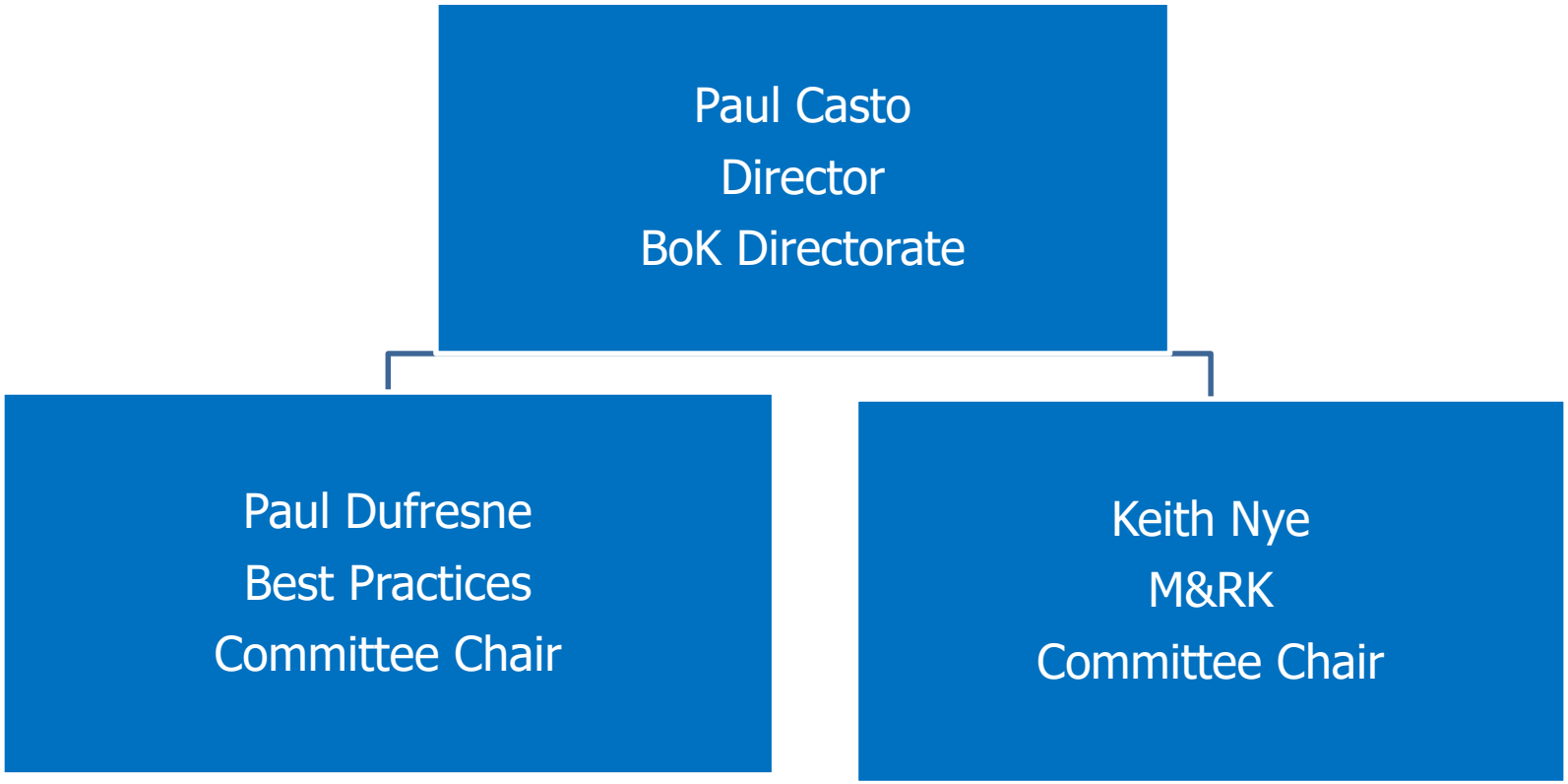
# BOK Directorate

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# Body of Knowledge Mission

Establish SMRP as a Global Authority on the Maintenance and Reliability Body of Knowledge for Best Asset Management Practices.

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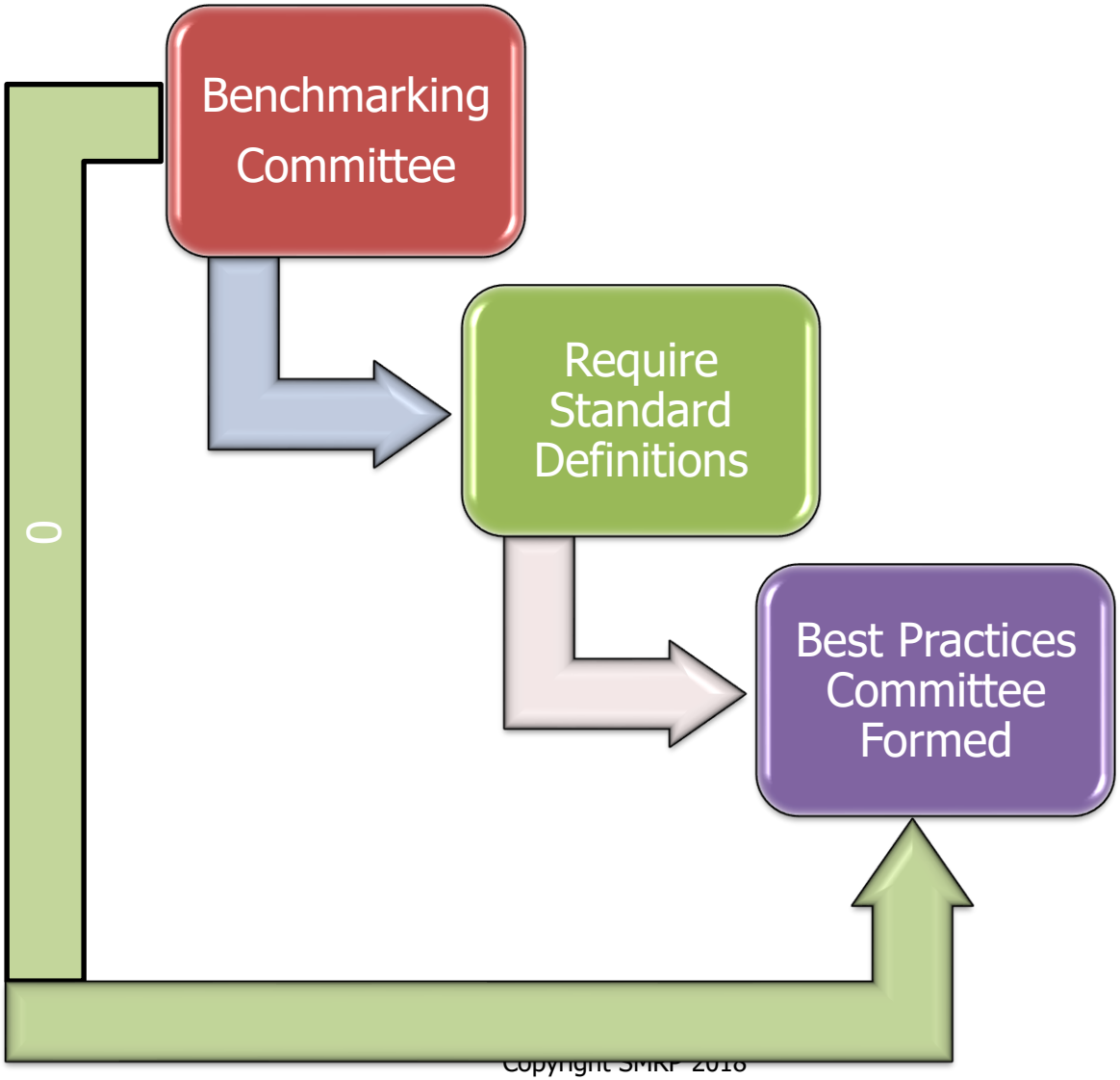
# SMRP Metric Initiative

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# Purpose of SMRP Metrics Initiative

1. Develop maintenance and reliability metrics using common terminology
2. Standardize M&R terms and definitions (Glossary)
3. Establish standard calculation methods for metrics
4. Provide a common platform to benchmark performance between peers and across industry verticals

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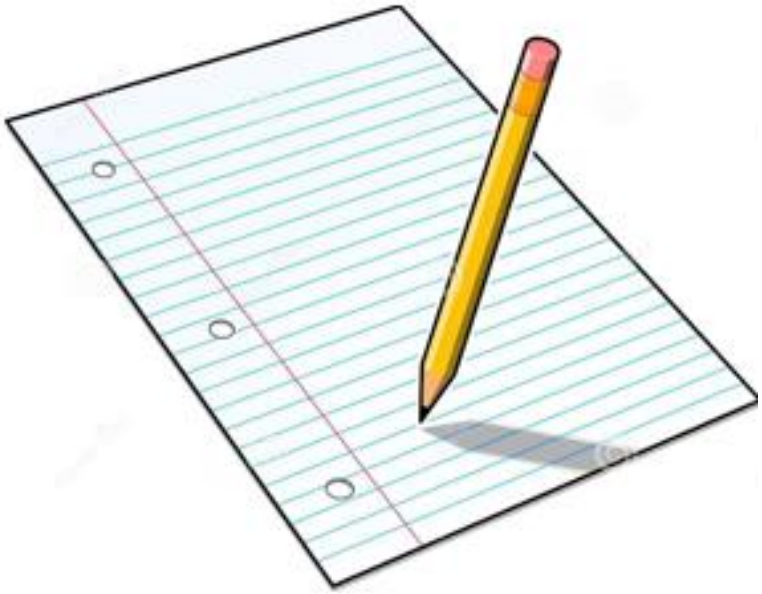
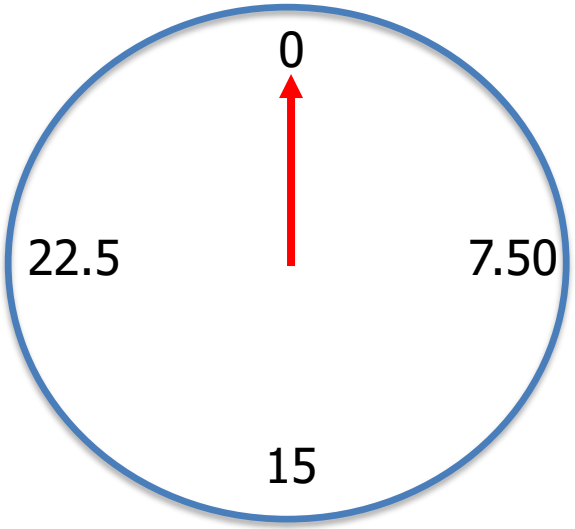
# Purpose of SMRP Metrics Initiative

Why do we need standardization and common terminology?

# Define Maintenance

Everyone grab your pen and write down your definition of maintenance and be prepared to read it to the class.



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# Defining Maintenance

The set of actions taken to ensure that systems, equipment and components provide their intended functions when required. (The primary focus of this definition is on maintaining the intended function of an item rather than its design performance.) Many designs provide excess performance capacity or endurance as an inherent characteristic of the design (e.g. the pump selected for a system may be rated at 100 gpm when the system design requirement is only 75 gpm). Maintenance that is oriented to sustaining excess capability not needed for operations expends resources without benefit. This is not good maintenance practice. This definition requires the function being maintained to be available when it is required. Since certain functions, such as weapons firing and overpressure relief, may not be required continuously, there may be a need to verify their availability. The terms "component, equipment and systems", as used in this definition, apply to hardware at a particular level where the analysis is being performed. This may be a system, a subsystem, equipment or component, depending on the specific task being examined.

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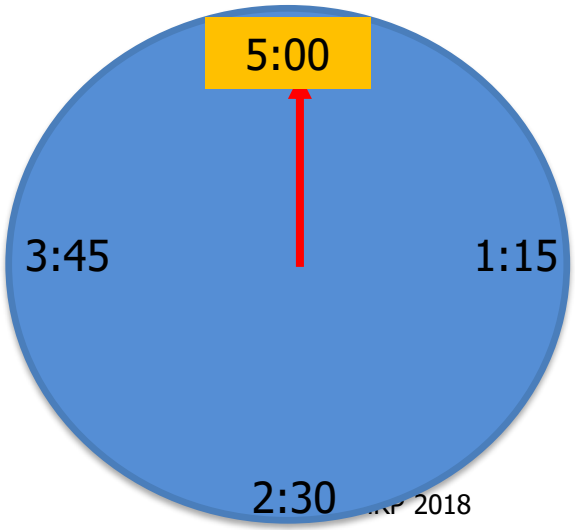
# Break into Groups

Take five minutes and describe what you think a good process would be to develop common, standard metrics



# What Did Your Group Agree On?

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# Metrics Development Process

| Select Most Commonly Used Metrics | Prepare Metric Description | Review Metric Description | Post on SMRP Website For Peer Review | Validate Metrics | Publish Metrics |
|---|---|---|---|---|---|
|  | Committee Member |  | SMRP Members |  | SMRP |
| Committee |  | Committee | CMRPs | Member Companies |  |
| | | | Industry/ Subject Matter Experts | | |
| | | |  | | |

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# Metric Definition Process

## Standard Approach to Defining Metrics

A. Definition
B. Objectives
C. Formula
D. Component Definitions
E. Qualifications
F. Sample Calculation
G. Best in Class Target
H. Cautions
I. Harmonization Comments
J. References

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# Metrics and the Five Pillars

| **Pillar 1 - Business and Management** |
| --- |
| 1.1 - Ratio of Replacement Asset Value (RAV) to Craft-Wage Head Count |
| 1.3 - Maintenance Unit Cost |
| 1.4 - Stocked Maintenance, Repair, and Operating (MRO) Inventory Value as a Percent of Replacement Value |
| 1.5 - Total Maintenance Cost as a Percent of Replacement Asset Value (RAV) |

| **Pillar 2 - Manufacturing Process Reliability** |
| --- |
| 2.1.1 - Overall Equipment Effectiveness (OEE) |
| 2.1.2 - Total Effective Equipment Performance (TEEP) |
| 2.2 - Availability |
| 2.3 - Uptime |
| 2.4 - Idle Time |
| 2.5 - Utilization Time |

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# Metrics and the Five Pillars

| **Pillar 3 - Equipment Reliability** |
| --- |
| 3.1 - Systems Covered by Criticality Analysis |
| 3.2 - Total Downtime |
| 3.3 - Schedule Downtime |
| 3.4 - Unscheduled Downtime |
| 3.5.1 - Mean Time Between Failures (MTBF) |
| 3.5.2 - Mean Time to Repair or Replace (MTTR) |
| 3.5.3 - Mean Time Between Maintenance (MTBM) |
| 3.5.4 - Mean Downtime (MDT) |
| 3.5.5 - Mean Time to Failure (MTTF) |

| **Pillar 4 - Organization and Leadership** |
| --- |
| 4.1 - Rework |
| 4.2.1 - Maintenance Training Cost |
| 4.2.2 - Maintenance Training Hours |
| 4.2.3 - Maintenance Training Return of Investment (ROI) |

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# Metrics and the Five Pillars

| **Pillar 5 - Work Management** | |
|---|---|
| 5.1.1 - Corrective Maintenance Cost | 5.1.2 - Corrective Maintenance Hours |
| 5.1.3 - Preventive Maintenance Cost | 5.1.4 - Preventive Maintenance Hours |
| 5.1.5 - Conditioned Based Maintenance Cost | 5.1.6 - Condition Based Maintenance Hours |
| 5.1.9 - Maintenance Shutdown Costs | 5.3.1 - Planned Work |
| 5.3.2 - Unplanned Work | 5.3.3 - Actual Cost to Planning Estimate |
| 5.3.4 - Actual Hours to Planning Estimate | 5.3.5 - Planning Variance Index |
| 5.3.6 - Planner Productivity | 5.4.1 - Reactive Work |
| 5.4.2 - Proactive Work | 5.4.3 - Schedule Compliance Hours |
| 5.4.4 - Schedule Compliance Work Orders | 5.4.5 - Standing Work Orders |
| 5.4.6 - Work Order Aging | 5.4.7 -Work Order Cycle Time |
| 5.4.8 - Planned Backlog | 5..9 - Ready Backlog |
| 5.4.11 - Preventive Maintenance (PM) & Predictive Maintenance (PdM) Work Orders Overdue | 5.4.12 - PM & PdM Yield |
| 5.4.14 - PM & PdM Compliance | 5.5.1 - Craft Worker to Supervisor Ratio |
| 5.5.2 - Craft Worker to Planner Ratio | 5.5.3 - Direct to Indirect Maintenance Personnel Ratio |
| 5.5.4 - Indirect Maintenance Personnel Cost | 5.5.5 – Internal Maintenance Personnel Cost |
| 5.5.6 - Craft Workers on Shift Ratio | 5.5.7 - Overtime Maintenance Cost |
| 5.5.8 - Overtime Maintenance Hours | 5.5.31 - Store Inventory Turns |
| 5.5.32 - Vendor Managed Inventory | 5.5.33 - Stock Outs |
| 5.5.34 - Inactive Stocks | 5.5.35 - Storeroom Transactions |
| 5.5.36 - Storeroom Records | 5.5.38 - Maintenance Material Cost |
| 5.5.71 - Contractor Cost | 5.5.72 - Contractor Hours |
| 5.6.1 - Wrench Time | 5.7.1 - Continuous Improvement Hours |

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# EFNMS-SMRP Metric Harmonization


- European Federation of National Maintenance Societies, Developed European standard EN 15341
- EFNMS and SMRP Developed List of harmonized metrics

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# EFNMS 22 Members

# EFNMS

## VISION

**We are recognised as the leading European network for knowledge and experience in maintenance and physical asset management** – That means that EFNMS has competencies in Maintenance but also in Physical Asset Management which includes Design, Configuration, Operation, Continuous Improvement and Disposal.

## MISSION

Develop the Maintenance profession, enhance innovation in maintenance, and increase awareness of the importance and the significance of Maintenance and Asset Management.

## VALUES

- **Neutrality**
  We are there for the interest of the maintenance community in Europe and our country and not for personal or company interests
- **Independency**
  We are independent of any political or financial influence
- **Contribution**
  We are there to contribute actively to the common goals of the EFNMS members
- **Openness**We are open and willing to collaborate with organizations world wide

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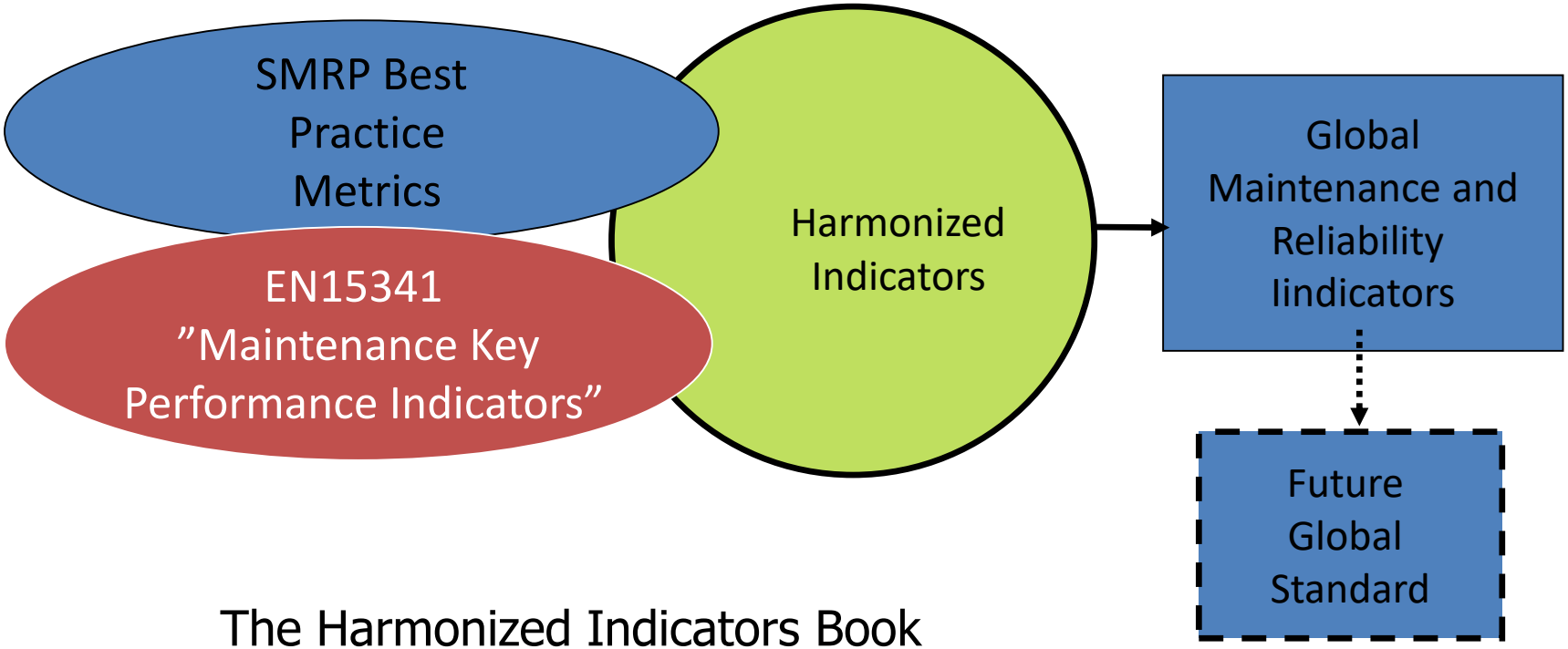
# EFNMS-SMRP Harmonization Project




The Harmonized Indicators Book documents differences and similarities for the indicators and metrics

**GMARI**
**Global Maintenance And Reliability Indicators**

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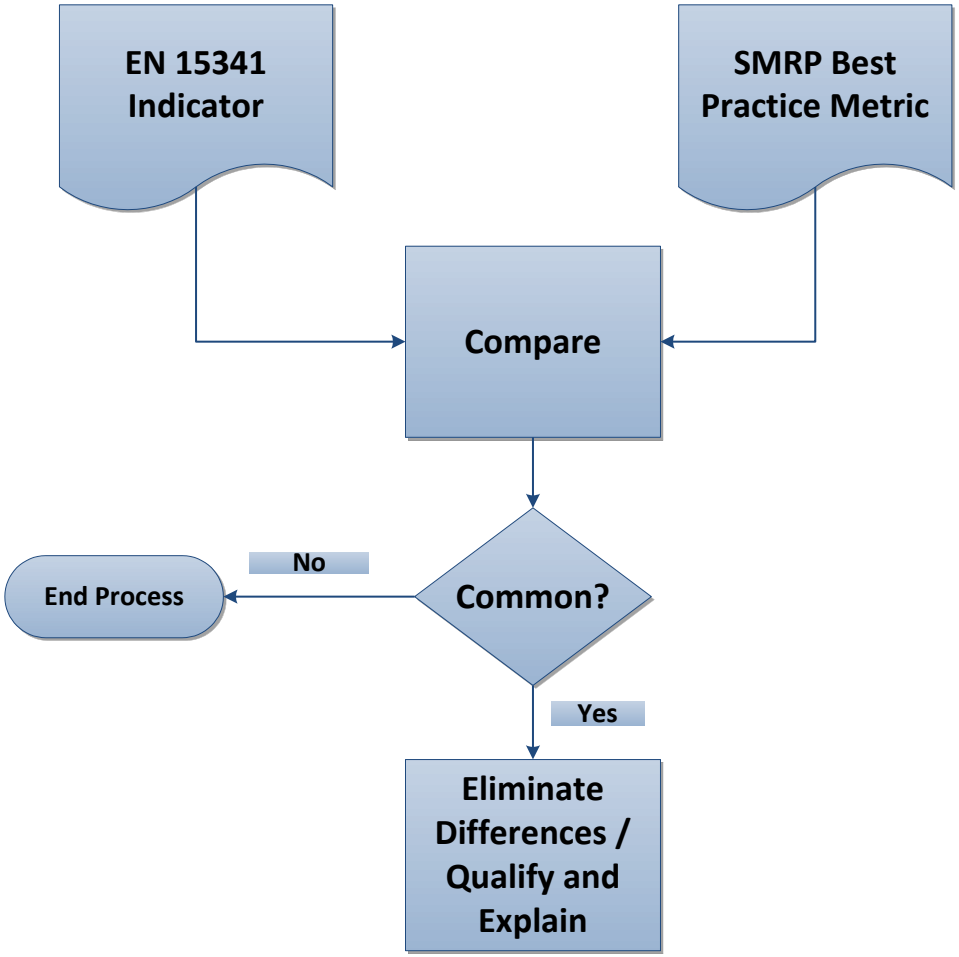
# The Harmonization Process

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# Harmonization Classification

Each harmonized indicator is given a qualitative classification

IDENTICAL – the bases of the indicators are the same, although there may be some differences in how they are presented. The differences are detailed in the comments.

SIMILAR – there are some differences in the differences that are detailed in the comments.

SAME PERFORMANCE – the indicators measure the same performance area, but there are significant differences in the definitions or calculations that are detailed in the comments.

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# Section 3
# Sample Metric Calculations

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# Learning Objectives

1. Understand how metrics are documented in the BP Compendium

2. Learn the standardized process for metric calculation

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# Sample Metric Calculations

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# Metric 5.4.2 Proactive Work

- Refer to the Metric Definition 5.4.2 handout as we walk through the document and the sample calculation
- Lets calculate together Proactive Work for each of the three sample plants A, B and C.

Remember there are 10 elements

A. Definition
B. Objectives
C. Formula
D. Component Definitions
E. Qualifications
F. Sample Calculation
G. Best in Class Target
H. Cautions
I. Harmonization Comments
J. References

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# Metric 5.4.2 Proactive Work

## DEFINITION

This metric is maintenance work that is completed to avoid failures or to identify defects that could lead to failures. Includes routine preventive and predictive maintenance activities and corrective work tasks identified from them.

## OBJECTIVES

This metric is used to measure and monitor the amount of work that is being done in order to prevent failures or to identify defects that could lead to failures.

## FORMULA

Proactive Work (%) =

[Work completed on preventive maintenance work orders, predictive maintenance work orders, and corrective work identified from preventive and predictive work orders (hours) / Total Maintenance Labor Hours] × 100

PW (%) = (PWC / TML) × 100

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# Metric 5.4.2 Proactive Work

- % Proactive work =

  $$\frac{\text{PM + PdM + Corrective from PM \& PdM}}{\text{Total Maintenance Labor Hours}} \times 100$$

- Let's look at the definitions for:

  PM, PdM, Corrective work, Failure, Total Maintenance Labor Hours

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# Metric 5.4.2 Proactive Work Component Definitions

## Preventive Maintenance (PM)

Actions performed on a time- or machine-run-based schedule that detect, preclude or mitigate degradation of a component or system with the aim of sustaining or extending its useful life through controlling degradation to an acceptable level.

## Predictive Maintenance

An equipment maintenance strategy based on assessing the condition of an asset to determine the likelihood of failure and then taking appropriate action to avoid failure. The condition of equipment can be measured using condition monitoring technologies, statistical process control, equipment performance indicators or through the use of human senses.

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# Metric 5.4.2 Proactive Work Component Definitions

## Corrective Work Identified from Preventive and Predictive Maintenance Work Orders

Work identified from preventive maintenance (PM) and predictive maintenance (PdM) work orders is work that was identified through PM and/or PdM tasks and completed prior to failure in order to restore the function of an asset.

## Failure

When an asset is unable to perform its required function.

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# Metric 5.4.2 Proactive Work Component Definitions

## Total Maintenance Labor Hours

Expressed in hours and includes all maintenance labor hours for normal operating times as well as outages, shutdowns and turnarounds. If operator hours spent on maintenance activities are captured, they should be included in the numerator and denominator of all applicable metrics. Include labor hours for capital expenditures directly related to end-of-life machinery replacement so that excessive replacement versus proper maintenance is not masked. Does not include labor hours used for capital expansions or improvements. Typically, total maintenance labor hours do not include temporary contractor labor hours.

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# Metric 5.4.2 Proactive Work Component Definitions

## Total Maintenance Labor Hours

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# Calculate Metric 5.4.2 Proactive Work

$$\% \text{ Proactive work} = \frac{\text{PM + PdM + Corrective from PM \& PdM}}{\text{Total Maintenance Labor Hours}} \times 100$$

| No. | Data | Units | Plant A | Plant B | Plant C |
|---|---|---|---|---|---|
| 2-7 | Total Maintenance Hours | Hrs/Year | 82,799 | 311,291 | 460,021 |
| 4-4 | Corrective Work Identified | Hrs/Month | 1,939 | 2,529 | 411 |
| 4-9 | PM/PdM Work Completed | Hrs/Month | 2,456 | 3,995 | 1,765 |

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# Metric 5.4.2 Proactive Work Calculation

Did you get it right?
Let's check your answers!


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# Metric 5.4.2 Proactive Work

$$\% \text{ Proactive work} = \frac{\text{PM + PdM + Corrective from PM \& PdM}}{\text{Total Maintenance Labor Hours}} \times 100$$

$$= \frac{2456 + 1939}{(82{,}799/12)} = 64.5\% \text{ for plant A}$$

25.1% for plant B, 5.7% for plant C

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# Metric 5.4.2 Proactive Work

PM, PdM and Corrective work ID'd from PM and PDM that was done before the failure

Concerns at each facility?

- What is included in Proactive work?
- What is Corrective work?
- What is the difference between Proactive and Reactive Work?

Corrective work is done after the failure or when a failure is imminent. Corrective work can be either Proactive or reactive

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## Proactive Work

This metric is maintenance work that is completed to avoid failures or to identify defects that could lead to failures. Includes routine preventive and predictive maintenance activities and corrective work tasks identified from them.

## Reactive work

This metric is maintenance work that interrupts the weekly schedule, calculated as a percentage of the total maintenance labor hours.

Is reactive work planned or unplanned work?

Is proactive work planned or unplanned work?

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# Section 4
# Why Use Maintenance and Reliability Metrics

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# Learning Objectives

1. Why Use Metrics?
2. Linking Business Results to the Shop Floor
3. Metric Hierarchy

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# Why Use Metrics

**"If you don't measure it, you can't manage it"**

Dr. Joseph Juran

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# Why Use Metrics


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# Metrics are Key for M&R Improvement

1. Doing "things right" – Maintenance Execution
2. Doing the "right things" – Reliability Execution
3. Making sure you are doing the "right things right"

How do you know if you are doing the "right things right"?

By selecting the right metrics to track performance

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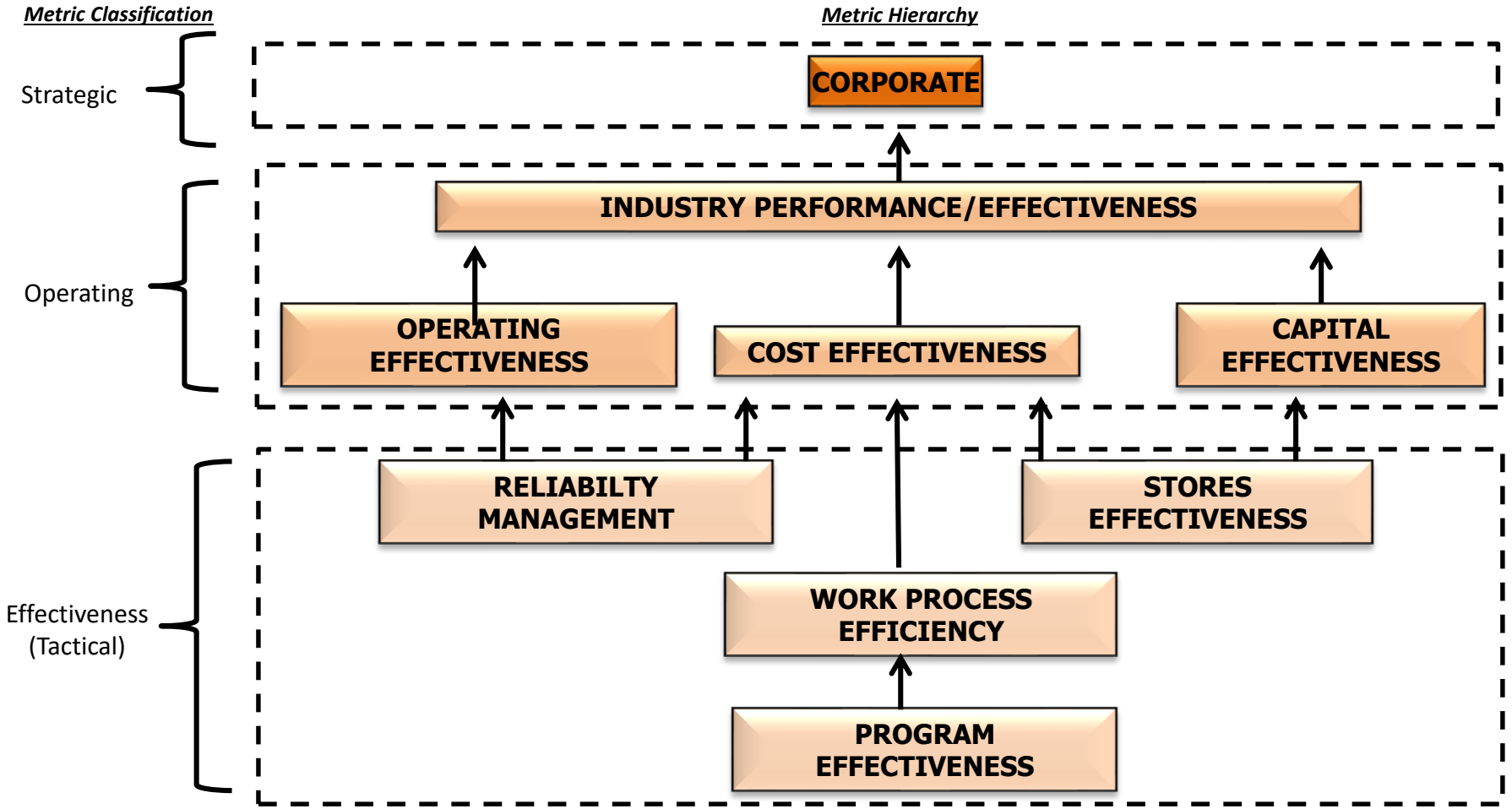
# Linking M&R to Business Results

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# Comparing Apples to Apples

When comparing figures and evaluating results please take into account:

- Location
- Laws & regulations
- Process severity
- Plant size
- Age of the plant
- Others

- It is better to be consistently inaccurate than absolutely correct?
- Consider using metrics that are cost independent … man-hours

Example: Labor costs vary widely across the globe

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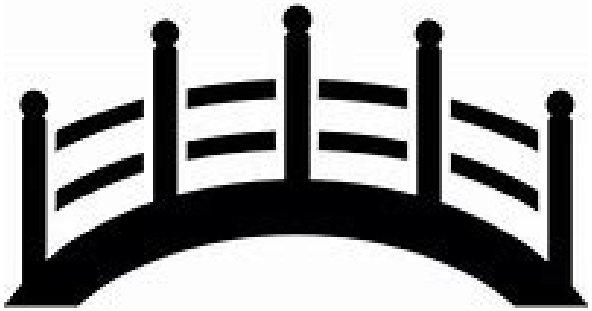
# Linking Business and Shop Floor



METRICS

Market Position
Cost of Goods Sold
Revenue
Return on Capital

Work Orders
PM, PdM, CBM
Bolts and Nuts
Bearings

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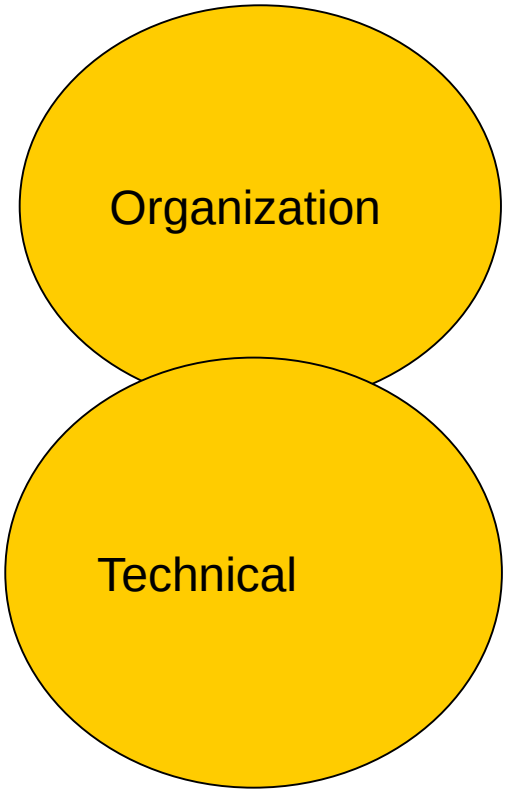
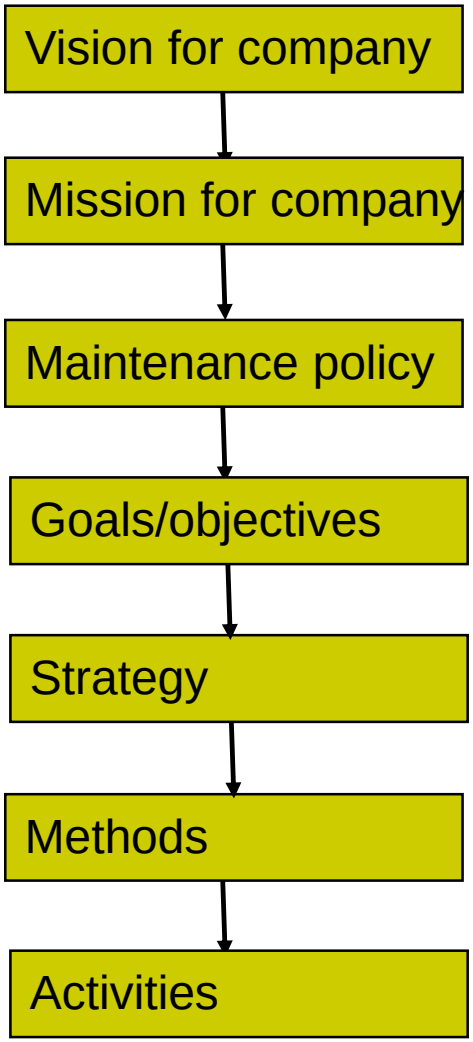
# Goals and Strategies for Maintenance




Company values

**(The way things are done)**

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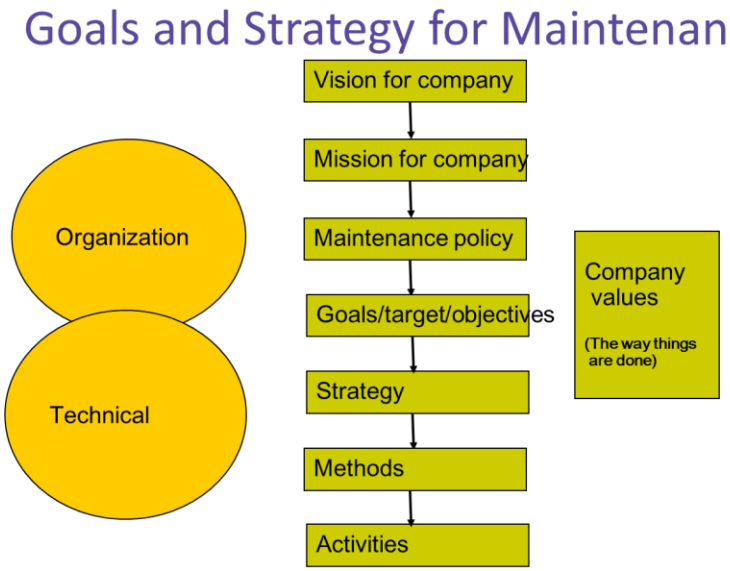
# Line of Sight to Top Goals

- How do you pick your metrics?
- What are the linkages from measurements to goals?
- Need a clear line of sight to the top vision and mission, otherwise you will be measuring things that have no impact on top goals

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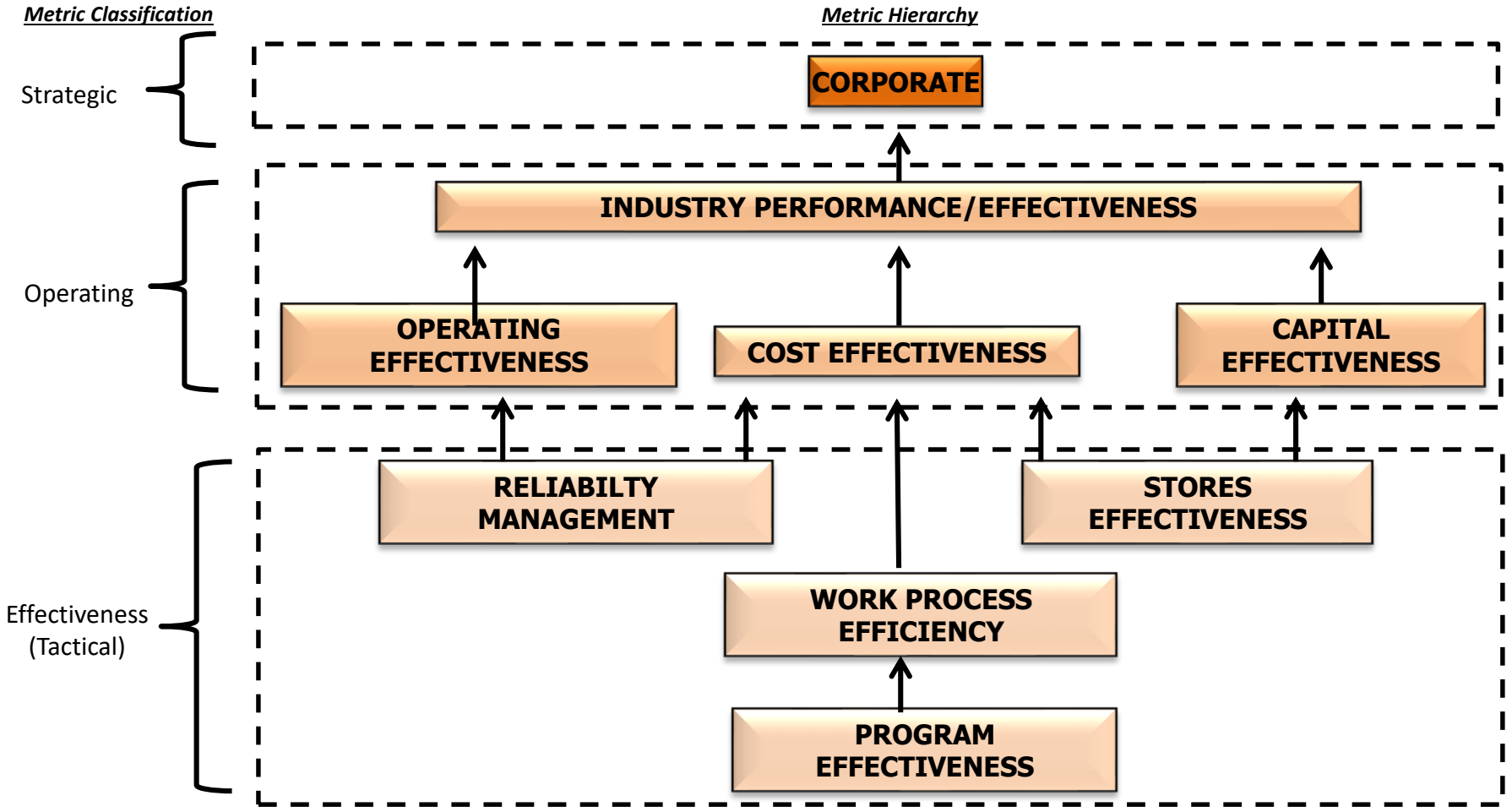
# Metrics Linked to Business Goals

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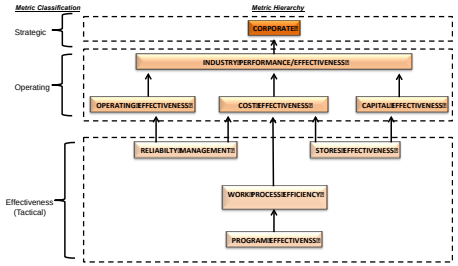
# Metric Hierarchy




Strategic

**CORPORATE**
RONA, ROCE, ROA

**Strategic Corporate Metrics:**

- Return on Net Assets (RONA)
- Return on Capital Expended (ROCE)
- Return on Assets (ROA)
- Return on Active Capital Employed (ROACE)
- Return on Average Assets (ROAA)
- Return on Invested Capital (ROIC)
- True Reject Rate (TRR)

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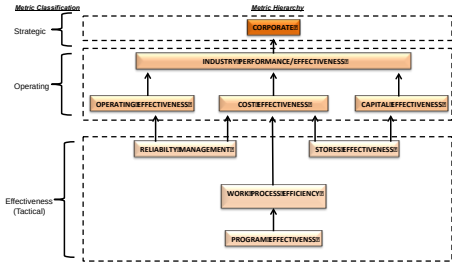
# Metric Hierarchy




Operating

**OPERATING EFFECTIVENESS**
TEEP, OEE, Asset Utilization, COPQ

**Operating Effectiveness Metrics:**
2.1.1 Overall Equipment Effectiveness (OEE)
2.1.2 Total Effective Equipment Performance (TEEP)
2.2 Availability
2.3 Uptime
2.4 Idle Time
2.5 Utilization Time

**COST EFFECTIVENESS**
Labor effectiveness, cost/unit , RAV

**Cost Effectiveness Metrics:**
1.2 Maintenance Unit Cost
1.4 Total Maintenance Cost as a Percent of Replacement Asset Value (RAV)
5.1.1 Corrective Maintenance Cost
5.1.2 Corrective Maintenance Hours
5.1.3 Preventive Maintenance Cost
5.1.4 Preventive Maintenance Hours
5.1.5 Condition Based Maintenance Cost
5.1.6 Condition Based Maintenance Hours
5.1.9 Maintenance Shutdown Cost
5.5.4 Indirect Maintenance Personnel Cost
5.5.5 Internal Maintenance Personnel Cost
5.5.7 Overtime Maintenance Cost

**CAPITAL EFFECTIVENESS**
Spare parts inventory % RAV

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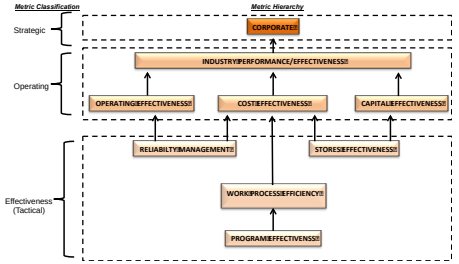
# Metric Hierarchy




Effectiveness (Tactical)

**RELIABILTY MANAGEMENT**
MTBF, MTBR, MTTR, MTTF

**Reliability Management Metrics:**
3.1 Systems Covered by Criticality Analysis
3.2 Total Downtime
3.3 Scheduled Downtime
3.4 Unscheduled Downtime
3.5.1 MTBF
3.5.2 MTTR
3.5.3 MTBM
3.5.4 MDT
3.5.5 MTTF

**STORES EFFECTIVENESS**
Inventory turns, stock-outs, delay for parts

**Stores Effectiveness Metrics:**
5.5.31 Store Inventory Turns
5.5.32 Vendor Managed Inventory
5.5.33 Stock Outs
5.5.34 Inactive Stocks
5.5.35 Storeroom Transactions
5.5.36 Storeroom Records
5.5.38 Maintenance Material Cost

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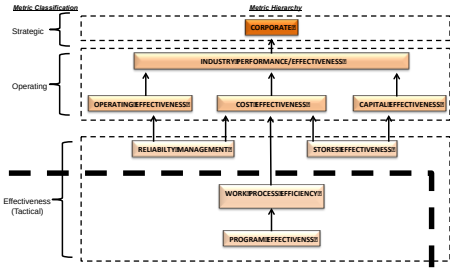
# Metric Hierarchy




Effectiveness (Tactical) Continued

**WORK PROCESS EFFICIENCY**
Planned to Total Work, Overtime As a Percentage of Total Hours, etc.

**Work Process Efficiency Metrics:**
5.3.1 Planned Work
5.3.2 Unplanned Work
5.3.3 Actual Cost to Planning Estimate
5.3.4 Actual Hours to Planning Estimate
5.3.5 Standing Work Orders
5.3.6 Planner Productivity
5.4.1 Reactive Work
5.4.2 Proactive Work
5.4.3 Schedule Compliance Hours
5.4.4 Schedule Compliance Work Orders
5.4.5 Standing Work Orders
5.4.6 Work Order Aging
5.4.7 Work Order Cycle Time

**Work Process Efficiency Metrics:**
5.4.8 Planned Backlog
5.4.9 Ready Backlog
5.4.11 PM & PdM Work Orders Overdue
5.4.12 PM & PdM Yield
5.4.14 PM & PdM Compliance
5.5.1 Craft Worker to Supervisor Ratio
5.5.2 Craft Worker to Planner Ratio
5.5.3 Direct to Indirect Maint Personnel Ratio
5.5.4 Indirect Maintenance Personnel Cost
5.5.5 Internal Maintenance Personnel Cost
5.5.6 Craft Workers on Shift Ratio
5.5.7 Overtime Maintenance Cost
5.5.8 Overtime Maintenance Hours

**PROGRAM EFFECTIVENSS**
Faults Detected Prior to Failure, Avoided Cost

**Program Effectiveness Metrics:**
4.1 Rework
4.2.1 Maintenance Training Cost
4.2.2 Maintenance Training Hours
4.2.3 Maintenance Training Return on Investment ROI)

**Program Effectiveness Metrics:**
5.6.1 Wrench Time
5.7.1 Continuous Improvement Hours

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# Section 5
# Group Exercise
# Speedy Mac Reliability Products (SMRP)

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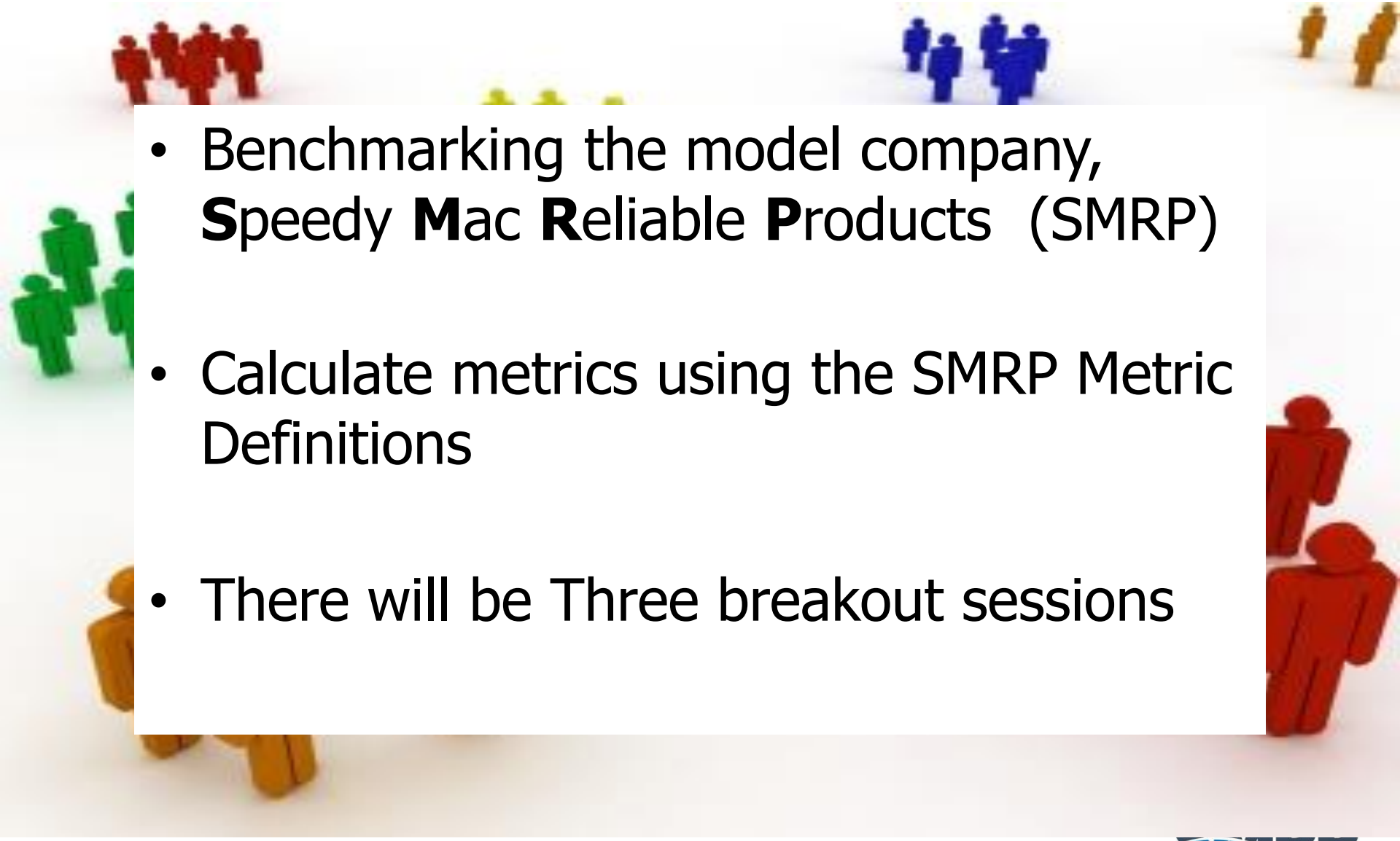
# Group Session



- Benchmarking the model company, **S**peedy **M**ac **R**eliable **P**roducts (SMRP)
- Calculate metrics using the SMRP Metric Definitions
- There will be Three breakout sessions

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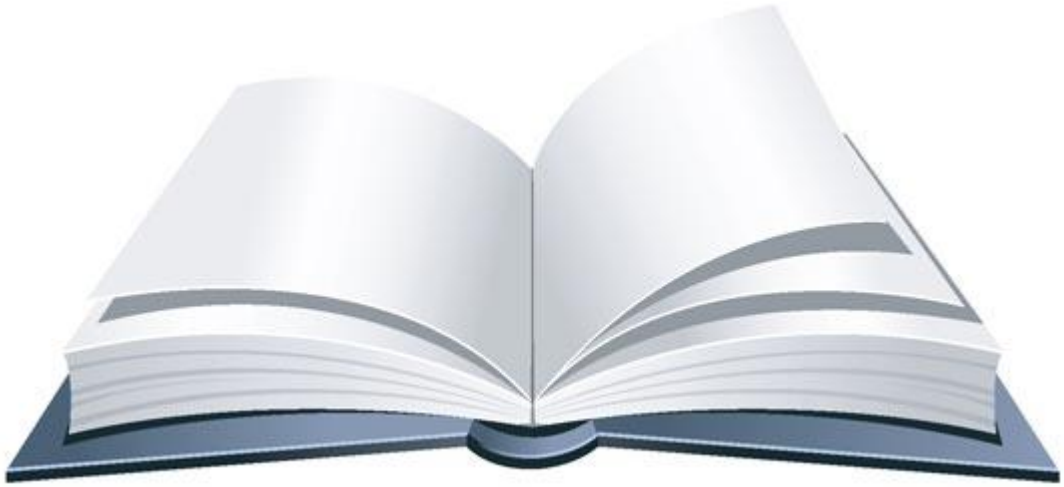
# Workbook Review



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- The CEO – Seymour Profit
- The Director of Corporate Reliability – Noah Lott
- The Maintenance Manager – Ben Ignored
- The Operations Manager – Maury Ficiency
- The Maintenance Planner – Claire Voyant

# Breakout Instructions

- Workbook has all data and information
- Glossary has additional information (I have one copy to share)
- Each Team will calculate metrics for the 3 plants for each metric in the session
- Data is provided in tables 1 – 9 and constants in table 10
- Formulas are provided
- Full metric definitions are in the Compendium

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# Instructions

Table 1 – Data from the Finance Department
Table 2 – Data from HR
Table 3 – Operations Data
Table 4 – Work Management Data
Table 5 – Planner Data
Table 6 – Storeroom Data
Table 7 – Cost Improvement Analysis Data
Table 8 – Work Study Data
Table 9 – Reliability Study Data on Pump Group 9
Table 10 - Constants

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# Instructions

- When you are complete with the calculations:
  1. Pick the worst performing plant for each metric
  2. Define a strategy to close the gap to the best performing plant
- Then write the metric data and the defined strategy on a flip chart – 1 flip chart for each of the three plants A, B and C (one per group)

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# Instructions

- When you are complete with the calculations:
  1. Pick the work performing plant for each metric
  2. Define a strategy to close the gap with the best performing plant
- Then record the metric data defined strategy for gap closure for class discussion

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# Break out Session 1

Metric 1.1 RAV per Craft/Wage Headcount

Metric 1.5 Maintenance Cost per RAV

Metric 2.1.1 OEE

Metric 5.5.71 Contractor Cost

1. Must we aim for a high or a low value?
2. Please give the strategies or activities which can improve the performance measured by the indicators?

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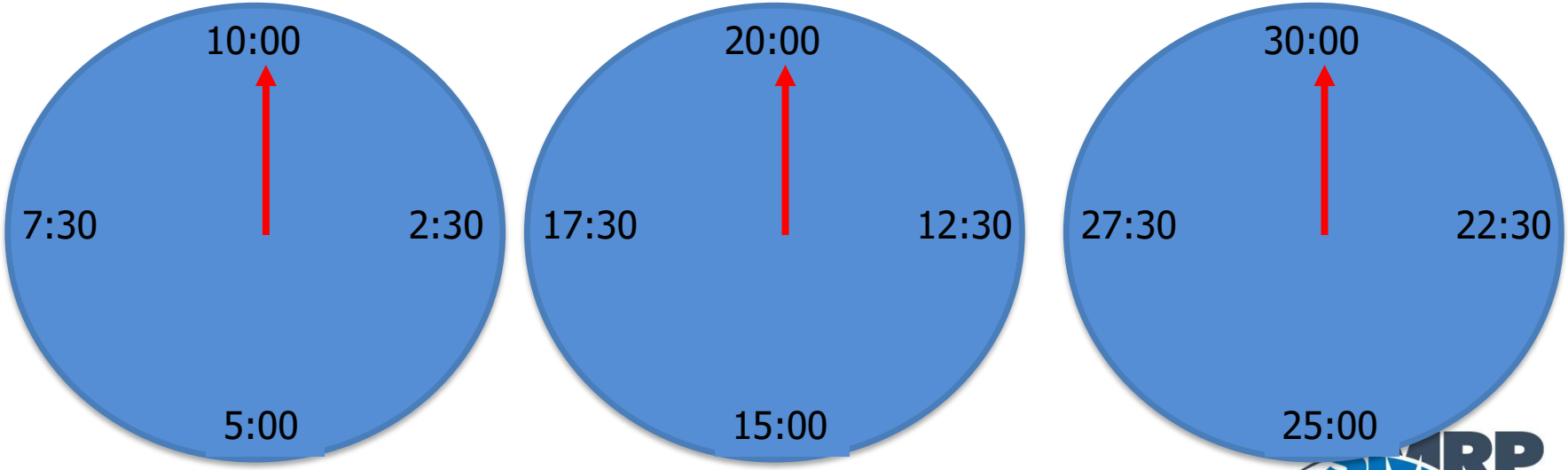
# Break out Session 1

Metric 1.1 RAV per Craft/Wage Headcount

Metric 1.5 Maintenance Cost per RAV

Metric 2.1.1 OEE

Metric 5.5.71 Contractor Cost

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# Break out Session 2

Metric 5.3.1 Planned Work

Metric 5.4.1 Reactive Work

Metric 5.1.5 Condition Based Maintenance Cost

Metric 5.4.9 Ready Backlog

Metric 5.4.3 Schedule Compliance – Hours

1. Must we aim for a high or a low value?
2. Please give the strategies or activities which can improve the performance measured by the indicators

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# Break out Session 2

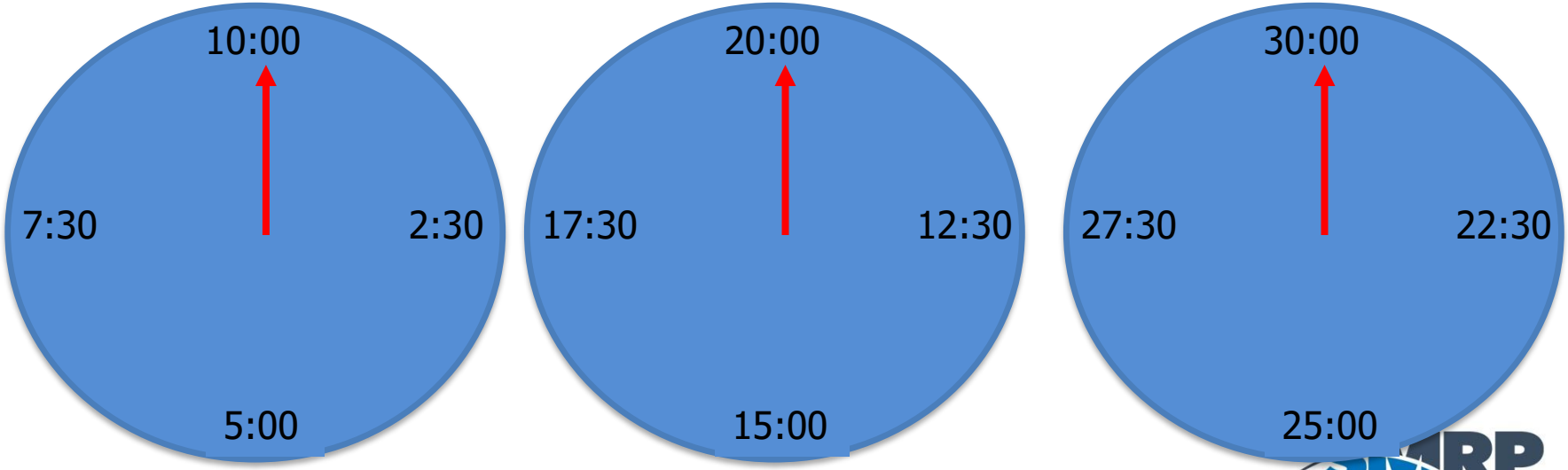
Metric 5.3.1 Planned Work

Metric 5.4.1 Reactive Work

Metric 5.1.5 Condition Based Maintenance Cost

Metric 5.4.9 Ready Backlog

Metric 5.4.3 Schedule Compliance – Hours

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# Section 6
# Selecting the Right Metric

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# Learning Objectives

1. Discuss a process for selecting metrics
2. Adjusting standard metrics
3. Leading versus Lagging Indicators

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# Process for Selection of Indicators

- What are the strategies in your organization?
- What are the goals and objectives?
- What is in the maintenance policy?
- Who are your customers and what do they expect from your organization?
- When are your customers ready?
- Are you familiar with the company values?

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# Metrics Development

**Even with standardized definitions some adjustments may still have to be made at the enterprise level**

- Still other considerations
  - Same thing done in different facilities?
  - Capital vs. expense discussions
- Still may have to work inside your company to get a standard definition

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# Developing Maintenance Metrics


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# Developing Maintenance Metrics

1. Appoint a task force, team, group
2. Agree on results, scope and objectives
3. Identify the 5 – 10 most important strategies in the company
4. Check for relevant metrics in….. SMRP, EFNMS, Web, others
5. If none are applicable develop company-relevant metrics
6. Perform as a test "is this the only measurement of strategy XX?"
7. Present metrics to others and adjust from comments
8. Present the system of metrics as Version 1
9. Re-evaluate

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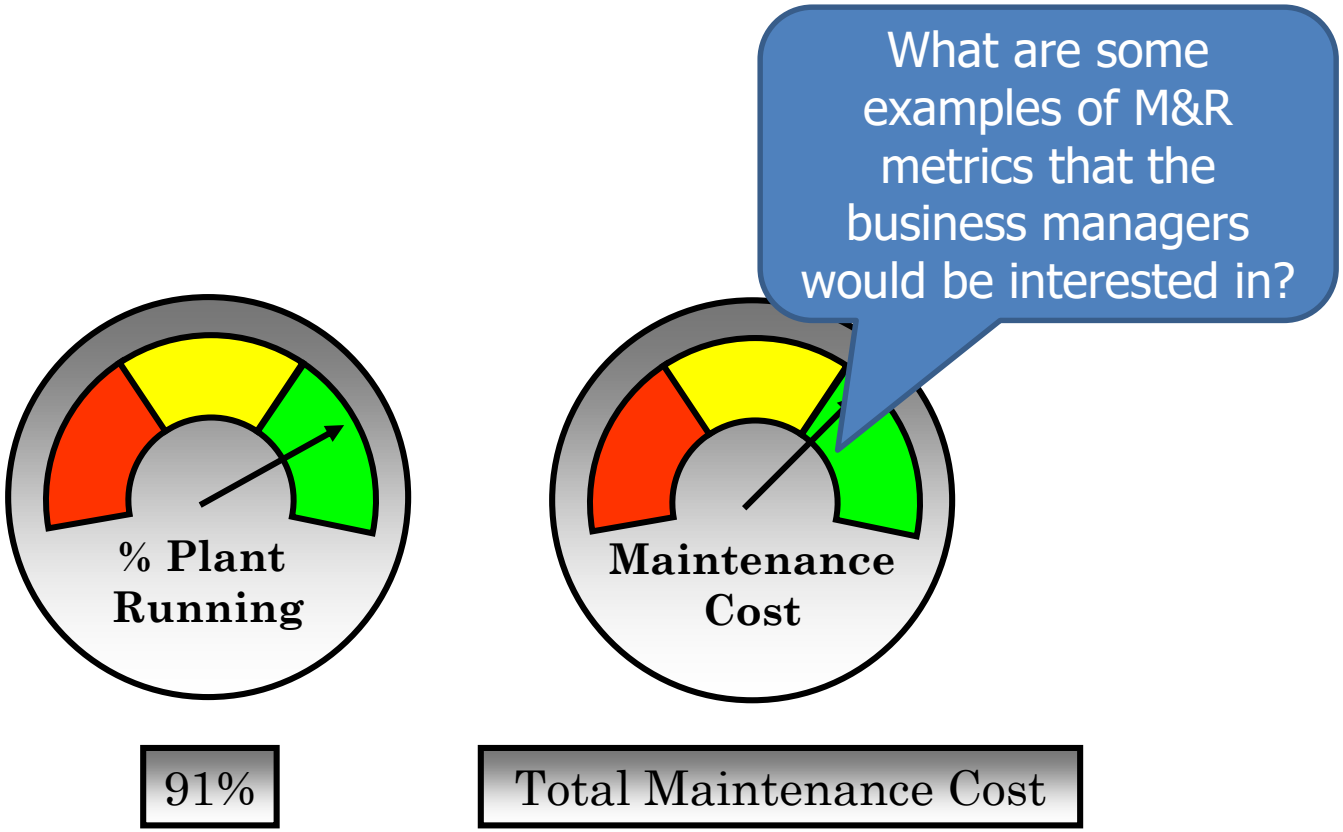
# Leading vs. Lagging indicators




Is this a reliable plant? How well does it run?

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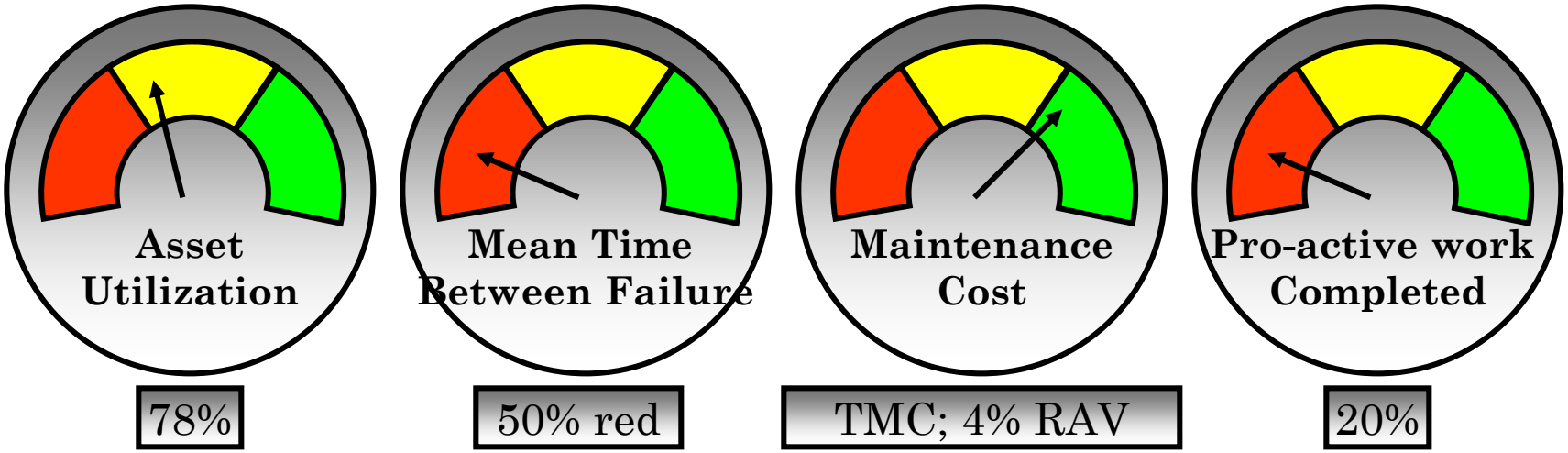
# Leading vs. Lagging indicators




What are the leading indicators telling?

MTBF and Pro-active work completed

What may have happened at this plant?

Which way are the indicators likely to move in the future?

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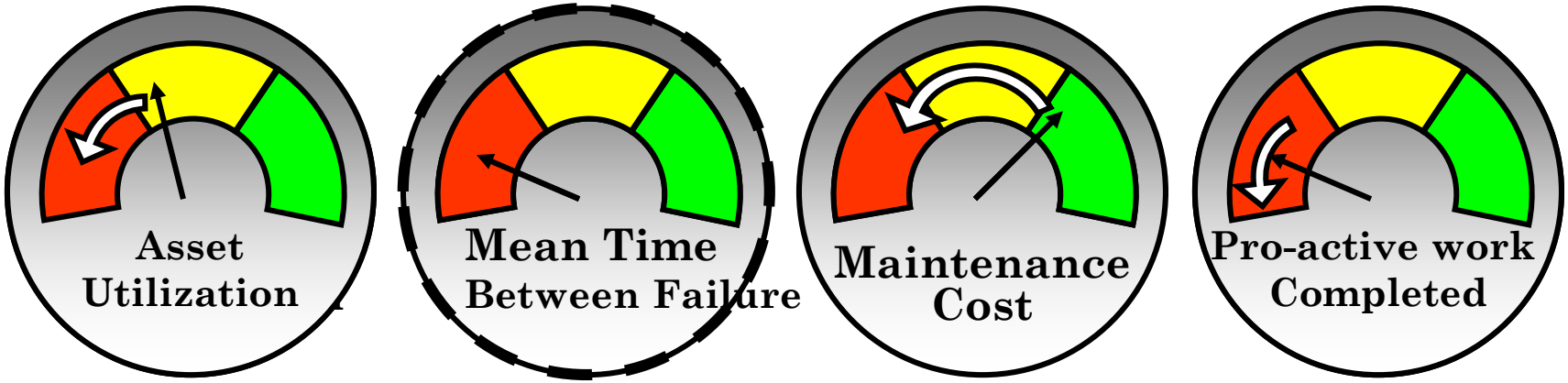
# Leading vs. Lagging indicators




Poor MTBF reduces asset reliability and assets fail, driving up the Maintenance Cost.

The failing assets force reactive work, which takes available crew capacity from proactive work

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# Death Spiral of Reactive Maintenance

MAINTENANCE COST

No Preventive Maintenance
No Predictive Maintenance
Poor Data Quality
No Data Analysis
Breakdown
Reactive Work
Less Planned Work
Breakdown Culture
increased Safety Incidents
Poor Work Culture
More Breakdowns
More Emergencies

Postpone PM Work
Ignore Predictive Results
More Breakdowns
Increased Urgency
More Failures
Reactive Work
Less Planned Work
Less time for PM/PdM
More Breakdowns
Increased Reactive Work
Increase Injury Rate
Less Dependability

PRODUCTIVITY

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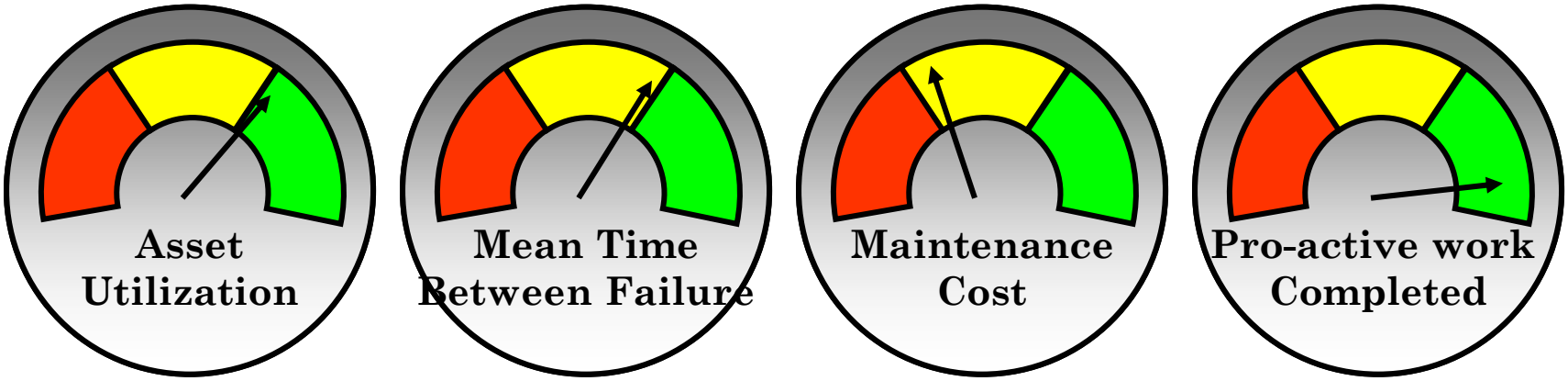
# Leading vs. Lagging indicators




What is being indicated in this plant?

Which direction are the indicators likely to go?  Why?

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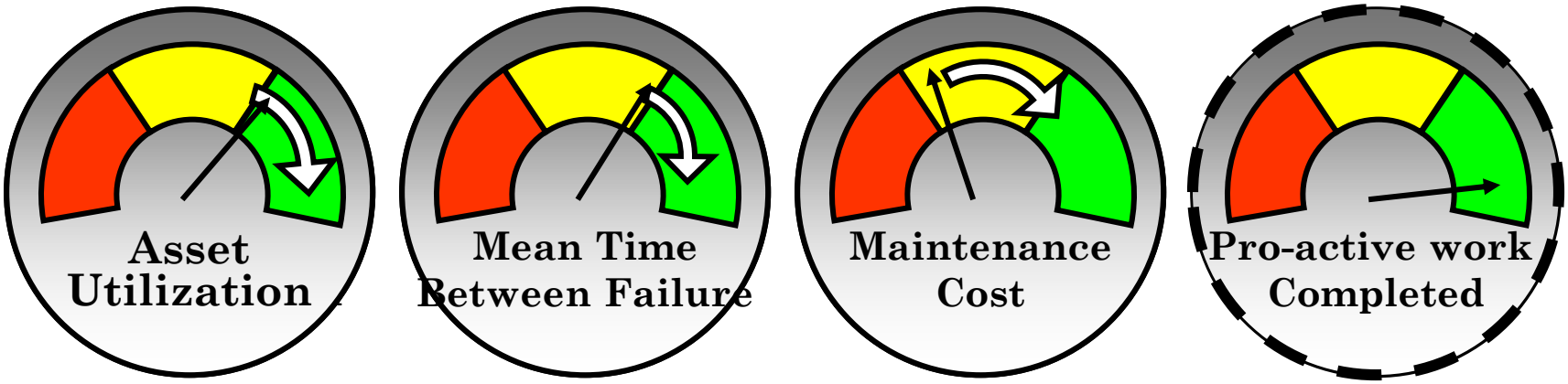
# Leading vs. Lagging indicators




What is the relationship between these metrics?

High level of pro-active work completed, will increase MTBF, will increase asset utilization and reduce maintenance cost

How do the metrics interact?

A good understanding of what going on requires a balanced scorecard of indicators

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# Section 7
# Benchmarking

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# Learning Objectives

1. Using Standardized Metrics for Benchmarking

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# Benchmarking

**Data benchmarking:**

**My position compared to the others**

**Process benchmarking:**

**What are the processes others have used to achieve the results**

**Benchmarking:**

**Learn, adopt, and improve**


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# Using Standardized Metrics for Benchmarking

1. Intra-company;  Inside a Site or Plant, Site to Site, Plant to Plant, Division to Division, etc.

2. Against Peer Group in Similar Industry

3. Against Best Practice Numbers

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# Results from Benchmarking

- Cost and availability improvement ideas
- Understand your contribution to department or plant results
- Attracts focus to areas which need improvement
- Identification of areas with excellent performance
- Motivates employees
- An understanding to each individual on how to contribute to improved performance
- Ability to compare plant performance

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# “Rules” for Using Metrics

1. Metrics must be understood

2. Must be able to influence

**Metrics are not a substitute for good management**

3. Metrics must be coordinated to the business objectives

4. Use positive Metrics (Availability versus downtime)

5. Check definitions – compare apples to apples

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# Considerations

Is it possible to measure everything in a company?

"Bath scale syndrome"

All areas measured will change

**Remember what gets measured and socialized will change**

Is it possible to describe a complex body such as an organization with 10 – 50 indicators?

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# Break Out Session 3

Metric 1.4 Stock MRO Inventory per RAV

Metric 5.6.1 Wrench Time

Metric 3.5.1 MTBF

Metric 3.5.2 MTTR

Must we aim for a high or a low value?

Please give the strategies or activities which can improve the performance measured by the indicators?

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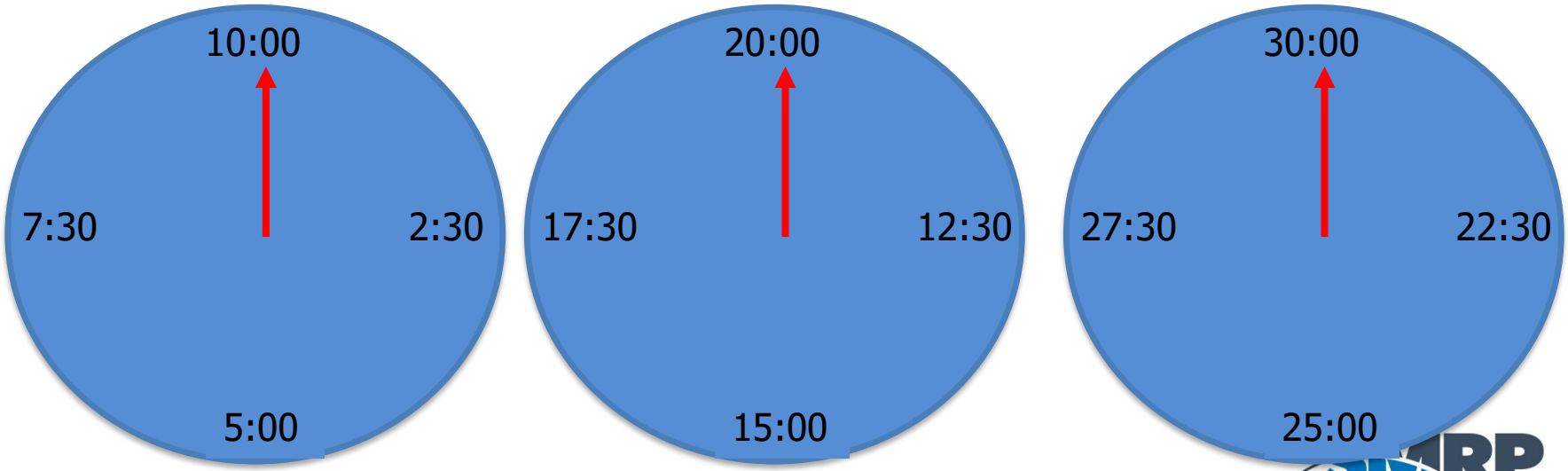
# Break out Session 3

Metric 1.4 Stock MRO Inventory per RAV

Metric 5.6.1 Wrench Time

Metric 3.5.1 MTBF

Metric 3.5.2 MTTR

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# Section 8
# Critical Information Needs

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# Learning Objectives

1. Effective Work Management
2. Effective Reliability Management
3. Effective Resource Stewardship

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# Critical Information Needs

Three major areas of interest for a Maintenance Manager:

1. Are we managing the work effectively?
2. Are we maintaining the necessary level of reliability?
3. Are we effective stewards of the company's resources (labor, material, financial)?

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# 1. Effective Work Management

## Questions:

1. Are we working on the right things?
2. Is the work being performed as efficiently as it should?
3. Is our capacity for work output keeping up with input?
4. Are we improving?

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# Working on the Right Things

- Need to measure Labor Distribution:
  - Corrective Maintenance Hours
  - Preventive Maintenance Hours
  - Condition Based Maintenance Hour

Best in Class Target Values

- Preventive Maintenance: 15% of total hours
- Corrective Maintenance identified through PM: 15%
- Predictive Maintenance: 15%
- Corrective Maintenance identified through PdM: 35%

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# Work Efficiency

Need to measure:

- Planned Work vs. Unplanned Work
  - Will either need a status code or other indicator to mark the work order as "planned"
- Schedule Compliance Hours
  - Calculated each week as part of the scheduling process (not necessarily done in the CMMS/EAM)

Can validate by calculating the Ratio of Replacement Asset Value (RAV) to Craft Headcount

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# Work Capacity

Need to measure:

- Planned Backlog
- Ready Backlog
- PM and PdM Work Order Backlog

These will indicate if craft resource capacity is balanced with workload demand

Can also measure Planner Productivity

- Indicates whether Planners have enough capacity to plan incoming work

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# Is Work Management Improving?

Monitor:

- Actual Cost to Planning Estimate
- Actual Hours to Planning Estimate

As Planning and Supervisory skills improve, variances should improve

Trend:

- Mean Time to Repair (MTTR)
- Wrench Time
- Both can indicate whether unnecessary delays are being eliminated

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# 2. Effective Reliability Management

Questions:

- Are we providing the right level of production capacity?
- Is my PM/PdM program effective?
- Are we getting better?

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# Production Capacity

- Overall Equipment Effectiveness (OEE) is the best measure of capacity utilization
  - Availability
  - Performance Efficiency
  - Quality Rate
- Should also measure Uptime
- Data can reside in different systems

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# PM/PdM Effectiveness

Need to measure:

- Reactive Work
  - Data comes from the Scheduling process (Reactive Work, by definition, breaks the weekly schedule)
- Proactive Work
  - Data comes from analysis of work by work type

Also monitor PM/PdM Yield

- Ensures a ROI of the PM/PdM program

On average, top performers produce about 1 hour of corrective work for each hour of PM work. On average top performers produce about 2.5 hours of corrective work for each hour of PdM work.

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# Improving Reliability

Trend:

- Mean Time Between Failure (MTBF) and Mean Time To Failure (MTTF)
  - Can measure by individual equipment or by equipment class / subclass
- Unscheduled Downtime
- Equipment Availability

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# 3. Effective Resource Stewardship

Questions:

- Are our maintenance costs appropriate and under control?
- Do we have the right quantity and type of spare parts?
- Do our craftspeople have the right skills?
- Are we getting better?

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# Maintenance Costs

- Need to measure Maintenance Cost as a Percent of Replacement Asset Value (RAV)
  - Compare to other plants in the company or to industry benchmarks
- Trend Maintenance Unit Costs
  - Decreasing trend can be a result of both cost reduction and capacity improvement

Top performers in all industries can maintain reliable plants for under 3% of RAV –regardless of industry.

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# Spare Parts

- Need to measure Stocked MRO Inventory Value as a Percent of RAV
  - Compare to other plants in the company or to industry benchmarks
- Monitor:
  - Inactive Stock
  - Stores Inventory Turns
- Recognize that inventory reductions should not be based on these factors alone; they should be accompanied by a risk analysis

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# Craft Skills

- Need to measure:
  - Maintenance Training Cost
  - Maintenance Training Hours
- Both can be compared to industry benchmarks to determine if the appropriate investment is being made in skills development
- Can also monitor Rework to infer whether skills are appropriate

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# Improving Resource Stewardship

Trend:

- Stock Outs
- Overtime Maintenance Hours
- Training ROI

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# Section 9
# Data Quality

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# Learning Objectives

1. Data Quality
2. Work Order Data
3. Equipment Data

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# Data Quality

- None of the aforementioned metrics will be accurate, nor will the data be trustworthy, without:
  - Accurate and thorough static Master Data
  - A well designed and operating Work Management process that creates accurate Transactional Data
- Transactional Data quality is dependent on Master Data quality

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# Data Quality

- None of the aforementioned metrics will be accurate, nor will the data be trustworthy, without:
  - Accurate and thorough static Master Data
  - A well designed and operating Work Management process that creates accurate Transactional Data
- Transactional Data quality is dependent on Master Data quality

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# Static Master Data Examples

- Locations
- Equipment
- Class / Subclass
- Specifications
- Failure Hierarchies
- Work Order Types
- Status Codes
- Priority Codes
- Material Items
- Bills of Material

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# Locations

- The record type that stores system information relevant to accounting and process descriptions
- Sometimes referred to as "Functional Locations"
- Primary record depicted in a CMMS/EAM hierarchy using a parent/child relationship
- Descriptions typically represent a process function
  - Turbine Generator Lube Oil System
    - Number 1 Lube Oil Pump
- A best practice is to limit the hierarchy to 5-6 levels at most; navigation difficulty increases with additional levels
- ISO 14224 provides a good model for a Hierarchy

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# Class / Subclass

A List of Values (LOV) that contains a specific breakdown of equipment types:

- Pump, Centrifugal
- Pump, Rotary Gear
- Pump, Peristaltic
- Pump, Vacuum
- Etc.

Not sufficient to merely classify as a “Pump”

- Attributes, failure codes, PM plans etc. will be different for each subclass

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# Failure Hierarchies

- A set of codes that enable the user to classify the failure for grouping and analysis
  - Problem, Cause, Remedy
  - Object Part, Damage, Cause, Action
- Enables validation of failure mode assumptions
- Most CMMS/EAM systems have the capability to develop the code structure by class/subclass
  - Failure modes for a Centrifugal Pump are different than those of a Peristaltic Pump or a Vacuum Pump

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# Work Order Types

- Represents the types of work being performed
  - Preventive Maintenance
  - Predictive/Condition Based Maintenance
  - Corrective Maintenance
  - Corrective Maintenance as a result of a PM
  - Corrective Maintenance as a result of a PDM
  - Etc.
- Should not reflect work urgency or priority
- Some systems also allow classification by activity type, enabling further analytical granularity

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# Work Order Status Codes

- Tracks the work order through the various stages of its life:
  - Creation/Initiation through Closure
- Used to manage the flow of work through the system
  - Approvers query work orders in "created" status
  - Material expediters follow up on work orders in "waiting for material" status
  - Schedulers build schedules with work orders in "ready to schedule" status
- Status codes needed are determined by your work management process
  - Look for steps where people need to query the system to perform their job tasks

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# Transactional Data Quality

- Good Master Data quality is not enough; you must have a well-defined work order system
- The work order system should be mapped with a process flow diagram
  - Eliminates ambiguity and clearly spells out individual responsibilities
  - Excellent training tool
  - Provides a basis for performing a work order system audit

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# Work Process "Absolutes"

- No maintenance work shall be performed, and no maintenance parts shall be purchased without a work order
- Maintenance charges to the accounting system must flow through the work order system
- The system must be populated completely with high quality master data
- Well-designed code lists are required:
  - Work types
  - Activity types
  - Status codes
  - Failure codes
- Make code lists practical!

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# Work Order System Audit

- Examine critical attributes of the workflow
- Select a representative work order
- Gather all personnel associated with the work:
  - Requestor
  - Planner
  - Scheduler
  - Maintenance Supervisor
  - Crafts
  - Storeroom Attendant
- Make copies of relevant documents
- "Score" the work order

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# Data Summary

To effectively manage the maintenance function, you must have accurate and trustworthy information

The majority of this information comes from a good work management process with accurate static master data and transactional data

Remember, **BAD DATA IS WORSE THAN NO DATA!**

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# Equipment

- This is the record that represents a physical asset in the field
- Equipment is "installed" in a location
- The record houses equipment specific attribute information:
  - MFG, Model, Serial #, Class/Subclass
- Descriptions should be equipment specific without reference to process information
  - Not "Lube Oil pump motor"
  - Instead, "Motor, AC, 75HP, 365T, 460V, 85A, 1800RPM"

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# SMRP Best-in-Class Targets

- All metrics were evaluated
- Committee members assigned to create a Best-in-class target for that metric
- Researched authoritative guidance on targets
- Draft target along with the references was presented to the BP Committee
- Target values, along with any cautions and target references were incorporated into metrics documents

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# Next project for the Best Practices Committee

1. Guidance on setting up the Second Phase hierarchy of metrics?
2. Evaluate level of effort required and value to a support ISO 55000
3. Update Compendium to version 5
4. Increase delivery of Metric workshop

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# Feedback

Please let us know what you'd like changed so we can improve this workshop

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# Contacts

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