

Executing Procedure-Based Maintenance

Drew D. Troyer, CRE, CMRP
Noria Corporation

USS Thresher Disaster – 10 April 1963



- Ship lost during sea trials after first shipyard overhaul
 - 129 lives lost
- Flooding attributed to failure of seawater system component
- Skill-of-the-craft relied upon for component installation
- Subsafe program instituted to prevent recurrence
 - Procedure & checklist based
 - Successful to date

Perception of Risk Drives Reliability Investments

Cause of Death	NY Times' front page articles per 1000 deaths
Cancer	0.02
Homicide	1.7
AIDS	2.3
Aviation	138.2

An aviation related death gets more than 80 times the media coverage of a homicide!

- *Is it a coincidence that operations and maintenance work in the commercial aviation business is tightly controlled with standardized procedures?*
- *What is the lesson for general industry reliability?*

Joe Split, Now What?

Facts to Ponder:

- An alarming percentage of our North American maintenance techs are eligible for retirement today.
- Most of what they know about designing, operating and maintaining your facility resides in their heads. When they're gone, so is your intellectual property, a phenomenon referred to as "corporate amnesia" – literally forgetting how to run your business.
- Unfortunately, a great deal of what your techs know about maintaining your facility is wrong or outdated.
- Most managers trivialize maintenance, so little effort is applied to putting in place systems to standardize and sustain program.
- Most plants and mills will relearn how to maintain their plant by trial and error.



How much will "corporate amnesia" cost your company? Can you even survive it?

Standardize for Lean

Before Lean 5S

Scrounge

Steal

Scramble

Stash

Search

After Lean 5S

Sort

Set in Order

Shine

Standardize

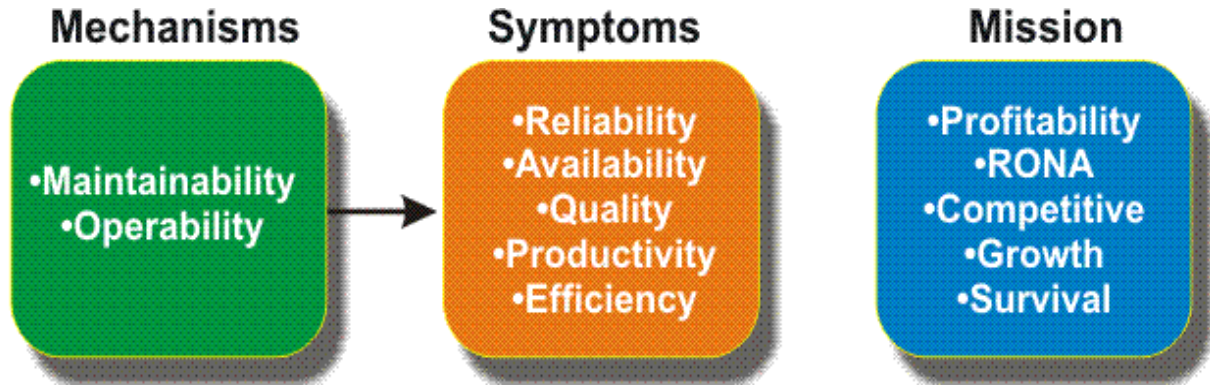
Sustain

Most American companies stop their 5S program at shine. In reality, they have a 3S program...

...standardizing work is a prerequisite to achieving sustained improvement.

Standardize Work for Profit

Standards are essential to lean operation



Causes

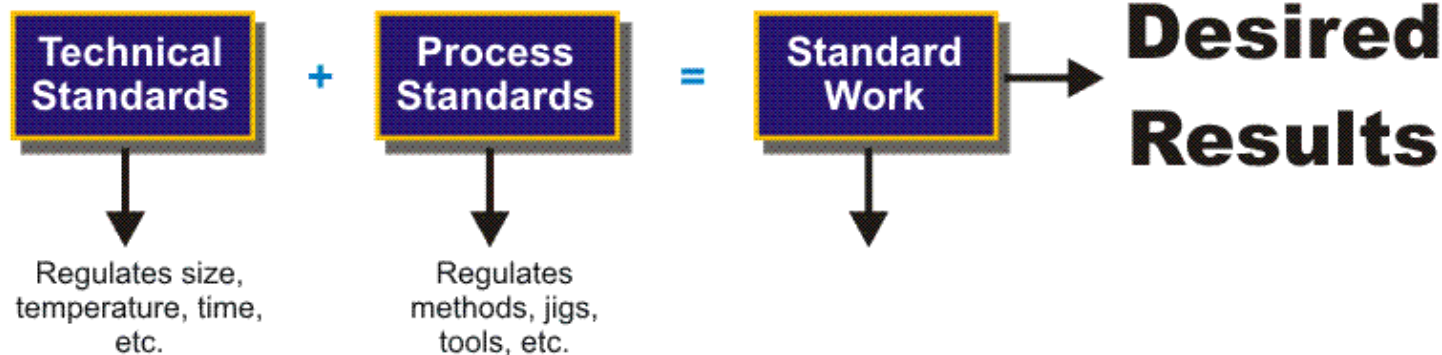


Summary of Standards

Type	Description
1. Regulations	Formally established task management methods
2. Quality standards	Quality requirements specified by customer to suppliers
3. Specifications	Customer-specified restrictions and conditions placed on parts and equipment suppliers
4. Technical standards	Detailed standards for manufacturing that stipulate dimensions, temperatures, ingredients, etc.
5. Process standards	Detailed work procedures (processes) - usually seen in work procedures sheets and instruction booklets - often abridged versions of procedures found in manuals
6. Manuals	Handbooks of detailed descriptions of work methods
7. Circular notices	Notices to inform people of new or revised standards
8. Memos	Used to communicate to manage extraordinary circumstances not otherwise standardized - also used for other types of notices, minutes, in-house reports, etc.

Work orders to “inspect the machine” or “PM the machine” aren’t procedures.

For Manufacturing:



People Plus Systems = Success

Systems Quality	Excellent	Succeed	Succeed and extend firms strategic advantage(s)
	Poor	Fail or leave firm (usually forced)	Fail or leave firm (usually voluntary) or change system
		Average	Exceptional
		People Quality	

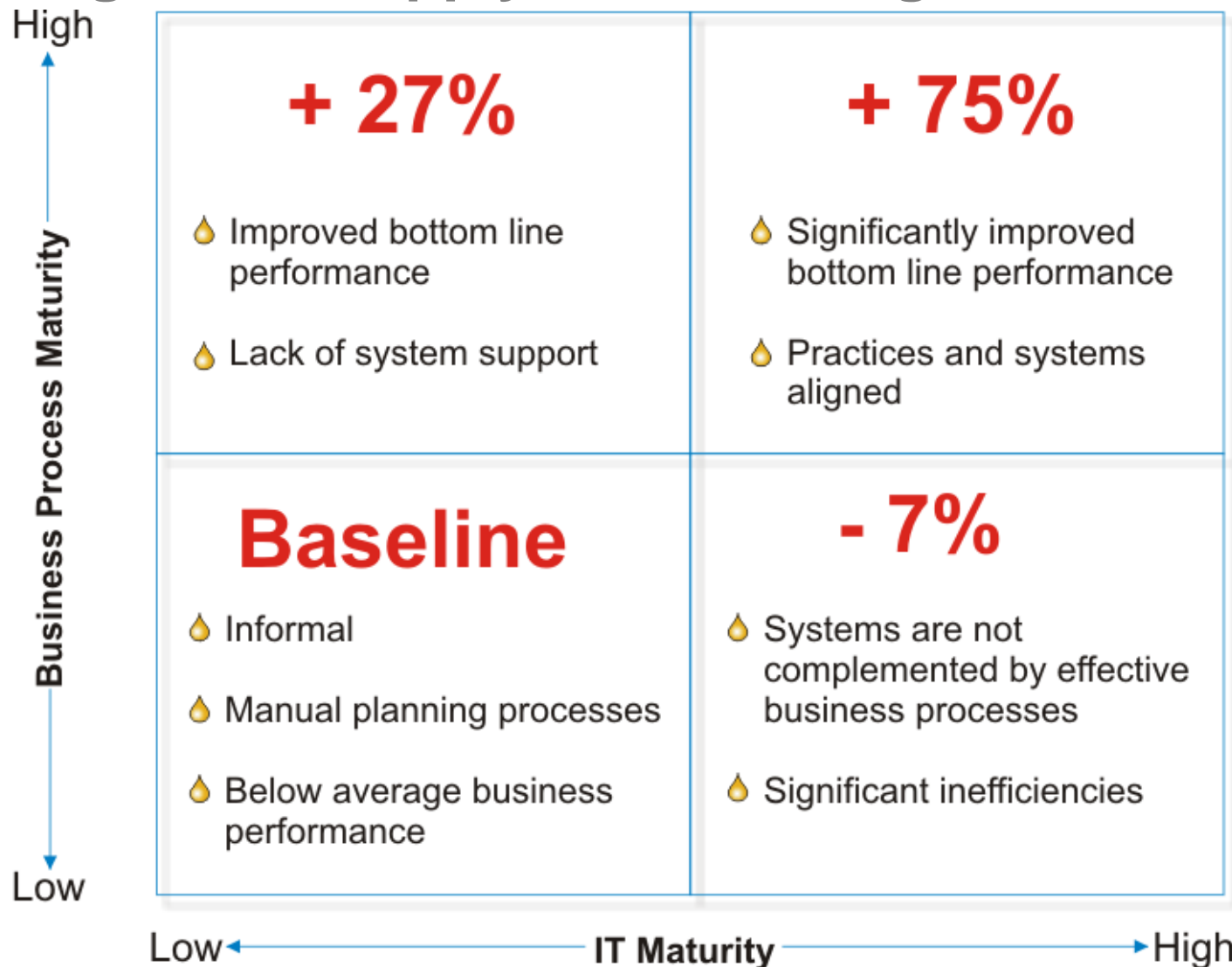
Top quality people can fail miserably in a bad system.

Conversely, average people can be very successful in a good system.

Effective system enablers:

- Leadership
- Game plan tied to corporate vision and mission
- Clearly defined roles and responsibilities
- Clearly defined and documented procedures
- Knowledge and skills management practices tied to processes and procedures.
- Performance measures tied to objectives
- Vision-centric rewards system

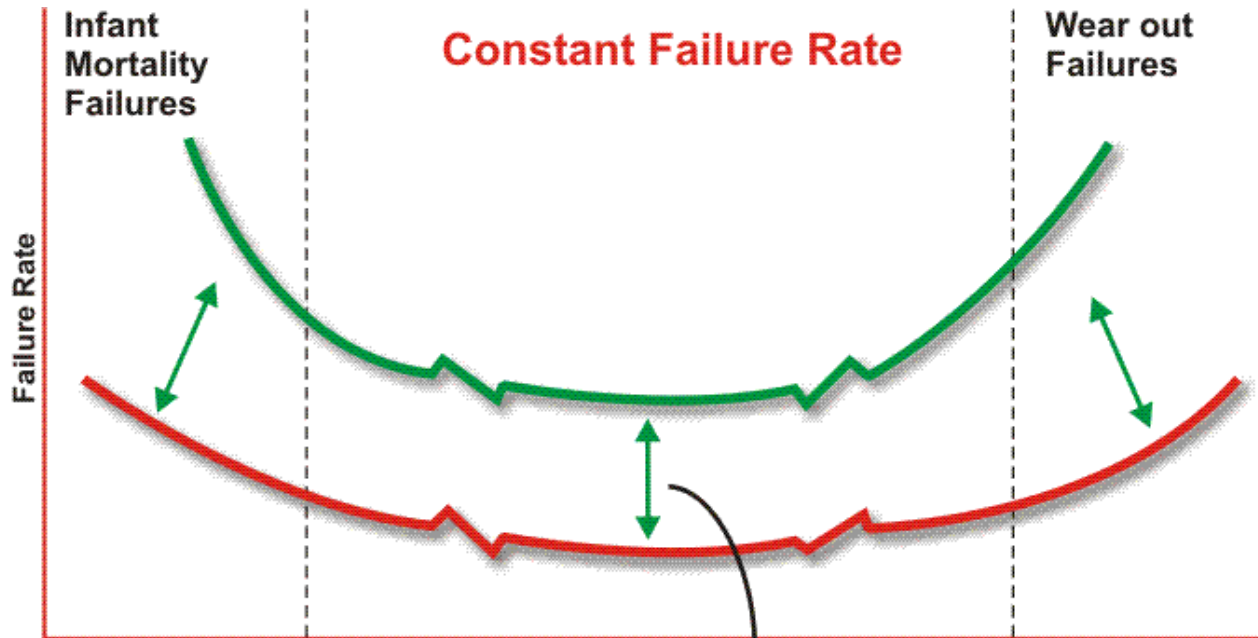
You Can't Just Buy Reliability...You Must Reengineer - Supply Chain Management Example



Standard Procedures Help You Keep Your Bathtub Clean

Reduce by Eliminating:

- Design defects
- Manufacturing defects
- Assembly and commissioning defects
- Operating defects
- Precision installation



Reduce by Managing:

- Overload Conditions
- Material Deterioration
- Fastener looseness
- Designed material selection

Reduce rate and extend service life by controlling:

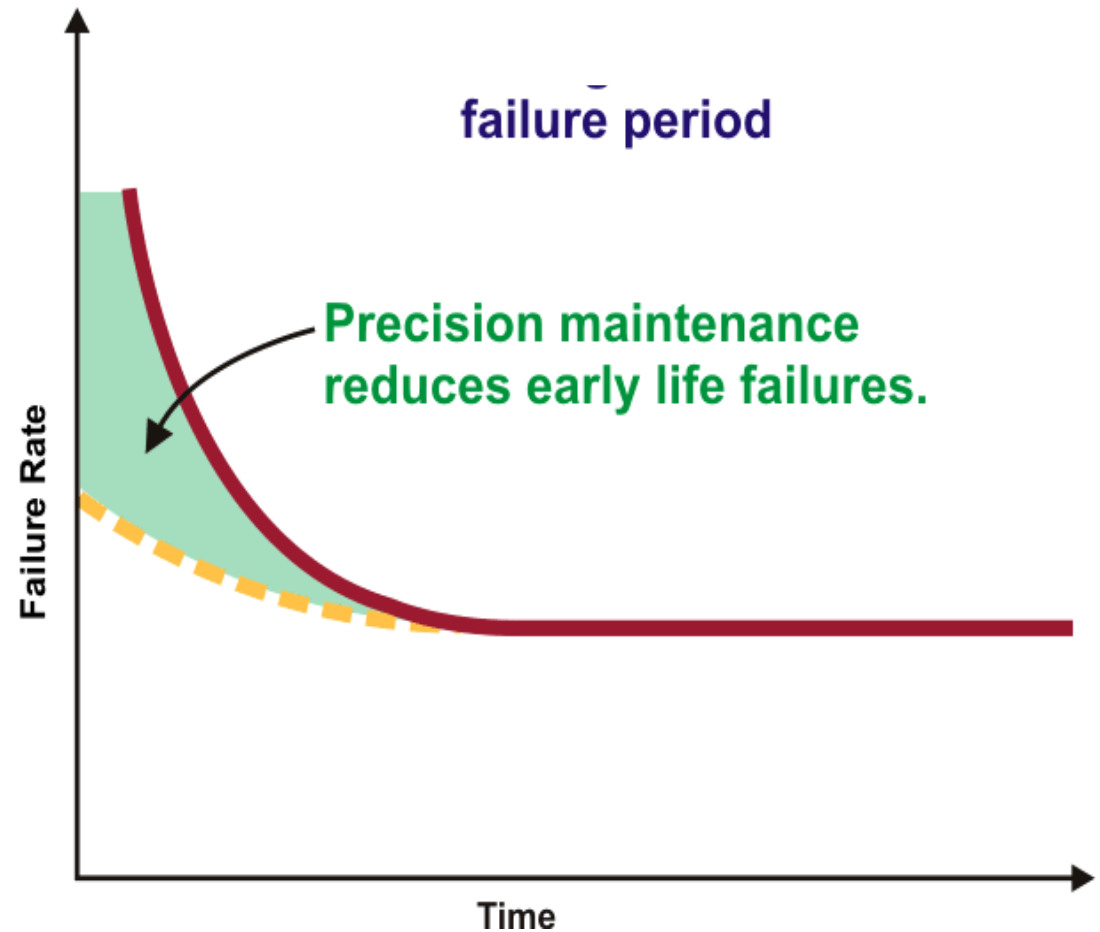
- Operational factors
- Environmental factors
 - Lubrication
 - Contamination
 - Etc.



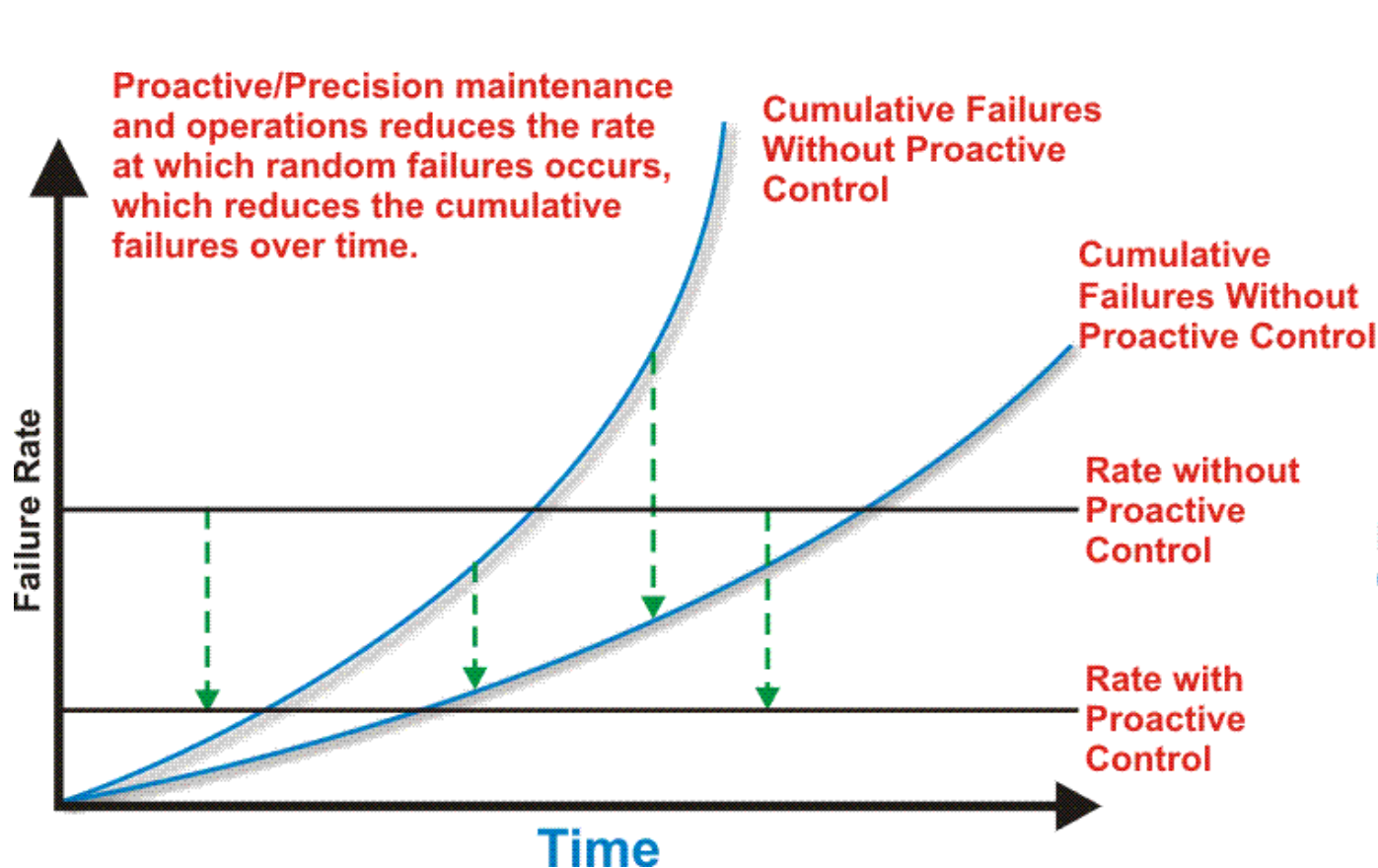
Standard Procedures are Required to Gain the Benefits of Precision Maintenance...

Precision Maintenance Avoids:

- Misalignment
- Unbalance
- Resonance
- Looseness
- Soft Foot
- Particle Contamination
- Chemical Contamination
- Moisture Contamination
- Excessive Heat
- Poor Lubrication



...And Proactive Control to Reduce the Steady State Failure Rate



Proactive/Precision Maintenance

- ⬢ Alignment
- ⬢ Balance
- ⬢ Installation
- ⬢ Fastner looseness
- ⬢ Lube contamination
- ⬢ Lube health and volume

Proactive/Precision Operation

- ⬢ Inspections/cleaning
- ⬢ Proper Start-up/Shutdown
- ⬢ Appropriate load/speed
- ⬢ Proper machine setup

Benefits of Procedure-based Manufacturing

Written Procedures

NORIA STANDARD PROCEDURES

Standard Maintenance NSP-S-002.01

General Considerations
 The importance of oil sample quality can not be overstated. Poor samples lead to poor decisions to act or not to act based upon falsely positive or negative oil analysis readings.

Some oil properties are generally homogenous and relatively unaffected by sample locations. They include:

- Viscosity
- Neutralization number
- FTIR for oxidation, sulfation, nitration and additive levels

Other properties are very dependent upon sample location. These include:

- Particle count
- Moisture levels
- Wear levels

Some general sampling guidelines include:

- Sample while operating under normal application and environment conditions
- Sample from live zones "on the run"
- Flush upstream of filters and downstream of components to assess the machine's condition
- Install testing sampling hardware that minimizes interference and allows samples to be drawn from the same place each time.
- Flush sampling ports effectively to reach the fluid of interest.
- Employ procedures that maximize data quality and consistency and minimize procedural noise and interference.
- Use clean bottles and tubing where required
- Sample at proper frequency
- Record sampling hours to "time normalize" the data
- Analyze or send the sample to the lab immediately
- Educate staff about the importance of high quality oil samples to the maintenance decision process.

• Train staff on the deployment of effective sampling procedures

Sampling Procedure
Drain-Port Location

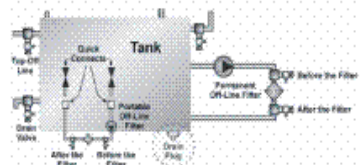
This method of sampling involves the removal of tank and sump drain plugs so that a sufficient quantity of oil can gravitate and drain into a sample container. Once the sample has been obtained the plug is threaded back into the port. In some cases an equal amount of makeup fluid must be added to the sump to make up for the fluid loss. In large tanks a ball valve often replaces the use of a pipe plug and serves as the tank drain.

Material Requirements for Obtaining a Sample

- An appropriate hand-wrench to extract the pipe plug from the port.
- A certified clean capped sample container
- A larger flushing container
- Bottle label
- Any other required documentation that will accompany the sample
- Appropriate shipping container(s) if the sample(s) is/are to be sent to an outside laboratory

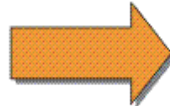
Sampling Procedure

1. Draw sample during normal operation or within 10 minutes of shutdown.

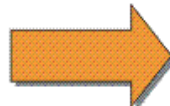


The diagram shows a cross-section of a tank with a drain port at the bottom. Labels include: Top-Off Line, Drain Valve, Quick Connector, Tank, Possible Off-Line Filter, Drain Plug, Filter, and Off-Line Filter. Arrows indicate the flow of oil from the tank through the drain port and filter into a sample container.

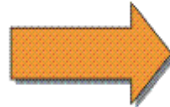
© Copyright Noria Corporation. Duplication or copying without written permission of Noria Corp. is strictly prohibited.



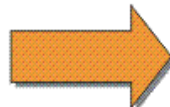
Clearly Define Best Practice



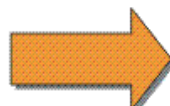
Consistency and Continuity



Reinforce Best Practice



Define Training and Certification



Enable Quality, Safety and Environmental Compliance

Anatomy of a Good Procedure

Unique identifier

General considerations including safety

Maintenance and operation procedures must reflect the environmental and operating context of the machine or system.

NORIA STANDARD PROCEDURES

Standard Maintenance NSP-S-002.01

General Considerations
 The importance of oil sample quality can not be overstated. Poor samples lead to poor decisions to act or not to act based upon falsely positive or negative of analysis readings.

Some oil properties are generally homogenous and relatively unaffected by sample locations. They include:

- Viscosity
- Neutralization number
- FTIR for oxidation, sulfation, nitration and additive levels

Other properties are very dependent upon sample location. Those include:

- Particle count
- Moisture levels
- Wear levels

Some general sampling guidelines include:

- Sample while operating under normal application and environment conditions
- Sample from live zones "on the run"
- Flush upstream of filters and downstream of components to assess the machine's condition
- Install testing sampling hardware that minimizes interference and allows samples to be drawn from the same place each time
- Flush sampling ports effectively to reach the fluid of interest
- Employ procedures that maximize data quality and consistency and minimize procedural noise and interference
- Use clean bottles and tubing where required
- Sample at proper frequency
- Record sampling hours to "time normalize" the data
- Analyze or send the sample to the lab immediately
- Educate staff about the importance of high quality oil samples to the maintenance decision process.

Sampling Procedure
Drain-Port Location
 This method of sampling involves the removal of tank and sump drain plugs so that a sufficient quantity of oil can gravitate and drain into a sample container. Once the sample has been obtained the plug is threaded back into the port. In some cases an equal amount of makeup fluid must be added to the sump to make up for the fluid loss; in large tanks a ball valve often replaces the use of a pipe plug and serves as the tank drain.

Material Requirements for Obtaining a Sample

- An appropriate hand-wrench to extract the pipe plug from the port
- A certified clean capped sample container
- A larger flushing container
- Bottle label
- Any other required documentation that will accompany the sample
- Appropriate shipping container(s) if the sample(s) is (are) to be sent to an outside laboratory

Sampling Procedure

1. Draw sample during normal operation or within 10 minutes of shutdown.

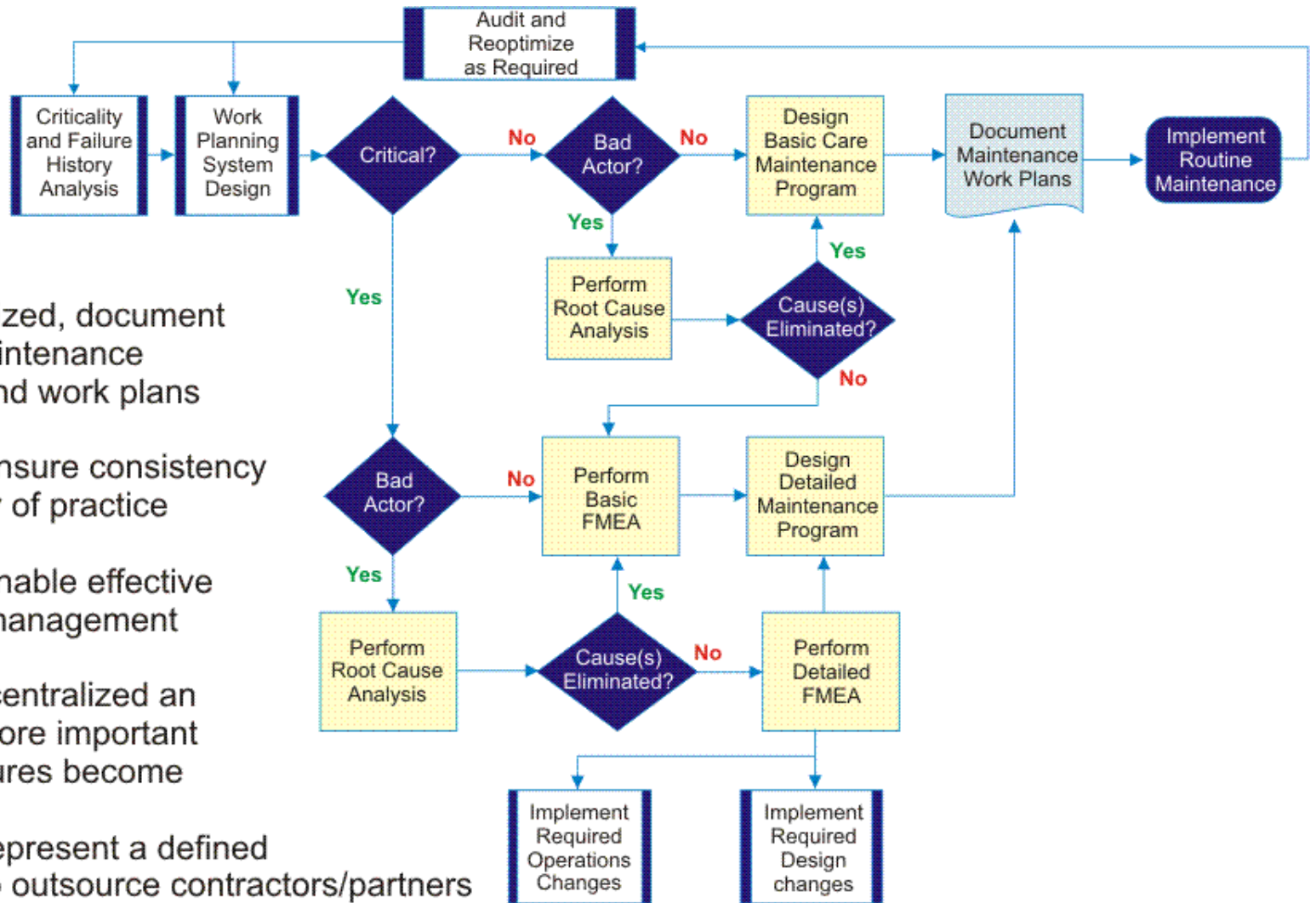
© Copyright Noria Corporation. Duplication or copying without written permission of Noria Corp. is strictly prohibited.

Material and tool requirements for kitting

Details specific to the particular procedure

Pictures and graphics to complement text

Procedure Based Maintenance - Routine Activities



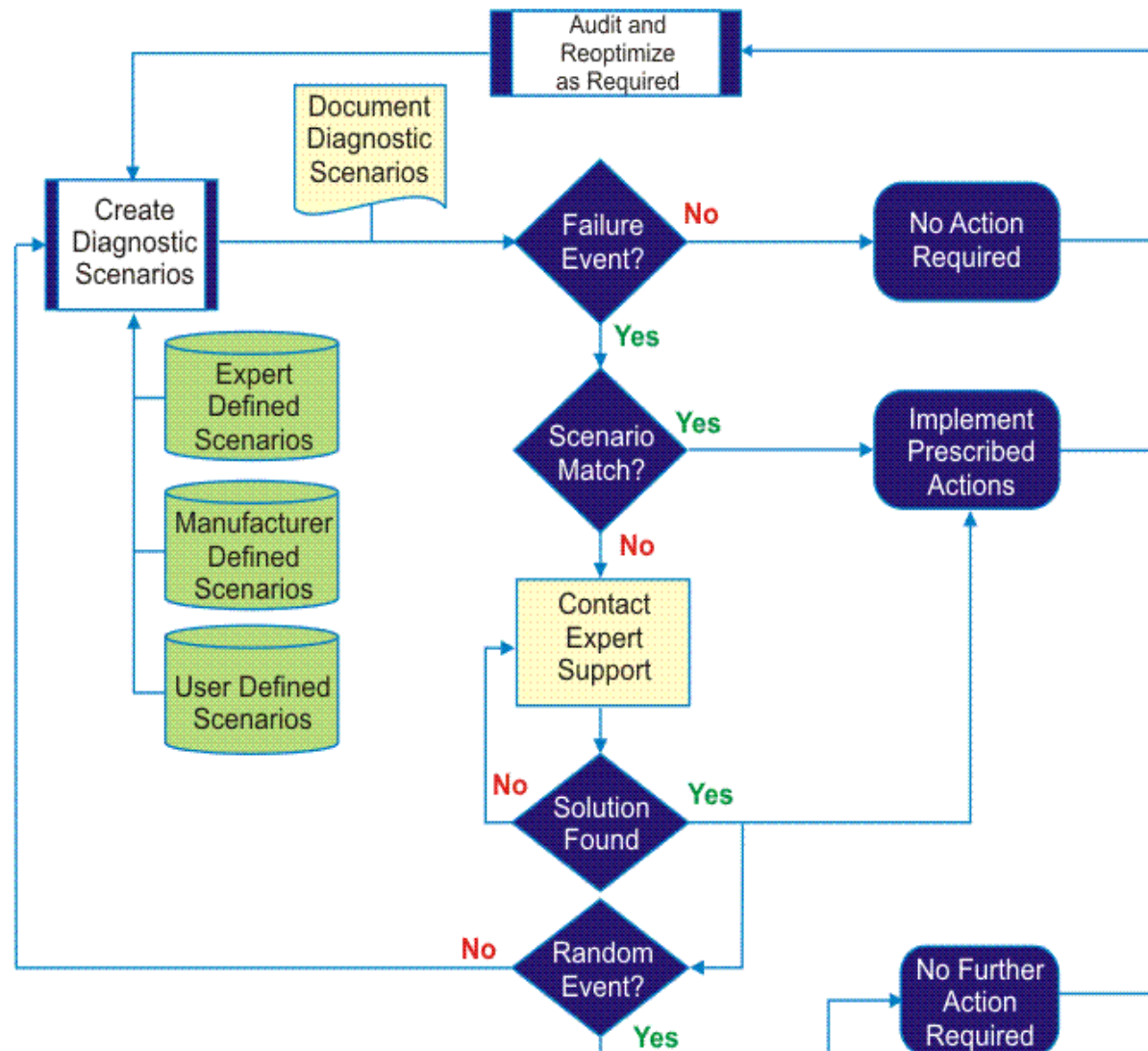
Key Points

- Once rationalized, document all routine maintenance procedures and work plans
- Procedures ensure consistency and continuity of practice
- Procedures enable effective training and management
- The more decentralized an activity, the more important detail procedures become
- Procedures represent a defined work scope to outsource contractors/partners

Procedure Based Maintenance – Diagnostic Scenarios

Key Points

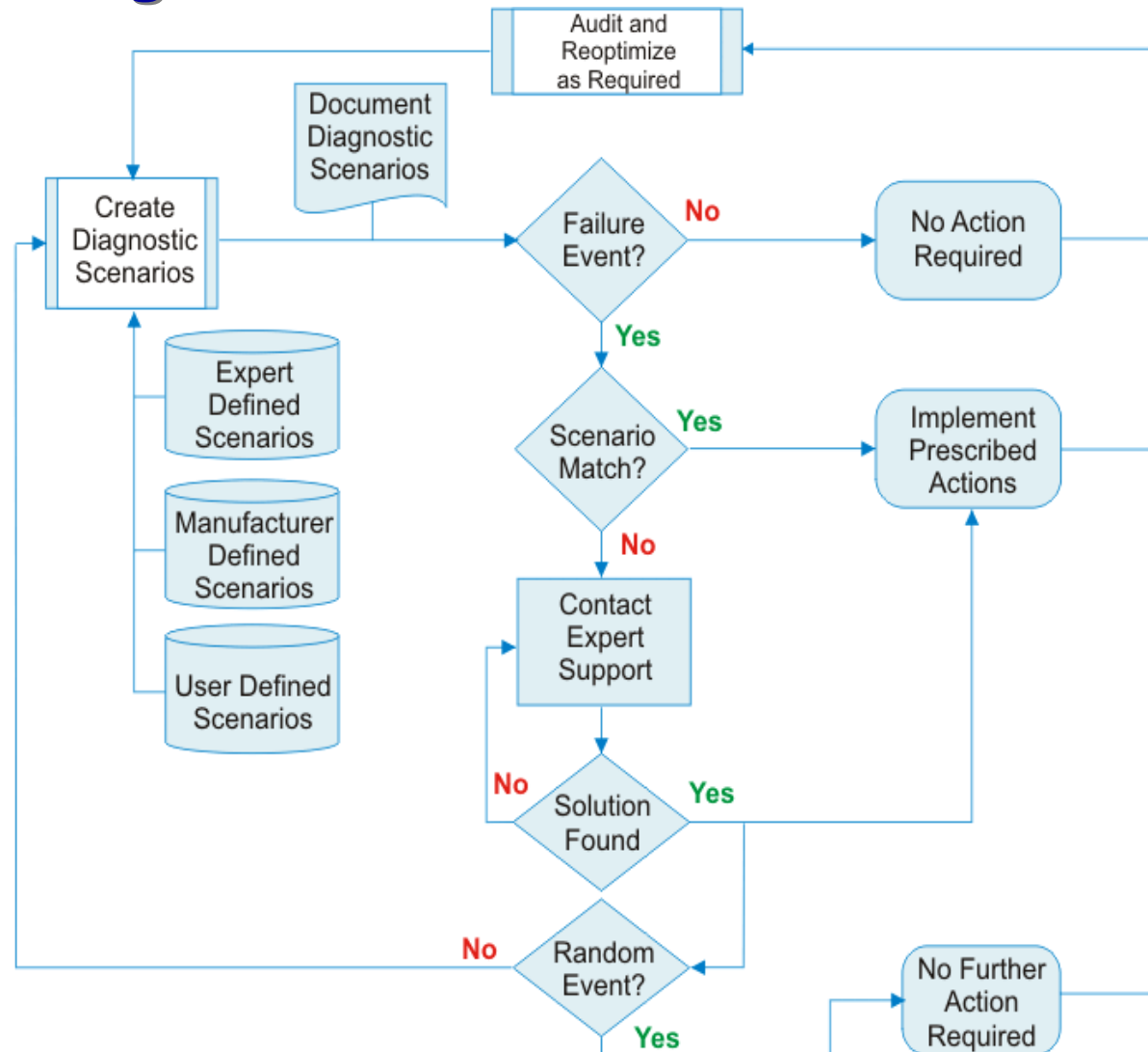
- Most diagnostic events are recurring and can be captured as a scenario
- It's important to incorporate the experience of users and the knowledge of experts and manufacturers
- Diagnostic and prescriptive scenarios must be connected with appropriate triggers
- Enables “knowledge scale economy” enterprise-wide implementation of practice
- Avoids “corporate amnesia”



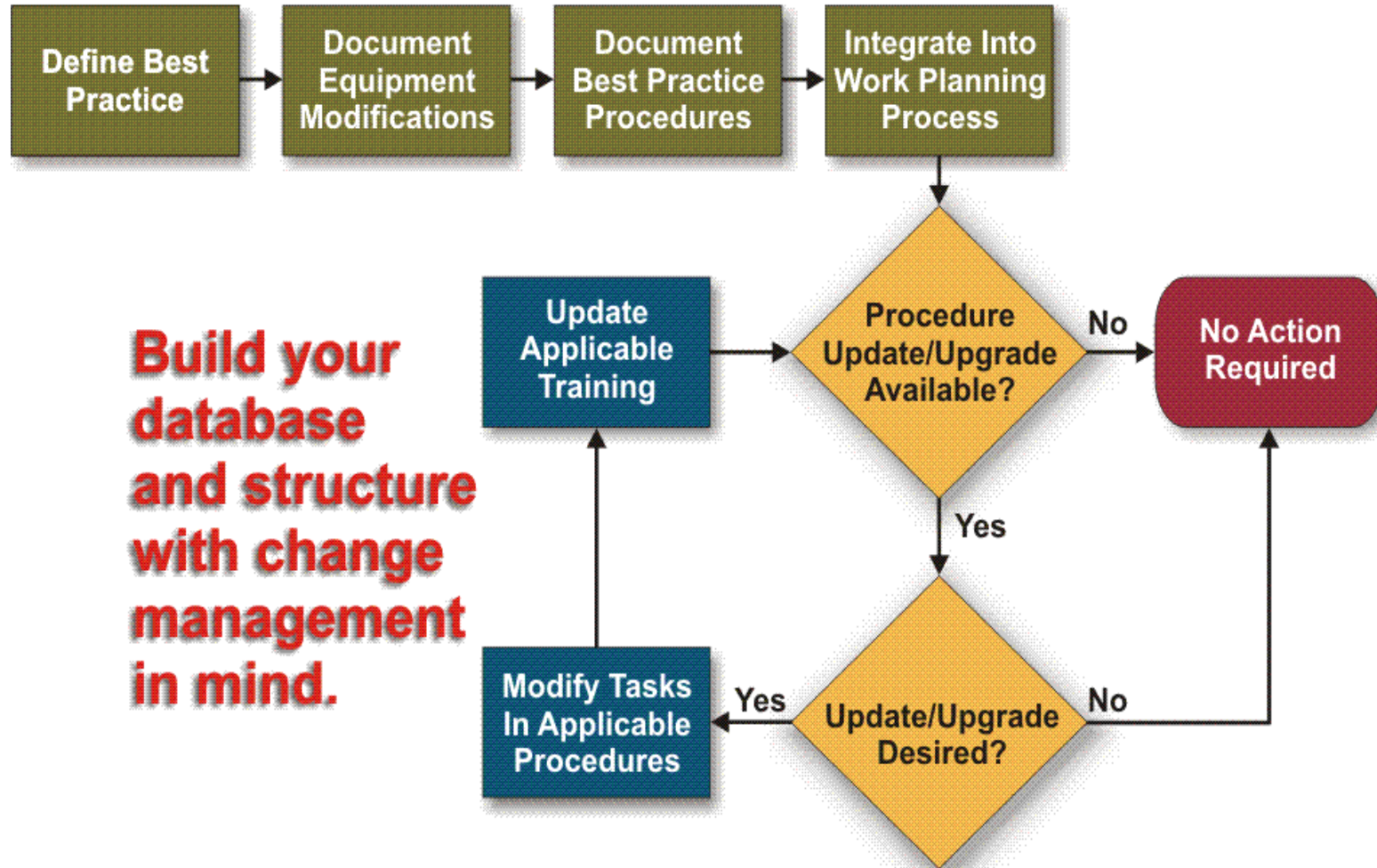
Procedure Based Maintenance – Diagnostic Scenarios

Key Points

- Most diagnostic events are recurring and can be captured as a scenario
- It's important to incorporate the experience of users and the knowledge of experts and manufacturers
- Diagnostic and prescriptive scenarios must be connected with appropriate triggers
- Enables knowledge scale economy enterprise-wide implementation of practice
- Avoids “corporate amnesia”



Procedure Development and Management



Build your database and structure with change management in mind.

Education is Key to Solving the Maintenance Paradox

Paradox

Maintenance has two problems:

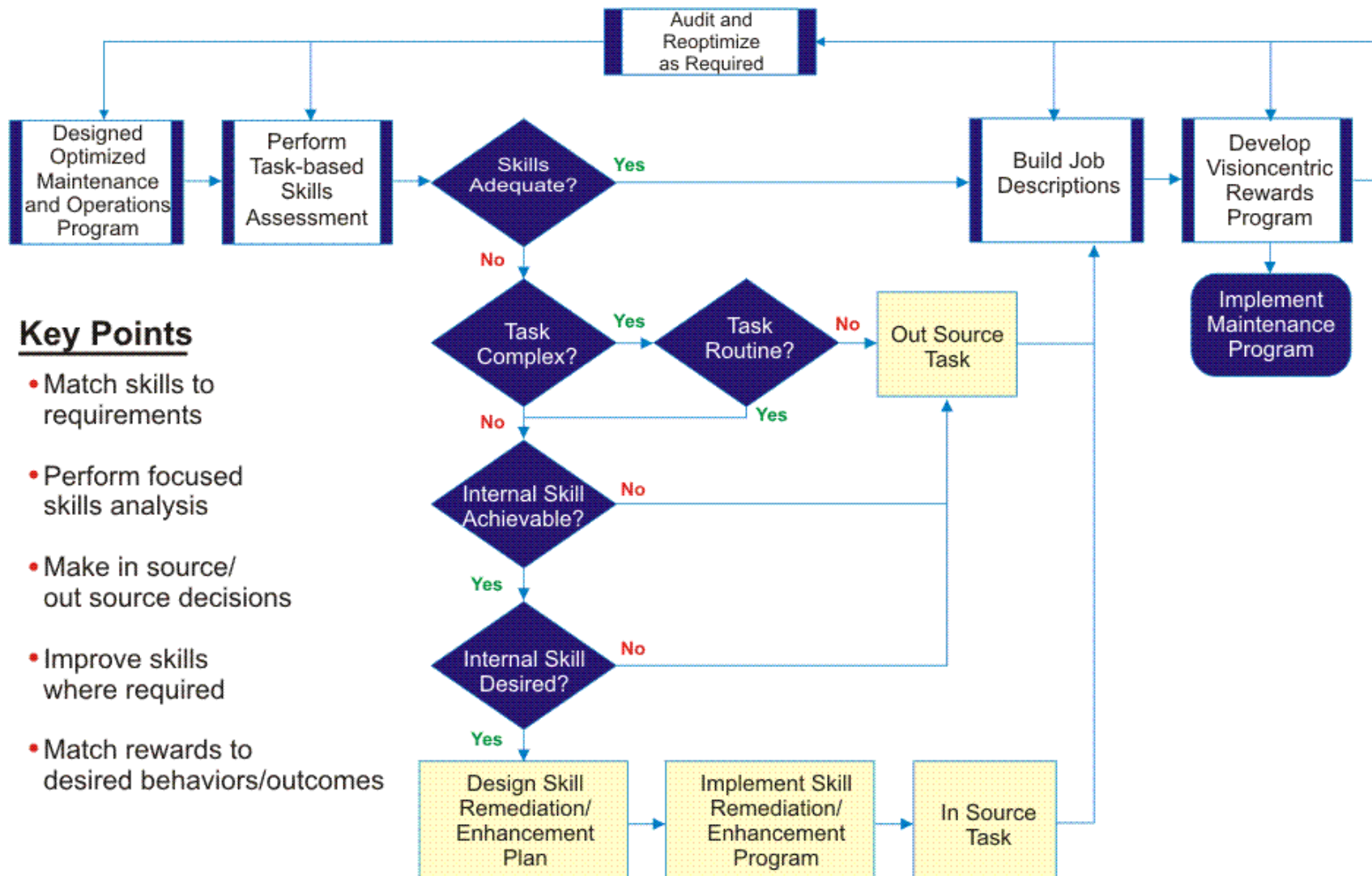
1. It's broken because we did not work on it.
2. It's broken because we did work on it.

Problems Restated

1. It's broken because we did not know how to prevent it from breaking (proactive). Or it's broken because we didn't know it was breaking and therefore didn't work on it (predictive).
2. It's broken because we didn't know it wasn't breaking and worked on it anyway (preventive). Or it's broken because we didn't know how working on it might cause it to break (training and skills).



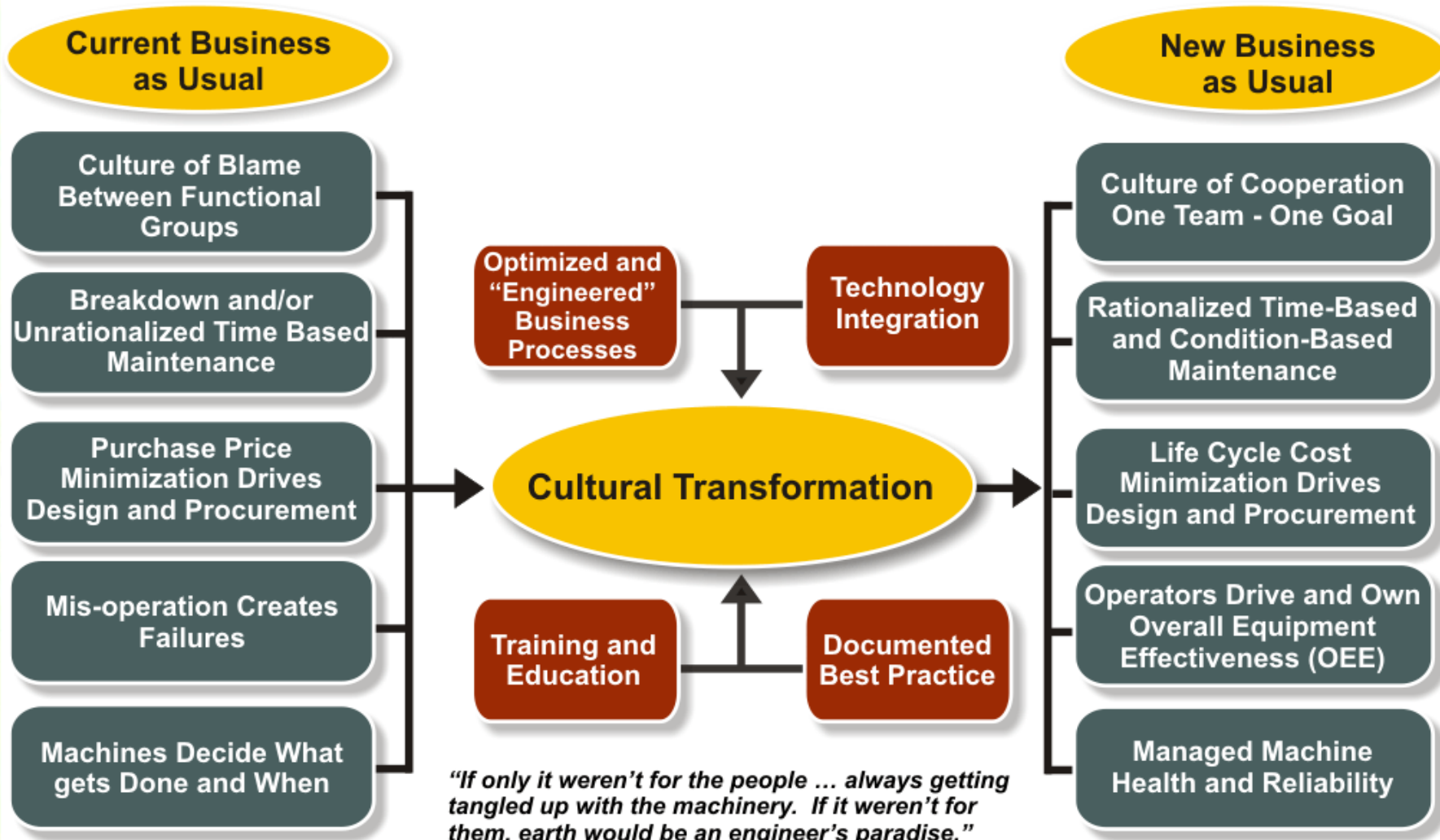
Connecting Skills Management to Procedures and Outsourcing Decisions



Key Points

- Match skills to requirements
- Perform focused skills analysis
- Make in source/ out source decisions
- Improve skills where required
- Match rewards to desired behaviors/outcomes

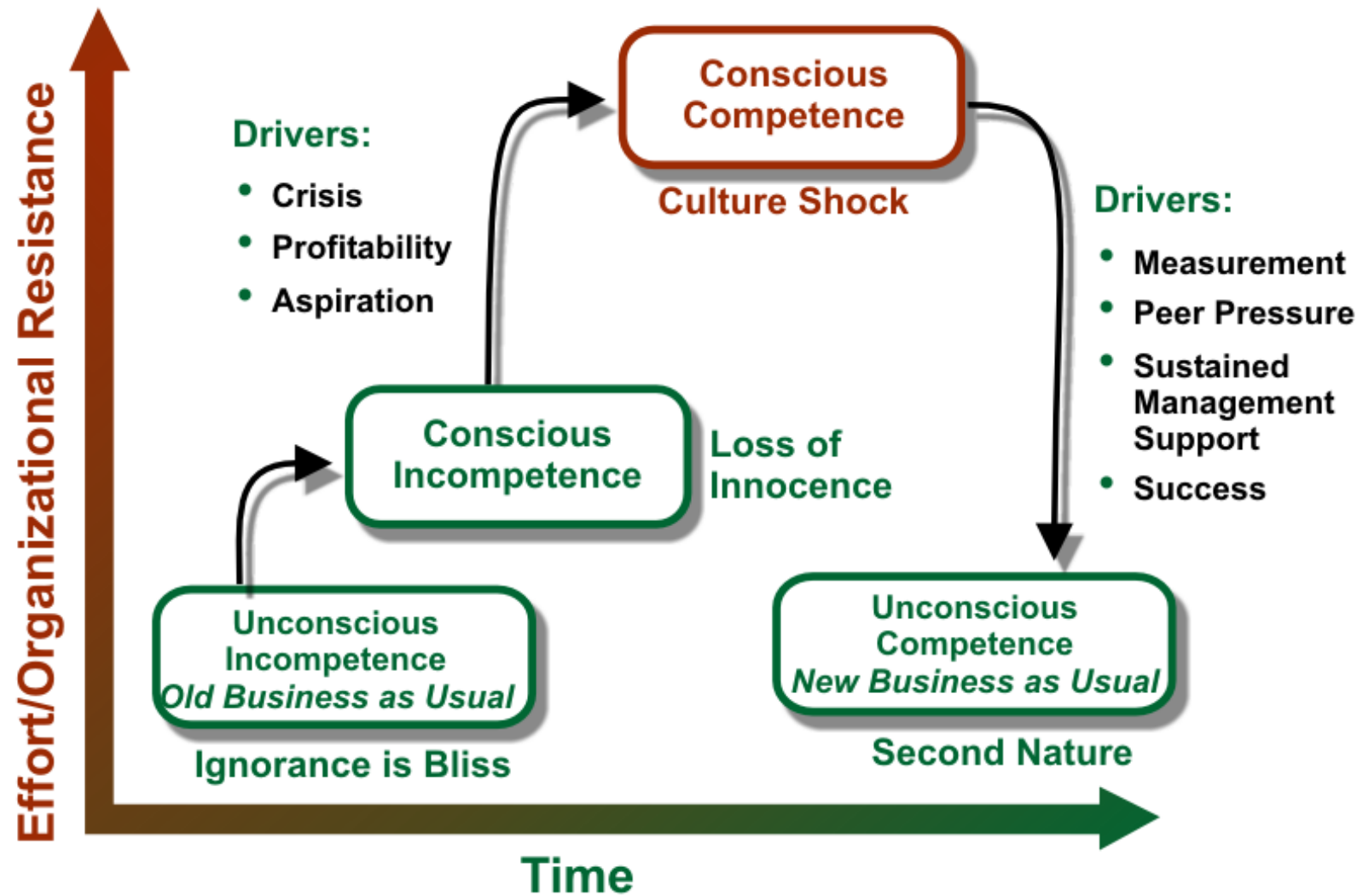
A New Business as Usual for Plant Reliability Management



"If only it weren't for the people ... always getting tangled up with the machinery. If it weren't for them, earth would be an engineer's paradise."

Kurt Vonnegut, Jr.

Time and Effort to Create a New “Business as Usual”



Comparing Productivity in the USA with Germany and Mexico

The 2004 figures below are for production workers in manufacturing:

Country	Productivity Per Hour	Cost Per Hour	Productivity Lever
USA	\$35.00	\$22.50	55.6%
Germany	\$31.00	\$31.50	-1.6%
Mexico	\$10.25	\$3.00	241.7%



Source:
The Economist –
December 17-23,
2005 issue, P-94.

Observations:

- As you may know, Germany's economy has recently been on the brink of collapse
- Executives depend upon figures such as these to determine where to invest capital
- Wage pressure occurs as countries develop – at \$6.50 per hour, Mexico will be on par with the USA – assuming no change in productivity
- Combining productivity with stability – the USA has a fighting chance – for now

Conclusions

- ◆ We can't continue to rely upon "tribal knowledge" as the basis for conducting maintenance work plans and procedures
- ◆ A large percentage of maintenance technicians are eligible for retirement today – what is your "corporate amnesia" risk factor?
- ◆ Airlines, nuclear power plants and critical military functions don't leave maintenance to chance – should you?
- ◆ Procedures define best practice, ensure consistency and continuity, serve as the basis for training and development and provide a basis for continuous improvement.
- ◆ Don't simply standardize what you do now – it could be wrong - take the opportunity to reengineer to incorporate best practice.
- ◆ Develop a system that facilitates management of change.