

TPM  **n Line.com**

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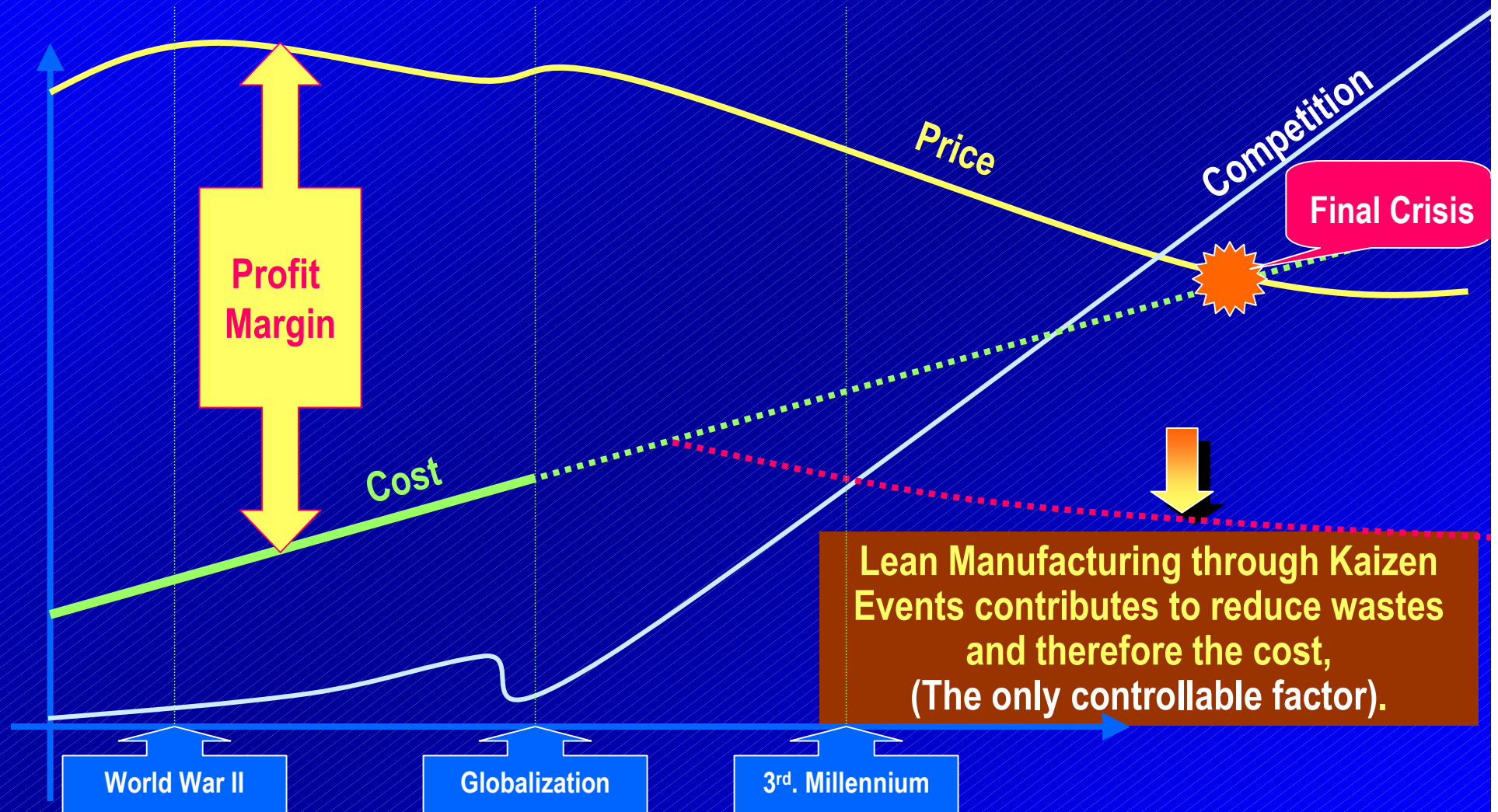
Productive

Maintenance

What We Will Review...

- The Origins of TPM. Why is it the foundation of Lean Manufacturing?
- Equipment Life Cycle
- The Original and the Human Structure of TPM
- Losses: Human Resources, Energy and supplies, Equipment related
- OEE Overall Equipment Effectiveness
- The 5Ss Discipline
 - Workplace Organization and the Value of Visual Controls
- The Training Process
- The Core of TPM: Autonomous Maintenance, One Point Lessons
- Maintenance:
 - Preventive
 - Planned
 - Prevented or Avoided
- Root Cause Analysis
- The Implementation Process
- Coordinator's responsibilities
- Visual Systems

Trends...

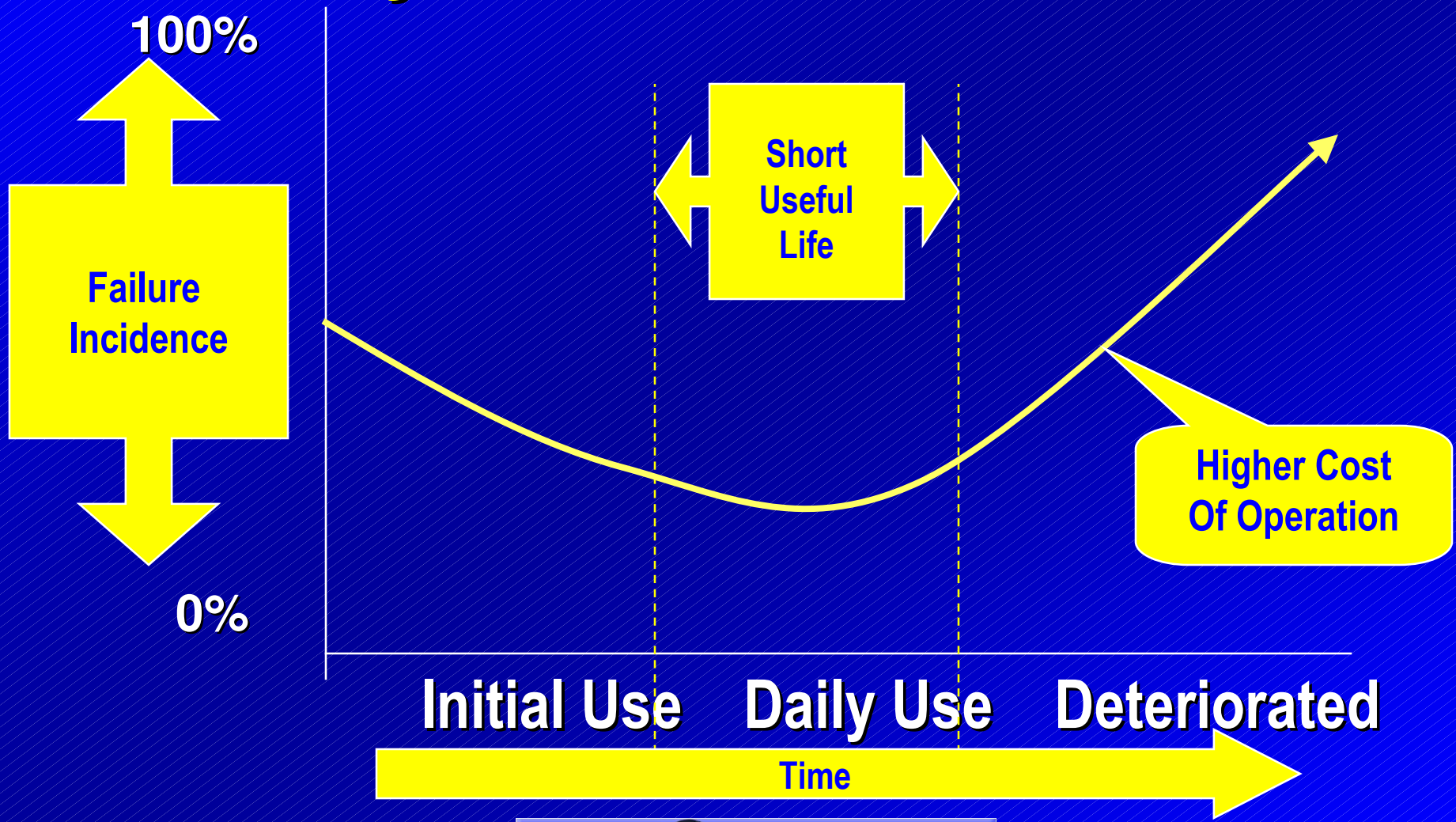


Based on Dr. W. E. Deming's statistical analysis, TPM is a Process to Identify and Eliminate Costs for the Whole Life Cycle of the Equipment...

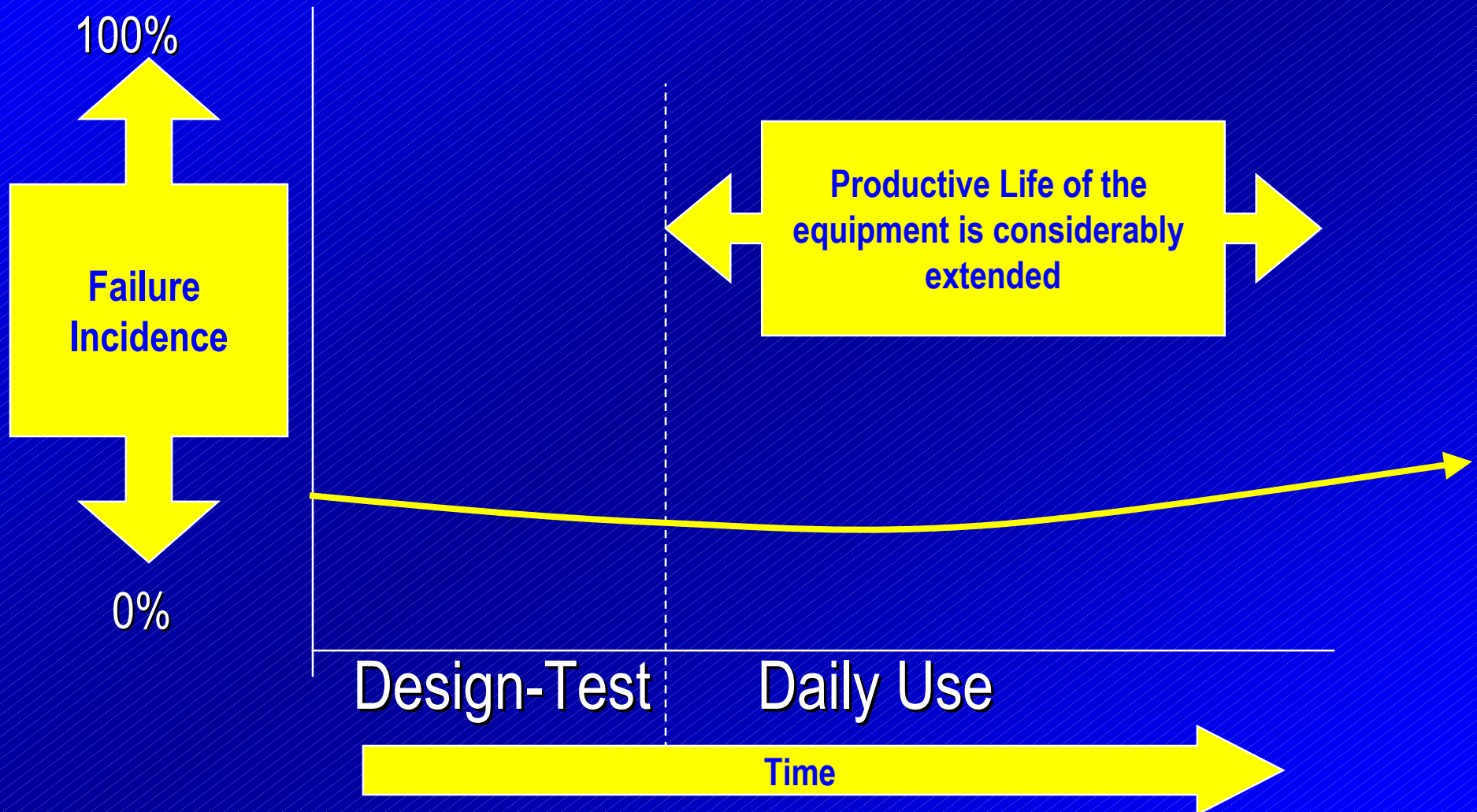


Equipment Life Cycle 

Traditional Equipment Life Cycle without T.P.M.



The Equipment Life Cycle With T.P.M.



Structure of TPM:
Any weakness in the elements
would keep it from performing

TPM

Planned
Maintenance

Preventive
Maintenance

Maintenance
Projects

Autonomous
Maintenance

Reliability
Centered
Maintenance

Education – Training – Management Support – Culturization

The 5 S Philosophy – Work Place Organization & Control

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Structure of TPM: Total Productive Management From the Human Point of View

TPM

Coordinated
Efforts to Understand
and Preserve
the Equipment

Mutual Support
and Innovative
Leadership
Structure

Education – Training – Management Support – Culturization

The 5 S Philosophy – Work Place Organization & Control

Applied
Human
Relations

Improved
Multi-level
Communication

Motivation
and Negotiation
Skills

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Leadership and Authority

- One of the most important advantages of TPM is the improvement in the Leadership environment
- People at different levels will increase their participation in decision making processes, relieving management from having to take care of the most minimal detail
- Only in a true leadership environment can we achieve maximum cooperation

Possible Losses in Human Resources

- Do we consider each employee as a person? Or do we hire them as if they were a mechanic device?
- We often waste very valuable features:
 - They are intelligent
 - They are creative, they have brilliant ideas
 - They are objective, imaginative
 - They can develop the right positive attitude
 - With a good communication we can take advantage of all these good characteristics.

Communication is The Key!

- In order to benefit from other people's cooperation we should become better communicators.
- When we communicate well, we will be able to help people motivate towards our positive goals.
 - They will have the opportunity to discover how their cooperation will generate benefits for them
- When we have disagreements, our good communication skills will help us achieve negotiation
 - When two people have different opinions, they both are right.
 - They base their opinions on their own knowledge and experience

Types of Losses on Equipment

- Major Breakdowns
- Adjustments, Tool Setups
- Minor Stoppages
- Lower performance than expected
- Wasted material-reworks-returns
- Shift or model start-up yields

Possible Wastes due to the Equipment

- **Material**
 - **Direct**
 - **Indirect**
- **Variations**
- **Operator Cycles**
- **Support Systems**

And... Speaking of wastes...

- Air, oil and steam leaks are so common that we tend to ignore them.
- We have lost the dimension of these losses because of “workshop blindness”.
- Let us see how far they can hurt us...

Compressed Air is NOT Free!

In this table we can estimate the amount of energy we may be wasting if our accumulated air leaks reach the size shown on the first column. To the cost of energy we should also add the compressors and equipment wear and tear, etc.

Leak Φ	CFM
1/16"	6.49
1/8"	26.00
1/4"	104.00
1/2"	415.00
3/4"	934.00
1"	1,661.00
2"	6,660.00

Each HP generates
4 to 5 CFM (at 100 PSI)
and each
HP = .75 KWH
We pay anywhere from
6 to 20 cents per KWH

This means:

We pay from
1 to 3.5 cents per CFM

Leak Φ	at: \$ 0.06	\$ 0.20KWH
1/16"	512	1,706
1/8"	2,050	6,833
1/4"	8,199	27,331
1/2"	32,718	109,062
3/4"	73,636	245,454
1"	130,953	603,175
2"	525,072	1,750,240

All calculations based on 100 PSI systems working 24 –7 – 365. The maximum per HP efficiency considered is 4.5 CFM.
Data supplied by Clear Dry Air, Inc.; Cummins-Wagner; Atlas Copco-Chicago Pneumatic Div.; compiled by TPMonLine

Oil Leaks Add UP!



Leaking...	Daily loss		Monthly Loss		Yearly loss	
	Gallons	Dollars	Gallons	Dollars	Gallons	Dollars
One drop per second	1	4.00	33	132.00	410	1,640.00
Two drops per second	2	8.00	67	268.00	821	3,284.00
Three drops per second	3	12.00	102	408.00	1227	4,908.00
Five drops per second	5	20.00	171	684.00	2045	8,180.00
Dripping stream	24	96.00	730	2,920.00	8760	35,040.00
1/16" stream.	84	336.00	2554	10,216.00	30660	122,640.00
1/8" stream.	268	1,072.00	7908	31,632.00	94900	379,600.00
3/16" stream	336	1,344.00	10220	40,880.00	122640	490,560.00
1/4" stream	936	3,744.00	28470	113,880.00	341640	1,366,560.00

Cost per gallon estimated at \$4.00 USD.
Add the cost of recycling, cleaning, etc..

Steam Losses

Example taken from a textile facility.
Each steam trap represents a 3/16"Ø leak.

<i>Total number of traps</i>	250
Cost of 1000 Pounds of steam (some plants may have a different cost)	\$ 5.00
Loss at a 3/16" leak @ 180 PSI	82.5 Lbs/ Hr
Loss in 24 hours of operation	1980 Lbs/ Day
Yearly loss @ \$5.00/1000 Lbs (360 Days)	\$ 3,564/ Year
3% Traps leaking = 8 Traps x \$3564/year	\$ 28,512/ Year
25% Traps leaking = 63 Traps x \$3564	\$ 224,532/ Year

Losses in U.S.Dollars

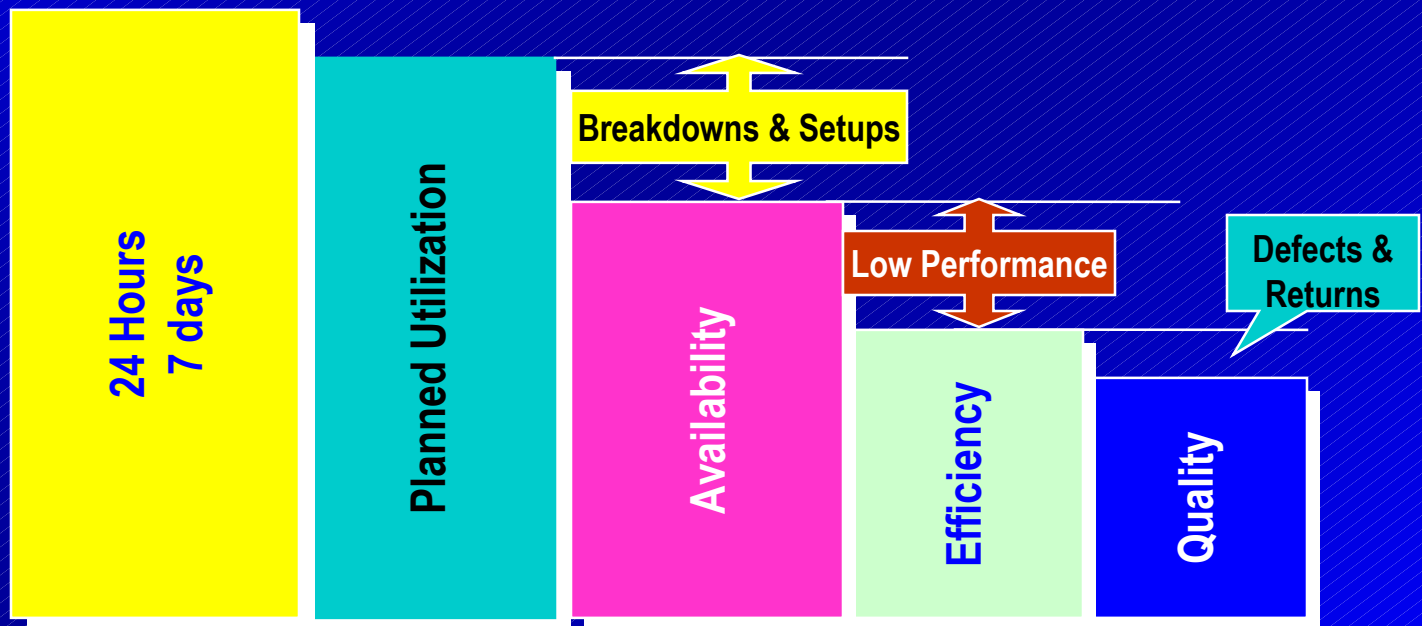
Calculations by Marshall Institute

OEE Overall Equipment Effectiveness

100%



0%



OEE Overall Equipment Effectiveness

Example:

Availability = 90+ %

x

Efficiency = 95+ %

x

Quality = 99+ %

= OEE = 85+ %

OEE Overall Equipment Effectiveness

Losses

Availability

Caused by:

Major Breakdowns
Setups Adjustments
of the Tooling, etc.

Efficiency

Caused by:

Minor Stoppages
Wrong Scheduling
or Expectancies

Quality

Caused by :

Waste/Rework
Rejects
Slow start of Shift/Lot

Work Place cleanliness and control...

5 S Program

The base for a “World Class” TPM Implementation

- Sort
- Set in place
- Shine
- Standardize
- Sustain

TPM Training Plan Through Kaizen Events

■ Identify optimal requirements

- Knowledge
- Skills
- Resources

■ Assess current situation

- Knowledge
- Skills
- Resources

■ Compare current situation to optimal and identify the differences

- Develop a sound, feasible plan to take care of the differences

Autonomous Maintenance

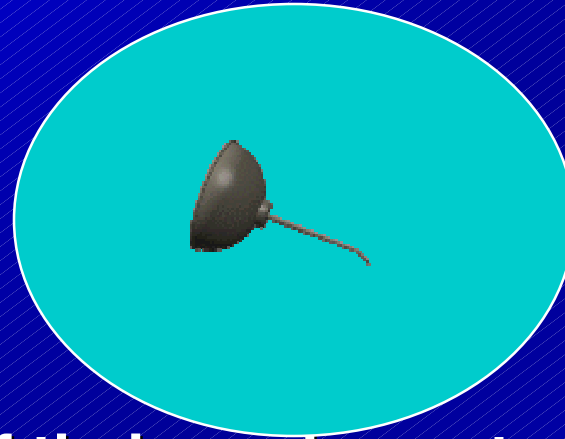
- It is a great advantage for each operator to become directly involved in continuous maintenance and improvement of his or her machine or equipment.

Autonomous Maintenance

- Clean, inspect, identify opportunities(5S)
- Apply 1st, 2nd & 3rd “S”
 - (Sort, Set in Place y Shine)
- Use the 3rd “S” to inspect the equipment
- **Tag** opportunities or discrepancies
 - Defects
 - Problems
 - Conditions are sub-standard
 - Conditions are different from “like new”
- Visual Deployment & Tag Verification
- Link to Maintenance Planned activity

Autonomous Maintenance

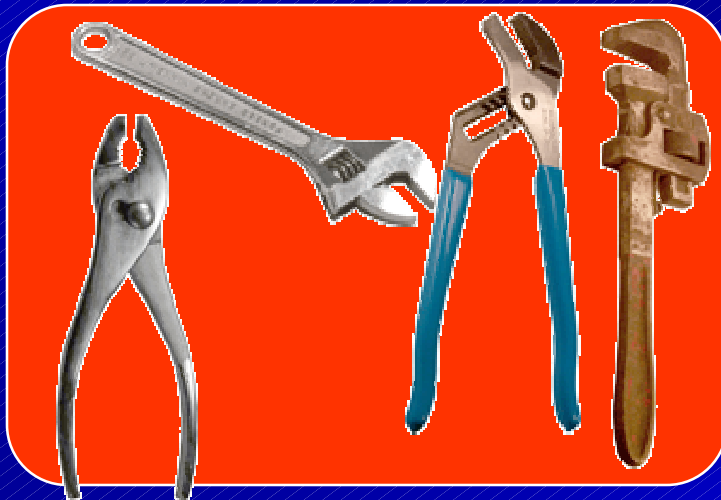
- The role of:
- **Operators**



- **Daily maintenance of their equipment**
- **Cleaning, Lubrication, Inspection**
- **Minor repairs**
- **Analysis data gathering**

Autonomous Maintenance

- **Maintenance personnel**
 - Major repairs
 - Planned Maintenance
 - Reliability Centered Maintenance (RCM)
 - Equipment development and improvement
 - “OPL” One Point Lessons
 - Professional approach... Use of the Right Tools (not the ones on the left)...



One Point Lessons

- Considered a key element in the development of Autonomous Maintenance, the OPL is an activity that gives the opportunity to the maintenance technicians and operators to share some of their knowledge on the machine and the process and to learn something new from each other.
- They will focus on one particular issue each time and develop a lesson that takes just a few minutes, then share it with their fellow operators and technicians.

One Point Lessons

- Operators and technicians will prepare these lessons using a piece of paper or cardboard and may enhance them with pictures and diagrams that will help the quick understanding of the subject and make it memorable and unique.
 - Sometimes a physical part will come handy.
- The lesson consists of three points:
 - 1. What will be explained...
 - A motivating message that shows why and how they will benefit.
 - 2. The explanation itself
 - 3. What was explained...
 - This will be the “feedback” part of the lesson

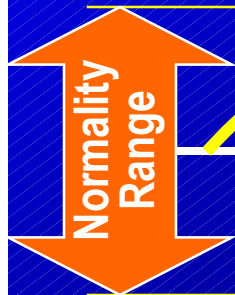
5 days +\$20,000 dollars!!!

Autonomous Maintenance



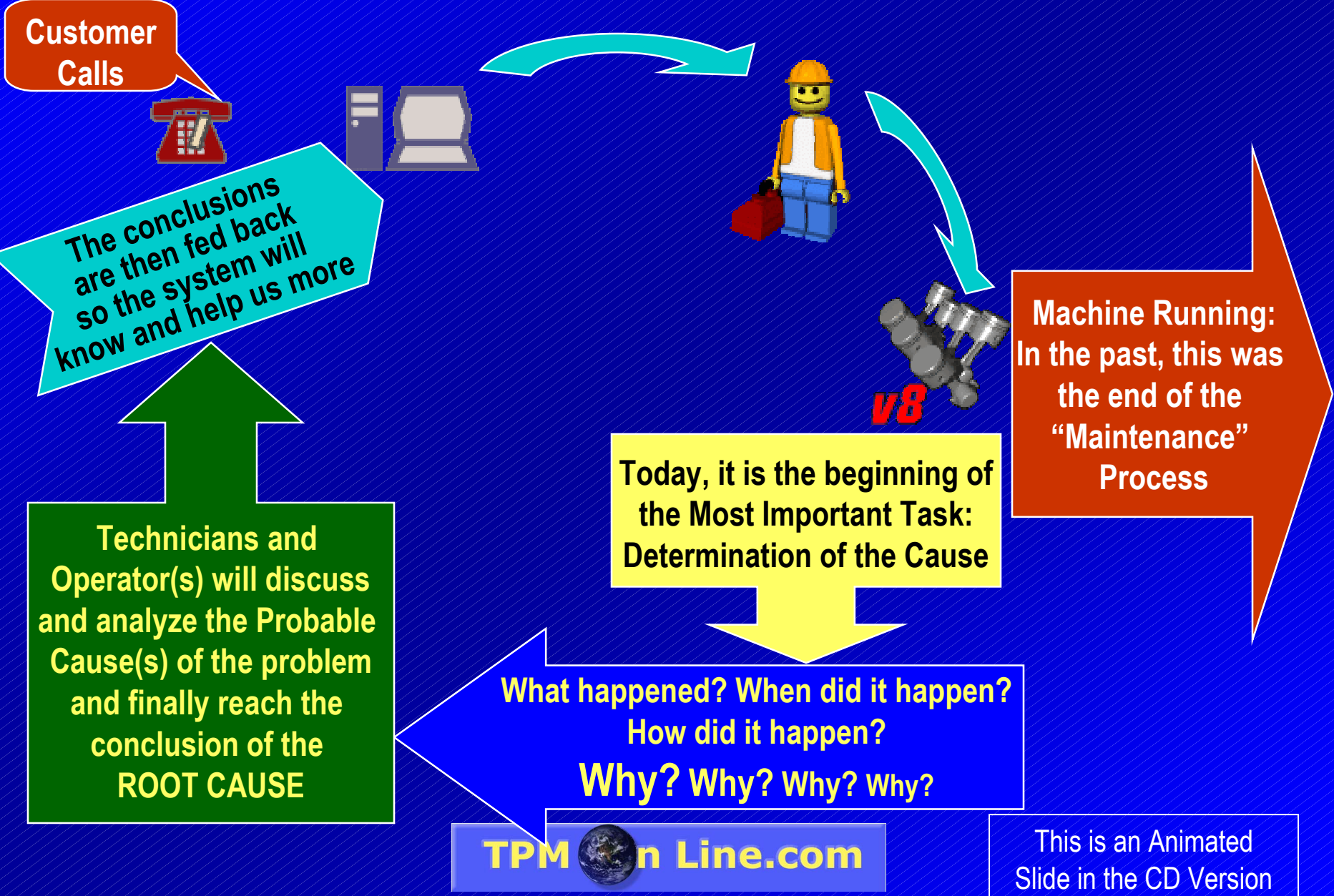
Evidence of Abnormality

200 dollars
5 minutes



When operators know and understand their machine, the daily inspection will allow for them to detect any abnormality in: Temperature, sound, speed, vibration. Then, a scheduled maintenance activity will take place. Maintenance is not about repairing machines when they break down, but doing what it takes to keep them working well.

The Maintenance Work Order Cycle...



Preventive Maintenance

- Follow Equipment Manufacturer's recommendations
- Redundant problems root cause analysis. Cost effectiveness analysis.
- Technical information and data based approach
- Purpose:
 - Increase time between breakdowns (Reliability)
 - Reduce time to repair equipment (Maintainability)

Kaizen Initiatives Advanced Maintenance Projects

- **Kaizen teams developing the 5S**
- **Specific problem/project**
- **Define beginning and end**
- **Typical Subjects:**
 - **Setups**
 - **Major Planned Stoppages**
 - **Development / Reengineering of Equipment and Installations**

Planned Maintenance

- **Scheduled Maintenance Activity**
- **Purpose: Avoid breakdowns**
- **“PM” (preventive maintenance)**

Maintenance Prevention

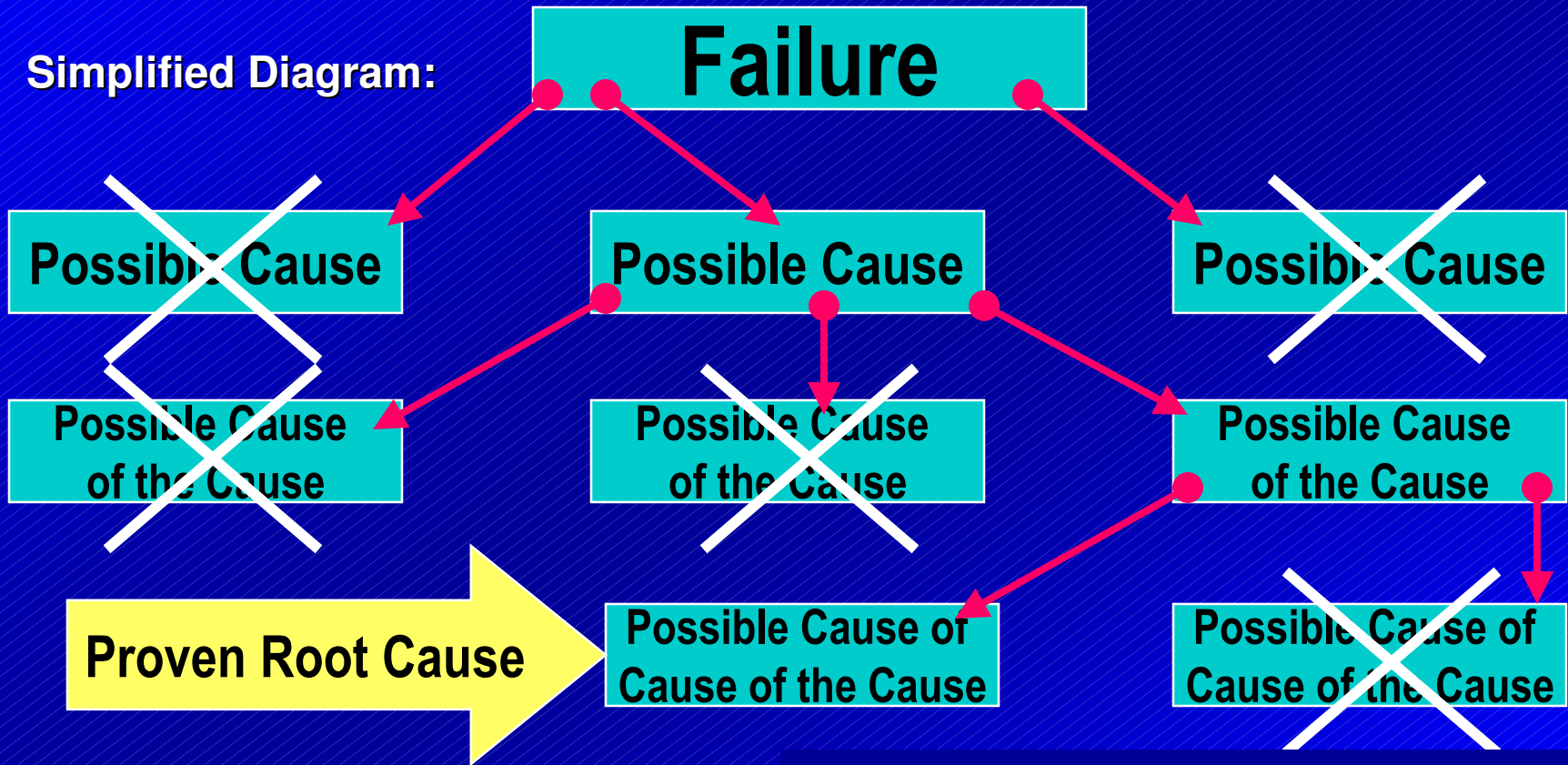
- **Design/develop** breakdown free, self-maintained equipment
- **Bring together multidisciplinary teams**
 - Operators, Engineers, Maintenance Technicians
- **Will intervene in:**
 - Design
 - Construction
 - Testing and Tryout
 - Installation
 - Launching
- **Benchmark other TPM projects in and out.**

Root Cause Analysis

- RCA is one of the most important advancements in TPM. Without a doubt, it is the way to prevent recurrence of problems.
- The process can be as extensive as needed depending on the importance of the problem.
- The participation of technicians, operators and some other people will be very valuable towards achieving the best results.
- The use of diagrams and pictures is highly recommended.

Root Cause Analysis

Simplified Diagram:



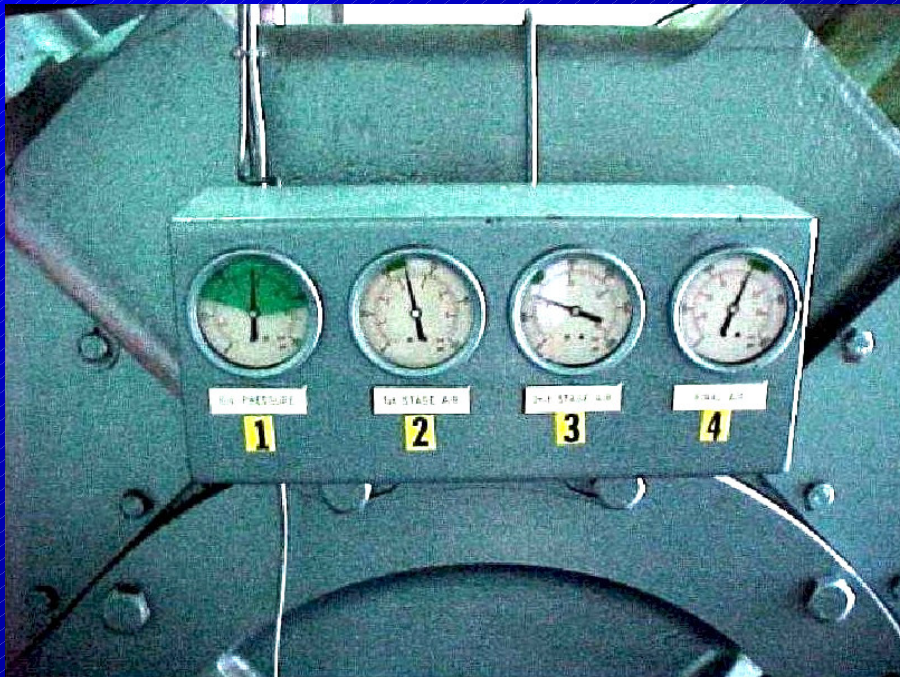
There may be more than three causes in each level and as many levels as needed..

The Visual Systems...

The language for the machine to tell us
how it is doing... Bob Williamson

- **No gauge or measuring device should be without a clear indication of:**
 - What is it measuring?
 - What should the right values be?
- **All rotating devices should:...**
 - Show the correct direction of rotation
 - Ball bearing and seal numbers printed on each of them will save downtime

Visual Systems



Fotos del artículo de Bob Williamson publicado en TPMonLine

They are a way for the equipment to communicate with us.

We can be creative so this is an effective communication:

- Green film or lines indicate the correct operating ranges...
- Numbers show the sequence of reading
- Signs to let anyone know what we are measuring

Visual Systems



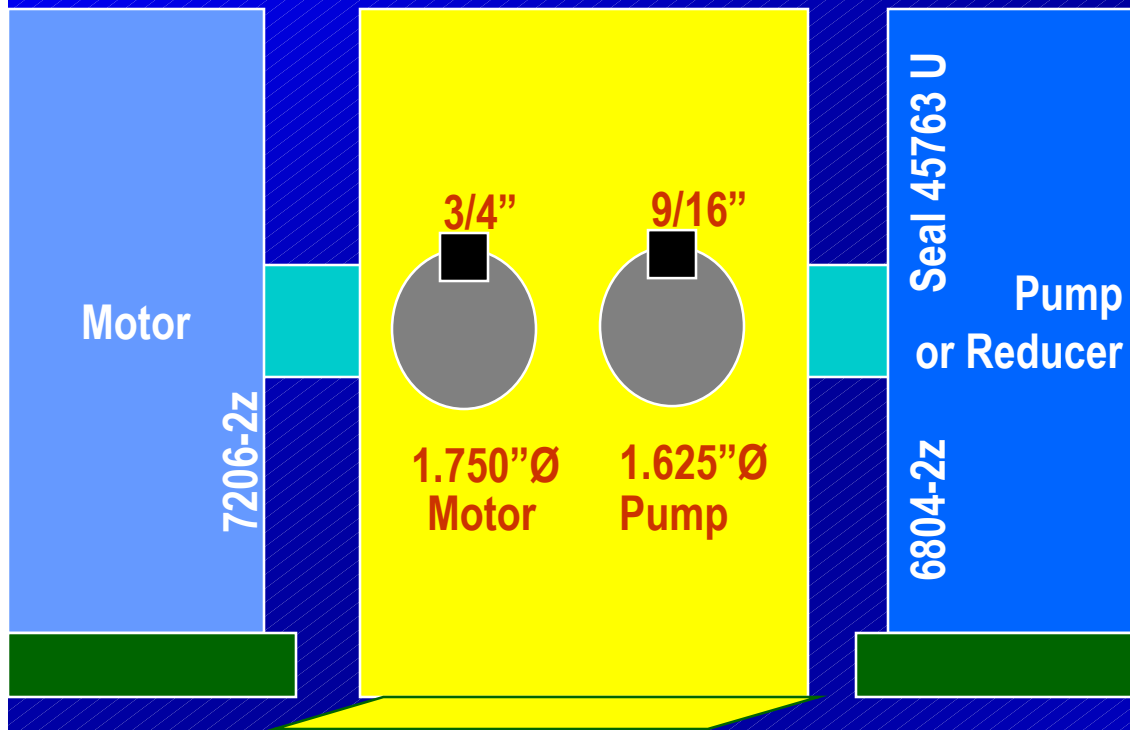
Fotos del artículo de Bob Williamson publicado en TPMonLine

They ease the operators' and technicians' jobs.

Help prevent mistakes by telling us:

- The type of lubricant or fuel to add and where to add it
- The correct rotation of the machine
- Type of belt or chain it requires, etc.

Visual Systems



When we need to replace a coupling, it is very useful to know in advance the diameter of the shafts and the width of the key as we schedule the change. These can show on the coupling cover.

It is also wise to print on the motor and other equipment the numbers of the bearings and seals that are used in them.

These measures increase maintainability reducing time and cost.

Implementation Model

1.) Planning

Analysis
Comparison
Policies & Goals
Master Plan

2.) Communication

Announcement
Organization
Continual Education
New Mindset

3.) Launch the program

Visible kick off
Teams, education, training,
Kaizen events
Autonomous, Planned and
Preventive Maintenance

4.) Sustain

Increasing responsibilities
awareness. Follow up.
Make statement of permanence.
This is not the
“program of the month”
Or “the flavor of the week”

The Role of the Coordinator – Facilitator

- **To know:**

- Their Plant
- Their Process
- Their Necessities
- Their Human Resources
- Their Material Resources

- **To disseminate the TPM Culture by:**

- Giving presentations to multi-level groups
- Giving individual presentations to...
 - Managers
 - Operators
 - Technicians
 - Anyone who would want to listen to them

The Role of the Coordinator – Facilitator

■ Schedule:

- Creating a Master Plan and keep it working in agreement with the customers' requirements & needs
- Training and implementation workshops

■ Coordinate:

- The most concerning needs of each area
- The resources needed in order to solve them

■ Communicate: (Using: Bulletin Boards, Fliers, Intranet)

- Projects
- Accomplishments
- Results

■ Justify:

- Resources
- Time

MORA International Consulting Services will answer or clarify any questions or doubts about this subject..

- **Please contact**
- **MORA International Consulting Services**
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