What is Maintenance?

“the work of keeping something in proper condition; upkeep”

Maintenance is the management, control, execution and quality of those activities which ensure optimum levels of availability and overall performance of plant are achieved to meet business objectives.

Nothing lasts forever

approaches to maintenance

main types of maintenance operations

- reactive maintenance
- preventive maintenance
- predictive maintenance
- reliability centred maintenance
- others

STUDY 2000

- >55% Reactive
- 31% Preventive
- 12% Predictive
- 2% Other

REACTIVE MAINTENANCE

run it till it breaks

Advantages

- Low cost (until equipment fails)
- Less Maintenance Manpower

Disadvantages

- Increased and incremental cost due to unpredicted downtime of equipment
- Increased labour cost, especially if overtime is needed
- Cost (possibly very high) involved with repair or replacement of equipment
- Possible chain reaction: secondary equipment or process damage consequential to equipment failure
- Inefficient use of resources (in the long run)

PREVENTIVE MAINTENANCE

PREVENTIVE MAINTENANCE

PREVENTIVE MAINTENANCE

PREDICTIVE MAINTENANCE

PREDICTIVE MAINTENANCE

PREDICTIVE MAINTENANCE

about RISK & RELIABILITY

FMEA
(Failure Mode and Effect Analysis)

FMECA
(Failure Modes, Effects and Criticality Analysis)

about RISK & RELIABILITY

FTA
(Fault Tree Analysis)

RELIABILITY CENTRED MAINTENANCE

RELIABILITY CENTRED MAINTENANCE

RELIABILITY CENTRED MAINTENANCE

RBM – RISK BASED MAINTENANCE
RBI – RISK BASED INSPECTIONS

RBI has been applied in industries such as oil/gas industry, power generation, refineries, petrochemical plants and pipelines.

RBI can be applied for static equipment such as pipe-work, pressure and atmospheric vessels, heat exchangers/coolers, filters and other static equipment.

RBI is used in calculating both the consequences of possible failures and the likelihood with which those failures are expected to occur. The product of consequences and likelihood is used to identify which equipment poses the greatest risk and therefore warrants the most inspection attention in order to manage that risk effectively.

RBI makes use of a broad range of technologies including consequence modelling, reliability and failure frequency analysis and limit-state approaches to provide industry with a risk-based method for evaluating and developing inspection plans.

IPF – INSTRUMENT PROTECTIVE FUNCTIONS

definitions:

Developed originally by Shell, the IPF methodology refers specifically to automated responses to abnormal situations as detected by instrumentation (typically alarm and trip functions).

The process entails the execution of a risk assessment for each protective function by a multidisciplinary team, accomplished by consideration of the instrument failure probability and the associated consequences.

The result of the classification enables specification of the most appropriate implementation and maintenance strategies for the IPF.

SHUTDOWN (TURNAROUND) MAINTENANCE & (PLANNED) OUTAGE MAINTENANCE

definitions:

Shut Down: scheduled down-period for a plant for scheduled maintenance for an extended period of time

"Turnaround" is intended to encompass all types of industrial projects for existing process plants including I&Ts (Inspection & Testing), shutdowns, planned outages, debottlenecking projects, revamps, catalyst regeneration, etc. where an operating plant must be shut down until the work is completed and then restarted - thus "turning around" the unit/plant.

The terms: "shut down" and "turnaround" have, in practice, the same meaning. However, turnaround maintenance may imply works which are not only of maintenance nature (for instance, plant revamping may be much more than just pure scheduled maintenance).

FORCED (UNPLANNED) OUTAGE MAINTENANCE

definitions:

Outage: an "**out-of-service**" condition of a plant (or part of it) that is unwanted, unplanned and unpredicted

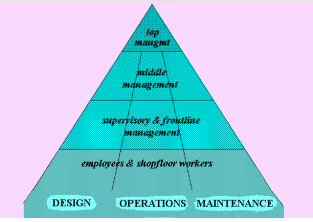
Forced Outage Maintenance is maintenance directed to bring back the concerned Plant to a "**in-service**" status as fast and reliably as possible

An unplanned outage can be dealt with:

- in the absence of any plan = panic management
- with a sufficiently or, preferably, well structured plan to manage the (any potential type of) outage

T P M

TOTAL PRODUCTIVE MAINTENANCE

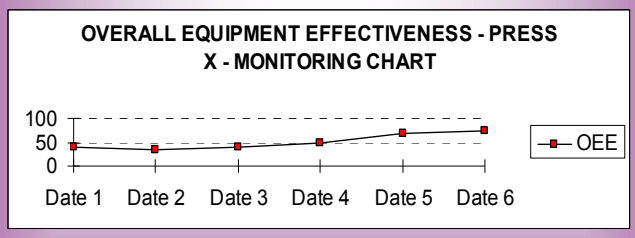


movie time

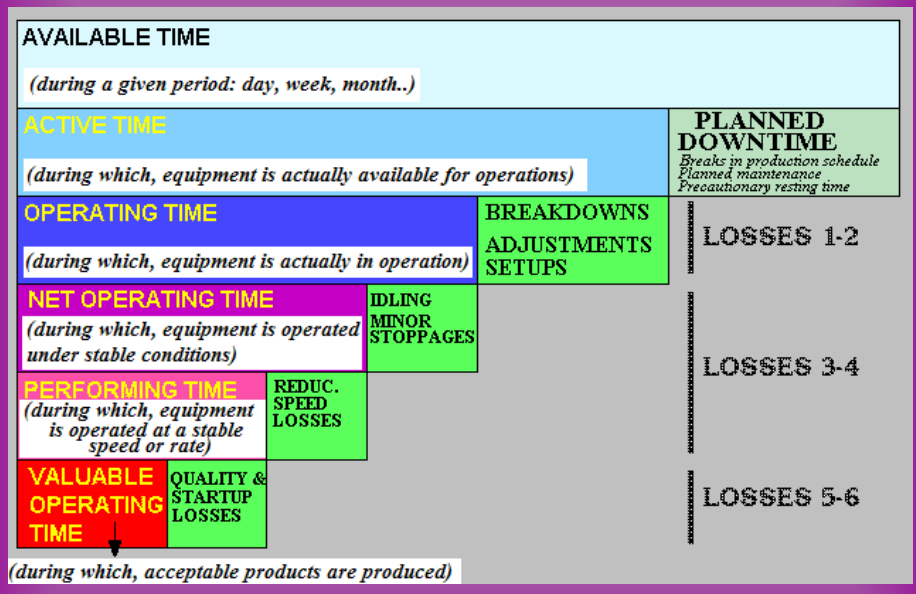
equipment: OK

surrounding waste

efficiency, effectiveness, losses



LOSSES AND EQUIPMENT EFFECTIVENESS



LOSSES AND EQUIPMENT EFFECTIVENESS

continuous process equipment & some construction equipment

similarly:

$$OEE = OR \times PR \times QR = \frac{\text{GOOD OUTPUT/IDEAL PRODUCTIVE RATE}}{\text{ACTIVE TIME}} =$$

$$= \frac{\text{VALUABLE OPERATING TIME}}{\text{ACTIVE TIME}} = OEE$$

exercise????

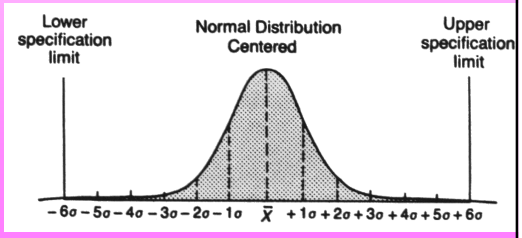
...oh, yes!!!

homework????

...oh, yes!!!

lean disciplines

Associating the Six Sigma Methodology with the TPM approach



TAKING THE TPM WAY…..

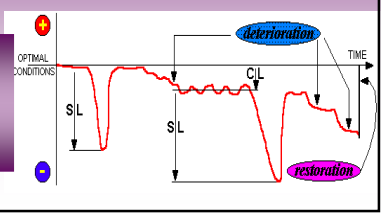
EQUIPMENT "RANKING"

chronic

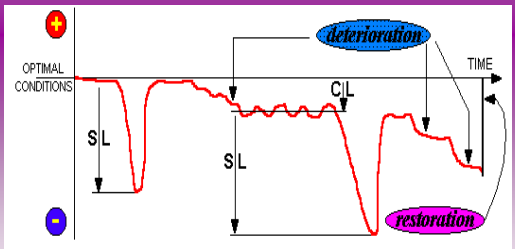
chronic losses

chronic losses

losses



THE GENERAL TPM APPROACH FOR REDUCING AND ELIMINATING CHRONIC LOSSES



REDUCING AND ELIMINATING CHRONIC LOSSES

5 Approaches or combination, as applicable:

a) IDENTIFYING AND ESTABLISHING OPTIMAL OPERATING CONDITIONS

b) RESTORING THE EQUIPMENT TO ORIGINAL/OPTIMAL OPERATING CONDITIONS

c) PREVENTING DETERIORATION

d) INCREASING EQUIPMENT RELIABILITY

e) ELIMINATING (ALL) SMALL DEFECTS

The P-M ANALYSIS

exercise????

...oh, yes!!!

CHRONIC LOSSES – FINAL REMARKS

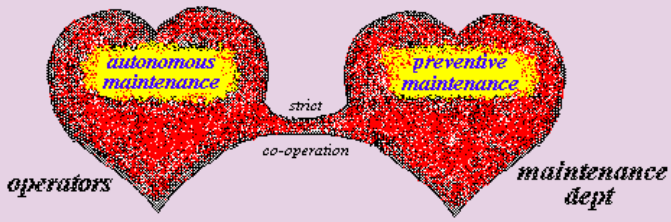
WHEN CHRONIC LOSSES (ESPECIALLY QUALITY LOSSES) ARE NOT ORIGINATED BY (HIDDEN) DEFECTS IN THE EQUIPMENT BUT RATHER BY **INADEQUATE METHODS**, A P-M ANALYSIS MIGHT BE INAPPROPRIATE

THE PROPER APPROACH IS THROUGH **TOTAL PROBLEM SOLVING TECHNIQUES** LIKE **TPS** AND **CEDAC**

PREVENTIVE MAINTENANCE

AUTONOMOUS MAINTENANCE

operation and maintenance are inseparable



common and joint responsibilities

The new relationship between Maintenance and Production

MAINTENANCE ACTIVITIES

IMPROVEMENT ACTIVITIES

MAINTENANCE ACTIVITIES

---> Prevent Breakdowns and repair faulty equipment. Combination of :

- **Autonomous Maintenance**
- **Preventive Maintenance** (daily-periodic)
- **Predictive Maintenance**

and

- **Corrective Maintenance** (sporadic, ad hoc)

IMPROVEMENT ACTIVITIES

---> Extend Equipment Life - reduce Maintenance time - avoid the need for Maintenance.

Combination of :

- **Reliability Improvement**
- **Maintainability Improvement**
- **Maintenance Prevention**
- **Maintenance-free Design**

COMMON TARGET:

MAX OEE

basically by means of:

- **DETERIORATION PREVENTION**
- **DETERIORATION MEASUREMENT**
- **RESTORATION OF OPTIMAL CONDITION**

MAINTAINABILITY IMPROVEMENT

improving equipment maintainability increases the efficiency of maintenance work and reduces repairs time

Maintenance PREVENTION

Maintenance Prevention targets at eliminating/reducing the need for Maintenance

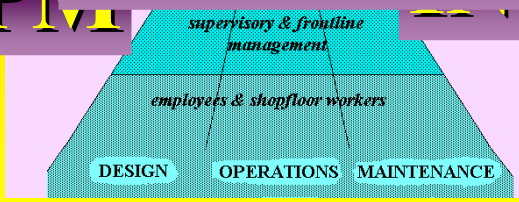
It is a TPM goal to reduce the need for maintenance (especially costly Preventive Maintenance) and, where possible, eliminate that need altogether.

the marriage TPM/RCM contributes substantially to the target

HOW TO GO INTO A TPM PROGRAM

HOW TO GO

A TPM PROGRAM



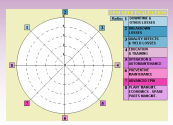
assignment????

...oh, yes!!!

MEASURING TPM EFFECTIVENESS

TPM

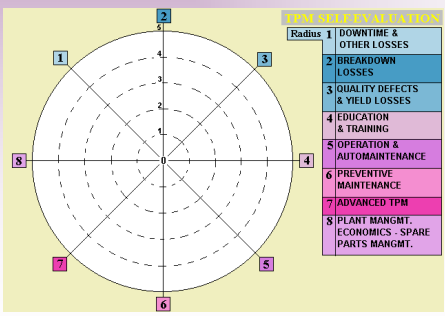
SELF-EVALUATION



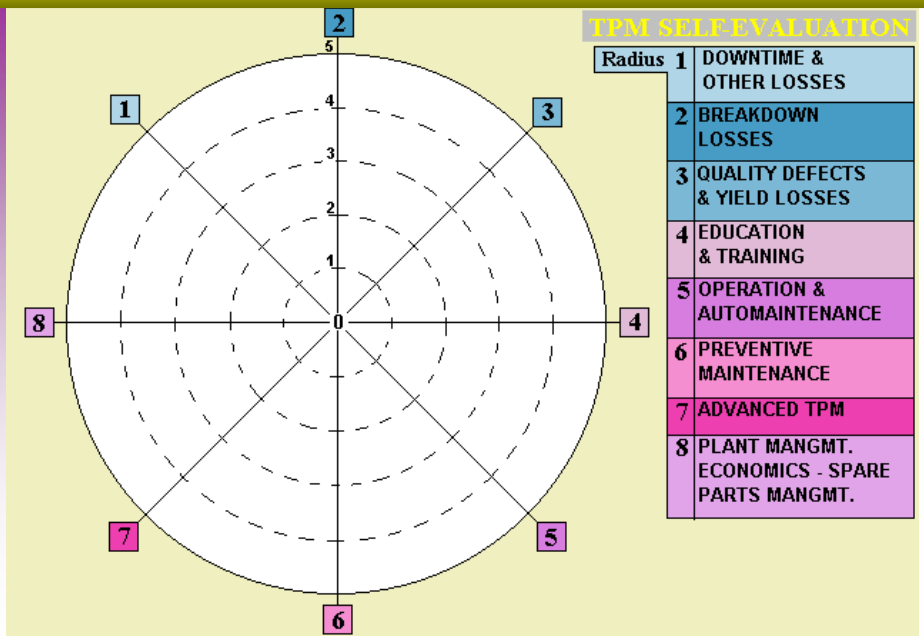
MEASURING TPM EFFECTIVENESS

TPM STATUS:

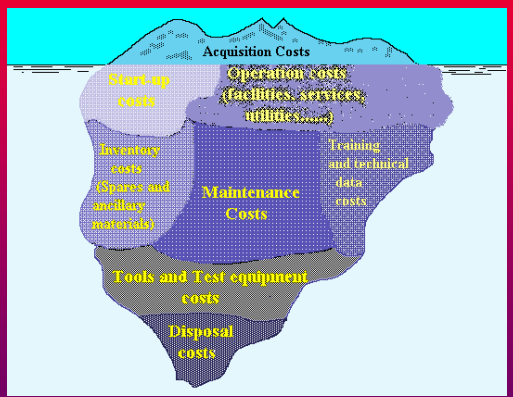
SELF-EVALUATION



MEASURING TPM EFFECTIVENESS



PLANT MANAGEMENT IN A TPM ENVIRONMENT



SPARE PARTS MANAGEMENT

"....everyone has a favourite horror story about large production losses caused when an essential part was missing in a store full of un-necessary materials and spares ...."

PLANT

MANAGEMENT

ECONOMICS

PLANT MANAGEMENT

PLANT MANAGEMENT

PLANT MANAGEMENT

ECONOMICS

REDUCING OVERALL COSTS OF MAINTAINING EQUIPMENT

Targets and strategies:

- a. Review Periodic Maintenance intervals
- b. When appropriate, switch from outside contracting to in-house facilities
- c. Audit Spare Parts Management
- d. Identify idle equipment and use it effectively (f.i: in Cell Production activities)
- e. Reduce energy use and service resources waste
- f. Eliminate Equipment Losses

MEASURING MAINTENANCE EFFECTIVENESS

➢OVERALL EQUIPMENT EFFECTIVENESS (OEE)

TPM Improvement Zone/Audit Review

Milestone 1: Introduction - Everyone involved Level: 1a (pass mark 30) 1b (pass mark 40)

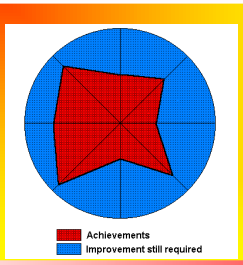
Department: Zone:

Auditors: Date:

	Review point	Assessment			Evidence
1	Is a TPM board in place for each improvement zone (OEE)?	SCORE	MAX	5	3 = up to date 4 = improved
2	Are safety procedures defined (SO)?	SCORE	MAX	5	3 = used 5 = improved
3	Workplace initial clean (CANDO Step 1) (OAC)	SCORE	MAX	5	CAN DO Audit Results
4	Equipment initial clean	SCORE	MAX	5	5 = maintained
5	Cross shift supervisor prioritisation (SO)	SCORE	MAX	5	3 = agreed
6	Identification of frequent problems (6 losses) and root causes (OEE)	SCORE	MAX	5	3 = recorded 5 = improved
7	Planned maintenance system	SCORE	MAX	5	3 = available
8	Equipment description (sketch, critical areas identified, process flow chart) (LEM)	SCORE	MAX	5	3 = acceptable 5 = understood
9	Checkpoints log pressure, temperature, RPM) and preventative maintenance (MAC)	SCORE	MAX	5	3 = available
10	Problem register in place recording equipment history including breakdowns and accelerated deterioration (OEE)	SCORE	MAX	5	3 = recording up to date 4 = reduction in stoppages
	TOTAL	SCORE	MAX	50	

INDICES

➢OPERATIVITY RATE (OR)



➢MEAN TIME BETWEEN FAILURES (MTBF)

case study

A non-TPM factory

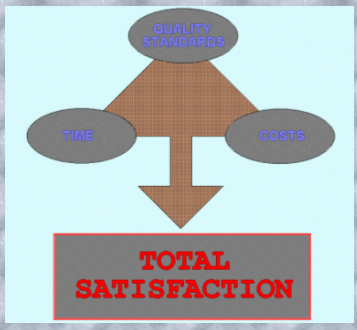
movie time

A non-TPM factory

adf

TRADITIONAL PROJECT MANAGEMENT

basics



PLANNING

PROGRAMMING

SCHEDULING

CONTROLLING

LIFECYCLE OF PROJECT WITH POOR PLANNING

Project initiation

Wild enthusiasm

Disillusionment

Wild chaos

Search for the guilty

Punishment of the innocent

Promotion of non-participants

Definition of the requirements (Planning)

PERT

(PROGRAM EVALUATION and REVIEW TECHNIQUE)

CPM

(CRITICAL PATH METHOD)

PROJECT

PROJECT RISK MANAGEMENT

CONTROL

ADEQUATE PLANNING

EASIER + MORE EFFECTIVE CONTROL

CONTROLLING PROJECTS

yesterday	*today - tomorrow*
giving orders	objectives definition by mutual **consent**
being at the head	**clear** definition of tasks at all levels
directing	planning & scheduling on the basis of **necessary** and really **available** resources
supervising	Progresses, Costs and Quality **Measurement Methods** based on a **clear**, **precise**, **pre-defined** system, **known** by all relevant members of the project team, and **agreed upon** by mutual consent
inspecting	At all levels: ➢**continuous monitoring** of actual results versus estimates and budgets ➢adequate and timely **re-scheduling** ➢regular **re-assessment** of time and cost "**to completion**" in a continuous projection process
controlling	

….then the world changed….

why enterprises don't "perform"...

….the root causes of poor performance date back to over 2 centuries ago…..

….we have gone into the 21st century, with enterprises designed in the 18th and 19th centuries to perform well in the 20th…..

WORLD-CLASS PERFORMANCE

the world-class enterprise operates "per process"

SEW

SYSTEMATIC

ELIMINATION OF WASTE

WASTE

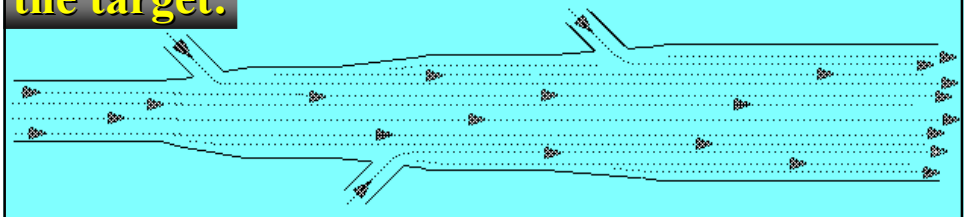
VALUE!

LEAN MANUFACTURING

and FLOW PRODUCTION

continuous flow

the target:



pipeline flow

LOT (BATCH) PRODUCTION

LONGER LEAD TIME

VS.

FLOW PRODUCTION

movie time

fake flow production

the “conveyor” method

eureka_conv1

eureka_conv2

simulation time

"batch production" vs. "one-piece flow"

one-piece flow
one-piece-flow_longer
one-piece-flow_fot

analysis

LEAN THINKING

what is it?

…are *Lean Thinking* and *Flow Process* principles and techniques suited to all industries?

The answer is always:

introducing:

LEAN PROJECT MANAGEMENT

basics

movie time

Lean Project Management

foreword

dehli_construct

movie time

spot the waste!

Construction Industry 1

EXAMPLES

cpt_sme_construct_short

any correlation between what you have seen and your work of every day?

Any similitude?

Check list:

- ✓ Moving
- ✓ Filing
- ✓ Answering
- ✓ Attending…
- ✓ Reporting
- ✓ Preparing
- ✓ Waiting
- ✓ Observing

- ✓ Meetings – "spot" meetings in the passage…
- ✓ Giving instructions – Receiving instructions
- ✓ Doing things "in case" – or "why not?"
- ✓ Ordering things – Setting-up things – Making sure..
- ✓ Checking – Inspecting - Supervising
- ✓ Talking – Clarifying – Explaining – Illustrating…
- ✓ Chatting - Phoning – Taking "this" call…
- ✓ Putting pressure – Chasing - Expediting – Dealing…
- ✓ Managing – Authorising, approving – Getting right…

Does all this create value for your clients?

LEAN PROJECT MANAGEMENT

taking the lean way

taking

the lean

way

specific tools/techniques for:

LEAN PROJECT MANAGEMENT

the PPC and its intelligent use

the "Last Planner" approach

Lean Project Management in Multi-Project situations

the TOC approach

multitasking

projecttoc

movie time

can construction become different?

look at this!!

san diego

movie time

a world-class project-driven enterprise

aea_wcp
or
aea_wcp_longer

Lean Maintenance

what is it?

Lean Maintenance

definition

Lean Maintenance is the systematic deployment of Lean principles in all maintenance-related activities in Maintenance of all kinds

movie time

spot the waste!

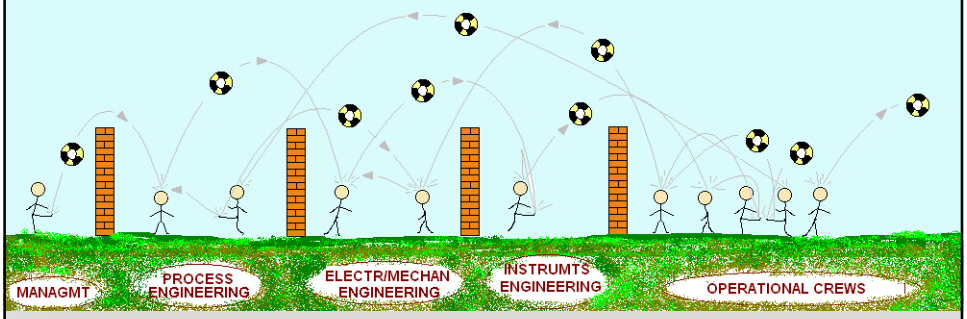
Maintenance World

EXAMPLES

maintenwaste

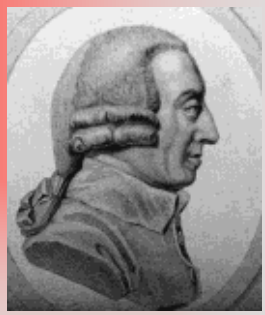
CONCURRENT (SIMULTANEOUS) ENGINEERING

TRADITIONAL OVER-THE-WALL ENGINEERING



CONCURRENT ENGINEERING

...another "Terminator" of Adam Smith theories.....



Lean Plant Management

what is it?

LPM and PEOPLE

Lean Maintenance & Lean Plant Management

A course presented by Carlo Scodanibbio

Organised by

CREDITS: the documentary material of this course is based on papers and works of

K.Arai

M.Baldini

N.Bodek

W.F.Christopher

T.Conti

E.del Turco

Lean Maintenance & Lean Plant Management

Power Point Presentation by Carlo Scodanibbio

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