



**TPM a Foundation of Operational Excellence and Partnership  
Working within the emerging World of Industry 4.0  
Learning Session 01 and 08**

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# Contents & Structure

Tuesday 19<sup>TH</sup> and Wednesday 20<sup>th</sup> November 2019 Workshop.

**-Delivered as Two Learning Sessions 01 (Part 01) and 08 (Part 02)**

| Schedule   | Slides   |
|--|----------|
| <b>Day 1 Tuesday 08.00-09.30 (Part 01)</b>   |          |
| Session 1-Operational Excellence &TPM-<br>Scene Setting & Overview   | 1 to 11  |
| Session 2-The 3 x P's of Purpose, Process &<br>People (with case study)                                    | 12 to 51 |
| Session 3-Asset Owners & O and M Service<br>Providers Working in Partnership (Plus<br>delegate exercise 1) | 52 to 78 |
| Wrap-up with review of Key Learning Points<br>(KLP's) & Tomorrow's Agenda                                  |          |

# Contents & Structure (cont...)

Wednesday 20<sup>th</sup> November 2019 Workshop -**Learning Session (08)**

| Schedule   | Slides     |
|--|------------|
| Day 2 Wednesday 08.00-09.30 <b>(Part 02)</b>   |            |
| Recap of Yesterday's Sessions  |            |
| Session 4 -Understanding the implications of Industry 4.0 in an O& M Environment               | 79 to 104  |
| Session 5 -Digging deeper with the 3 x P's Water Utility Case study (Plus delegate exercise 2) | 105 to 196 |
| Session 6 Upskilling & TPM roles & responsibilities fr front line O&M staff                    | 197 to 212 |
| Final thoughts and Workshop evaluation   | 213 to 216 |

# Introduction to this workshop

**The TPM System of Work can be applied to Industrial Sectors representing....**

- All forms of Public Utilities (water, gas, electricity) and Transport systems-(One of the case studies will include a Waste Water treatment plant application)
- Facilities such as Airports, Docks, Terminals involving major physical assets.

**As well as the more traditional sectors representing .....**

- Primary and Secondary raw materials, Petro-chemical Plants, Processing and Conversion, Construction Materials
- Food, Drink, Pharmaceutical, Medical Devices and Healthcare including Hospital equipment and laboratories.
- All types of three tier supply chain Manufacturing and Assembly plants

# Overview of Learning Session

This two part, 3 hour Workshop is based on over 25 years experience of applying the TPM system of work principles across a wide spectrum of environments, industries and utilities. Relevant examples which include 3<sup>rd</sup> party Operations and Maintenance service providers for the Asset Owner include...

- BP Offshore & Golar Nor Floating Production & Offload Facility (FPSO)
- Rolls Royce Aero Engines Utilities & Facilities partner-Mitie.
- London Heathrow Terminal 5 Baggage Handling system involving 4 x Major Stakeholders including Operations and Maintenance Service Providers
- In all these environments Effective Partnership & Teamwork has been paramount to deliver improved Asset Reliability and Performance & hence **joint** Business Success for the key stakeholders.
- The key is to *adapt* the classic 'in-house' approach to TPM *without corrupting* its well-proven principles and processes

# A question for you.....

***If you are an operator or maintainer -Where would you prefer to work ?***

# Before TPM Activity



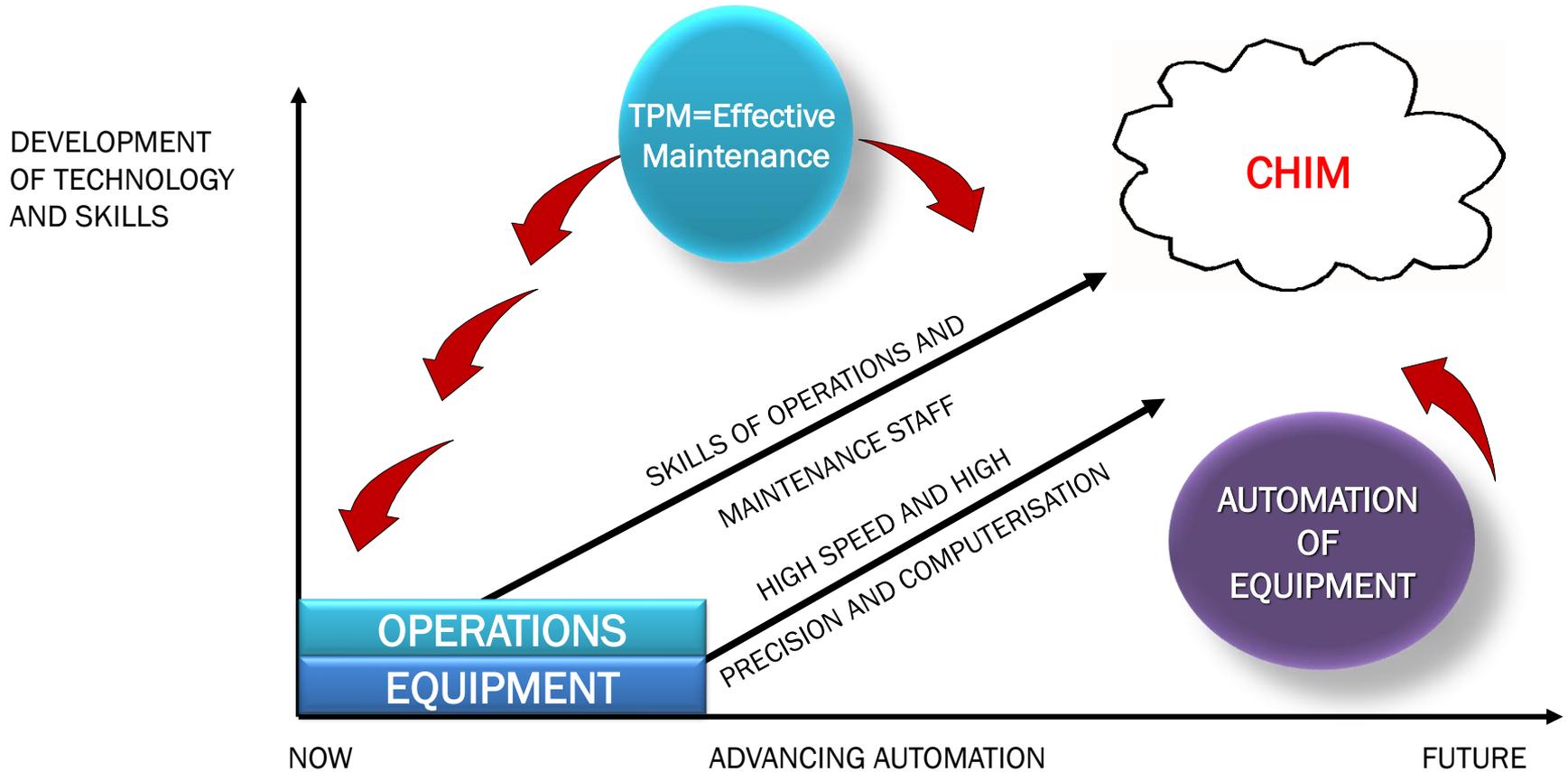
# After TPM Activity 20 Weeks Later



# 1992-TPM Award winning plant

| <b>Key Performance Indicator</b> | <b>Start Point Reference</b> | <b>6 Years Later</b> |
|----------------------------------|------------------------------|----------------------|
| Breakdowns per month             | 250                          | 5                    |
| Overall Equipment Effectiveness  | 65%                          | 88%                  |
| Productivity Index               | 100                          | 180                  |
| Return on Investment             | \$1.00                       | \$4.50               |

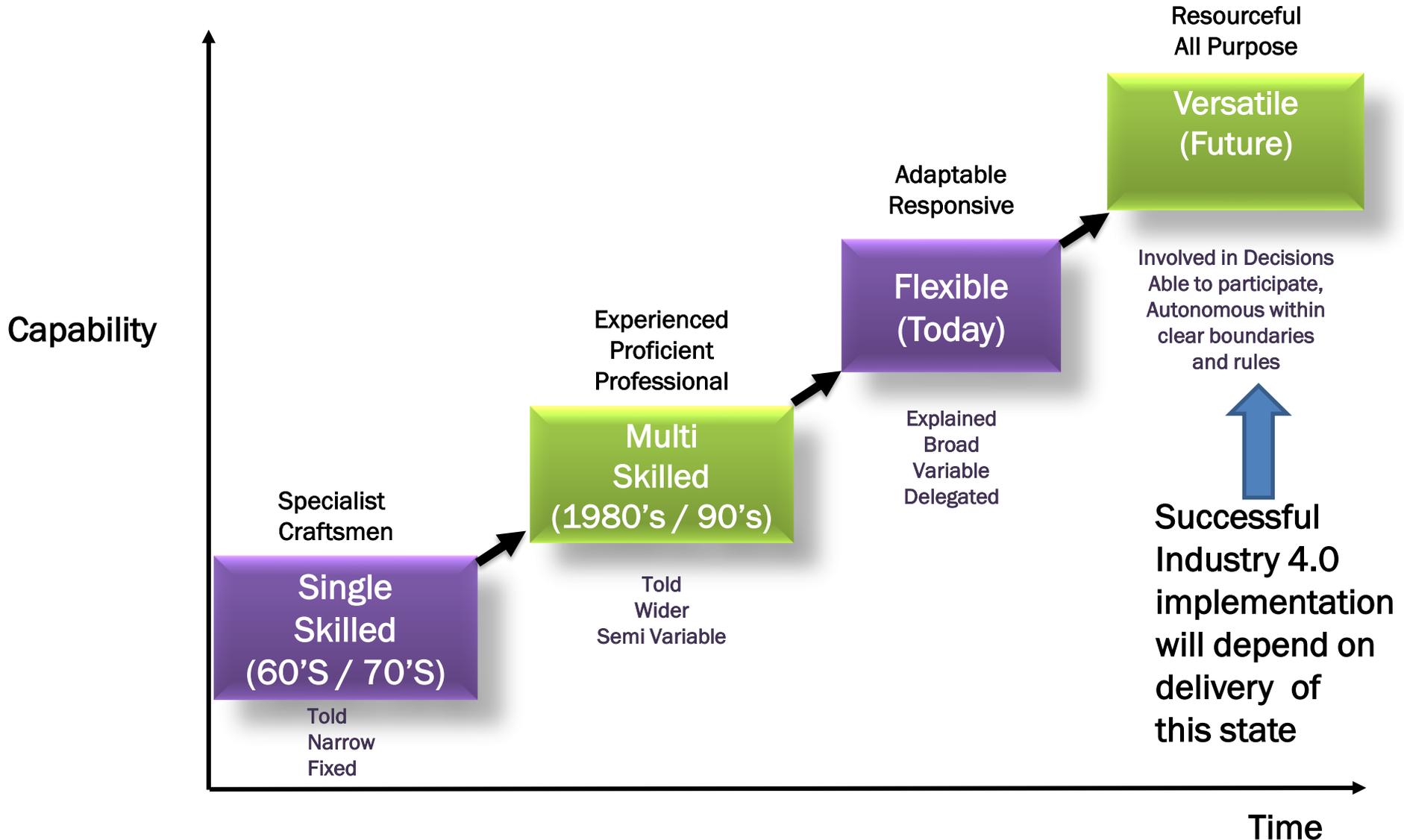
# My 'light bulb' moment-Daiken, Japan 1992



**Computer/Human Integrated Manufacture**  
Is No **Dream** But Reality !

# The Learning Organisation

## The European history and experience

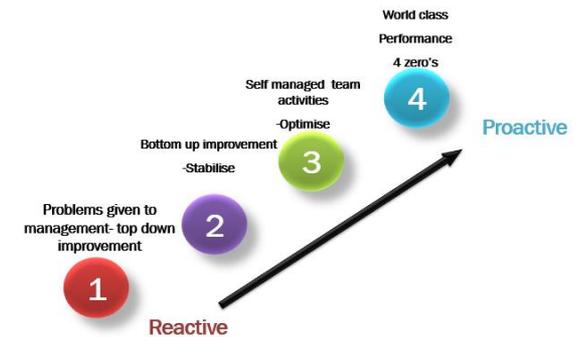
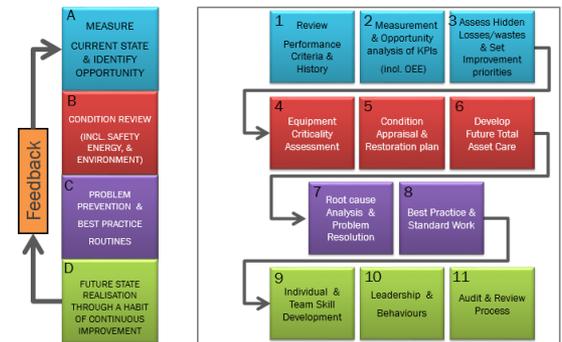
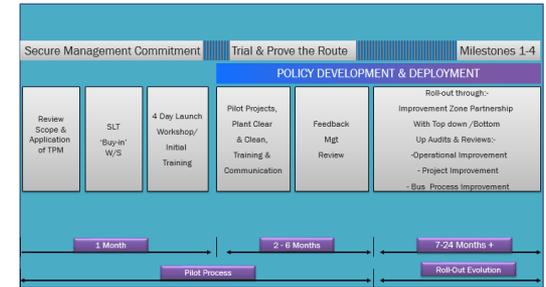


# TPM is an enabling system & philosophy for delivering Operational Excellence-3 x P's



# The TPM System & Model

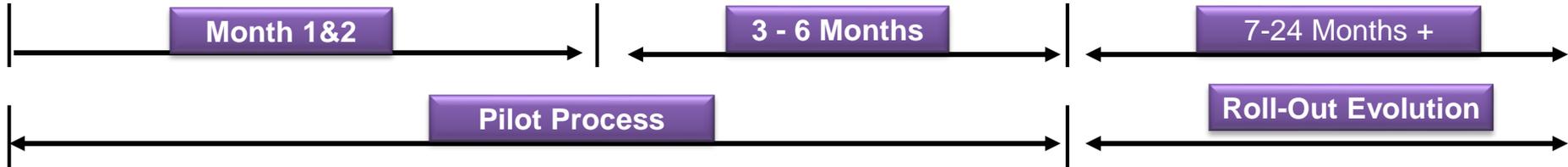
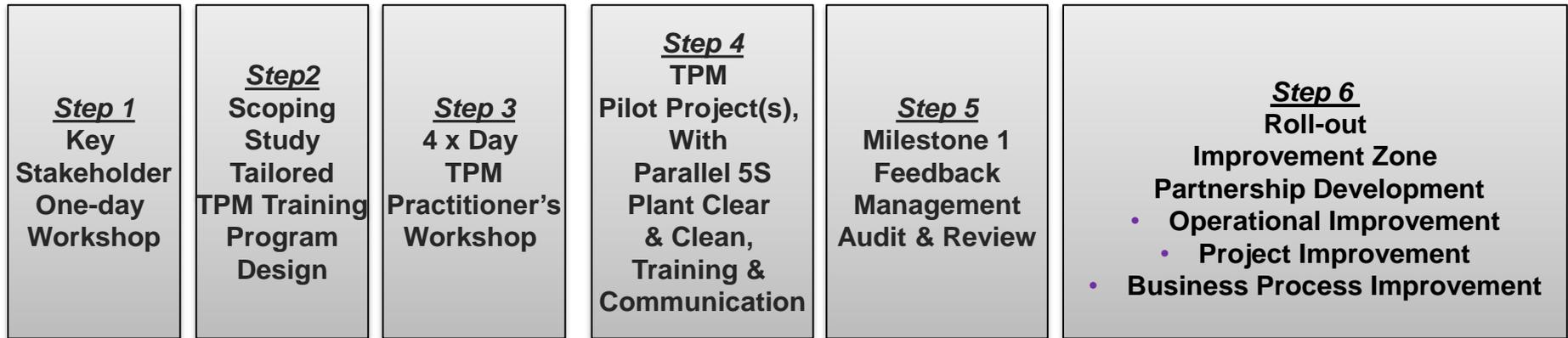
- Our TPM programme is applied via a defined introductory and deployment process within the business unit-Purpose
- The application of our TPM model is applied through a defined sequence of team based '*learning by doing*' activities where they explore in detail and hence understand the Process.
- The outputs of this application are aligned to an evidence based assessment process linked to the teams progress through the model and the operational excellence journey itself- People



# Six step TPM training implementation process to 'learn by doing'



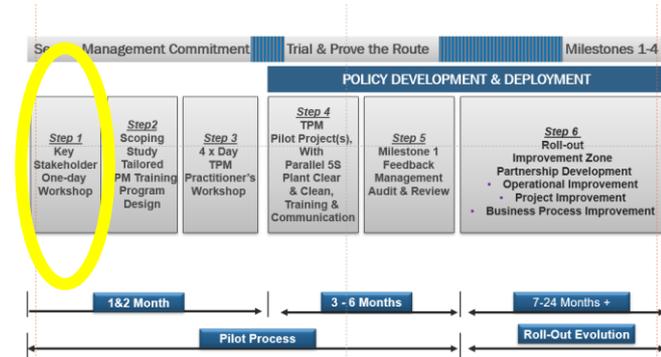
## POLICY DEVELOPMENT & DEPLOYMENT



# Step 1 Key Stakeholder one day TPM Awareness Workshop

## THE OBJECTIVES OF THE ONE DAY KEY STAKEHOLDER TPM AWARENESS WORKSHOP ARE TO:

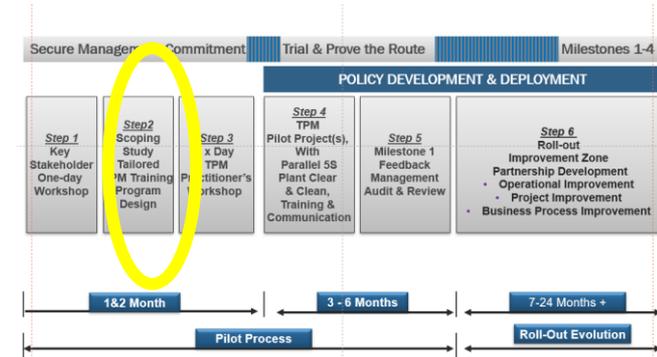
- To familiarise the Leadership Team and all other relevant Key Stakeholders with the principles of TPM and the implications of embarking on a TPM Training Programme within that Company's specific Industry and Business environment
- To review progress of current initiatives and future plans and intentions within their operational excellence /continuous improvement journey and how TPM might fit into these and help to deliver the Company's Business Drivers and Cultural aspirations.



## Step 2 Secure Management Commitment: Plant Level TPM Scoping Study

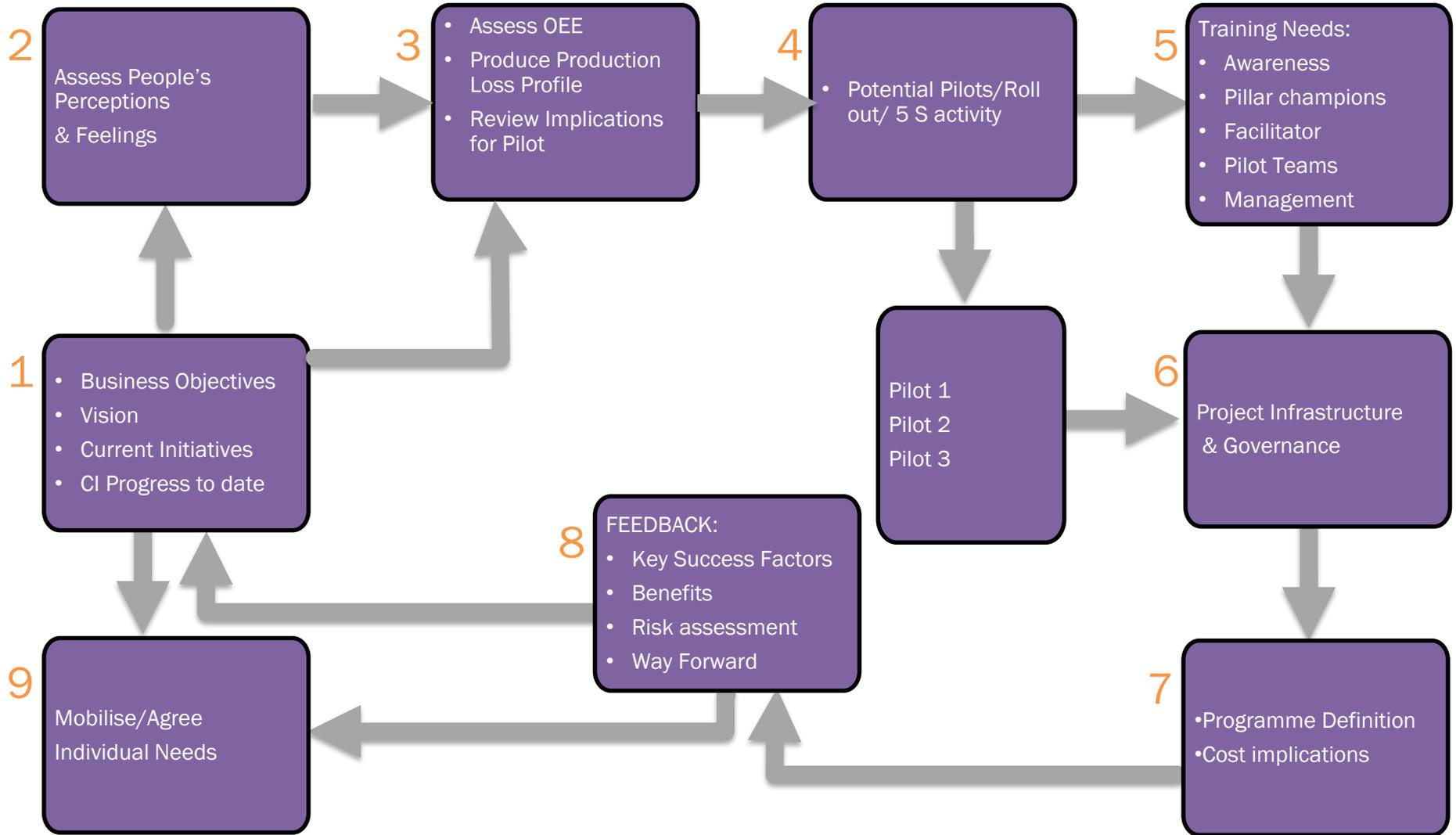
### THE OBJECTIVES OF THE PLANT SPECIFIC SCOPING STUDY ARE TO:

- Assess equipment, door to door and supply chain losses and potential for improvement
- Carry out a cost/benefit appraisal
- Assess people perceptions and readiness for the TPM Program
- Identify Pilot opportunities and priorities
- Identify the Critical Success & Risk Factors
- Develop a first cut Plant roll out approach
- Specify full implementation and training plans to cover:
  - Potential pilot(s)
  - Likely benefits from pilots -plus direction for site wide application & potential financial benefits
  - Shift Logistics, team size and membership, plus resourcing costs
  - Key contact membership and pillar champion roles
  - Initial awareness, communication and training plan plus timing
  - Facilitator support requirements plus training
  - Pillar Champions., Steering group membership, Governance and terms of reference



**DEVELOP A PRESENTATION FOR MANAGEMENT REVIEW AND APPROVAL (SEE NEXT 2 x SLIDES)**

# Step 2- Local Management TPM Review Process- The Scoping / Diagnostic Study



# Step 2 Secure Management Commitment: Half day Site Leadership Team ‘Buy-in’ Workshop

THE OBJECTIVES OF THE HALF DAY WORKSHOP ARE TO:

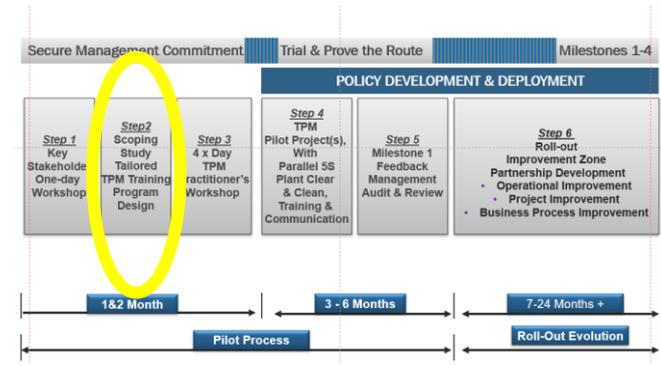
Review the Scoping Study Outputs , Plans and Intentions

in order to:-

- Gain Senior Management commitment to ‘sign-off’ the recommended TPM System of Work, Process & Program in terms of priority and resources of people, money and time.
- Review current plans and initiatives and how TPM fits into these and helps to deliver the Business Drivers
- Define potential inhibitors to TPM and resultant countermeasures to minimise the identified risks
- Agree a future TPM vision for the Site/Plant/Company
- Set a policy framework to guide improvement and implementation
- Define a management governance & control system, including Pillar champions for the programme
- Define terms of reference for the Step3- Four day TPM Practitioners Training W/Shop (ie attendees & timing)

**INVOLVEMENT:**

- Site Leadership & Senior Management Team & Employee Representatives



# Step 3-Secure Management Commitment: TPM Practitioner's Training Workshop

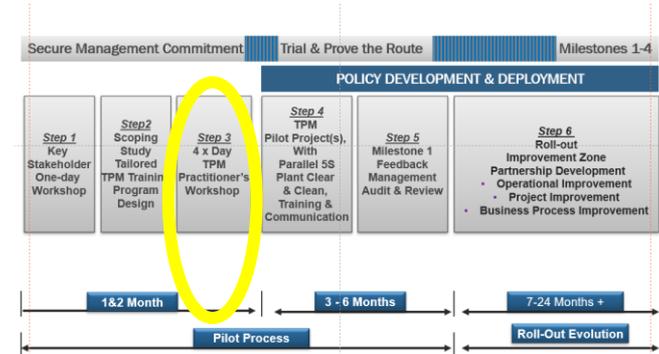
## THE OBJECTIVES OF THE 4 DAY "IN-HOUSE" TPM PRACTITIONER'S WORKSHOP ARE TO:

- To provide a thorough understanding of TPM and how to put it into practice
- To provide a framework and understanding for CI Facilitators and Coaches to work in, and influence the behaviour of multi-discipline and multi-interest teams.

At least 70% of the Training Workshop is focussed on carrying out the 4 x Cycle, 11 Step TPM Improvement Process on your own "live" operations on-site so that delegates can experience the on-the-job reality of putting TPM techniques into practice as a '*learn by doing*' activity.

## WHO SHOULD ATTEND?

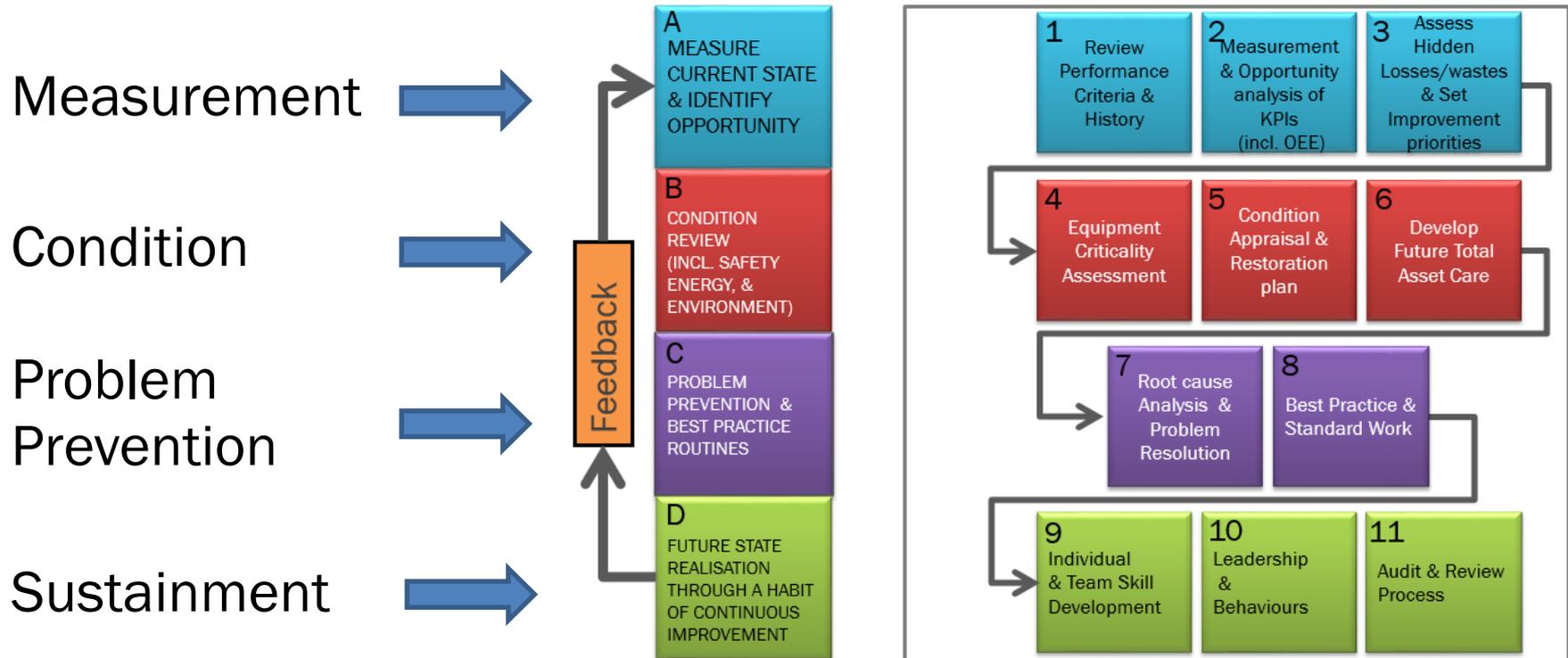
- Proposed CI & TPM Facilitators/Trainers,
- Team Leaders & Shift Team Members as Operators and Maintainers at the sharp end of the business.
- Pillar Champions. You may be the General Manager, Group Leads or similar, with executive responsibility.
- Change 'Driver' - you will be a Middle Manager, Supervisor or Team Leader at the sharp-end of the business, responsible for producing quality output from consistently reliable equipment.



# TPM 4-Day Hands-on Practitioners Workshop. (learning by doing)

| <p><b>DAY 1</b><br/>08.00-16.30</p>  | <p><b>DAY 2</b><br/>08.00-16.30</p>  | <p><b>DAY 3</b><br/>08.00-16.30</p>   | <p><b>DAY 4</b><br/>08.00- 16.30</p>  |
|--|--|---|---|
| <p><b>Introduction to TPM</b><br/>World class sports icebreaker<br/>Exercise- Maintenance Assessment</p> <ul style="list-style-type: none"> <li><b>TPM Principles and techniques with Case Studies</b></li> </ul> <p><b>Morning</b></p>                            | <ul style="list-style-type: none"> <li><b>CONDITION CYCLE (On-the Job)</b><br/>Exercise – Car criticality assessment</li> <li>Step 4)Criticality Assessment on the assets-visit to the assets</li> </ul> | <p><b>Start Building TPM Activity Boards</b></p> <ul style="list-style-type: none"> <li>Consolidating Measurement and Condition cycles<br/>Step 6) Future Asset Care</li> <li><b>Supporting techniques</b> <ul style="list-style-type: none"> <li>➤ Changeover optimisation</li> <li>➤ Early Equipment Management</li> <li>➤ Overview of non-equipment Cultural Steps 9,10 &amp;11 to Realise sustainable Future State</li> </ul> </li> </ul> | <p><b>Revisit 8 steps and complete activity boards</b></p> <ul style="list-style-type: none"> <li>Prepare for feedback presentations</li> <li>TPM Pilots and plan for roll out across plant</li> <li><b>Review and key learning points</b></li> </ul> |
| <p><b>Afternoon</b></p> <ul style="list-style-type: none"> <li>Visit to Pilot and Plan the Plan Equipment Description</li> <li><b>MEASUREMENT CYCLE (On-the-Job)</b><br/>Step 1) History/Records<br/>Step 2) OEE Measures<br/>Step 3) 6 Loss Assessment</li> </ul> | <p>Step 5a)Condition Appraisal</p> <p>Step 5b)Refurbishment Plan</p>   | <p><b>PROBLEM PREVENTION CYCLE (On-the-Job)</b><br/>Step 7) Problem solving<br/>Step 8) Best practice routines</p> <p><b>Prepare TPM Activity Board feedback presentations</b></p>  | <ul style="list-style-type: none"> <li><b>14,00-15.30 Syndicate presentations with Leadership team present</b></li> </ul> <p>Course Assessment<br/>Close</p>  |

# Four Cycles within the TPM model



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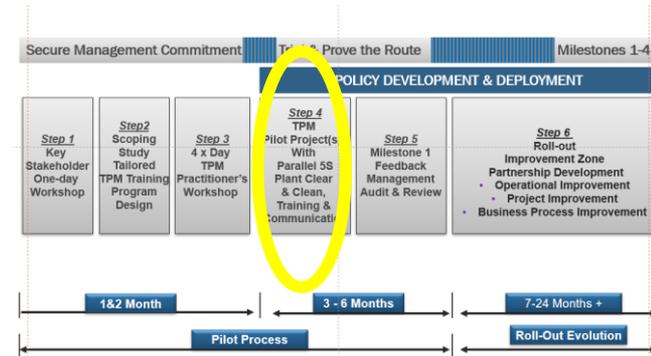
# Step 3-TPM activity board 4 day Practitioners training event feedback example



## Step 4-Trial & Prove the 11 Step TPM Process

### THE OBJECTIVES OF THE FULL TPM PILOT PROJECTS MOVING TOWARDS MILESTONE 1, ARE TO:

- Raise awareness of hidden losses, the techniques to eliminate them and the value of doing so.
- Highlight the gaps in the fabric of management which need to be addressed to create the environment.
- Design, Develop and implement a plant wide Clear and Clean process using 5S philosophy to raise standards and begin the process of problem ownership
- Establish performance and measurement to record progress, with specific audit and reviews
- Establish infrastructure to support eventual site wide deployment of TPM, including Pillar Champion roles, responsibilities and TPM training and coaching needs.
- Gain experience of the application of TPM principles and techniques contained within the TPM 11 Step Improvement Plan including VSM, Precision Changeovers and Cost & Loss Deployment
- Define the TPM Continuous Improvement Master Plan to guide priorities and transformation of the operation

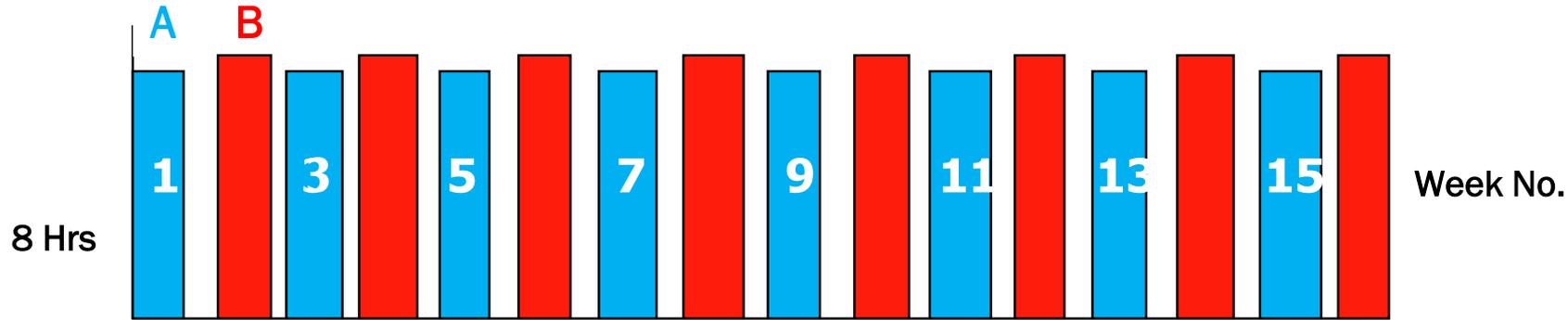


# Typical 24 week TPM Pilot Project Activity Program

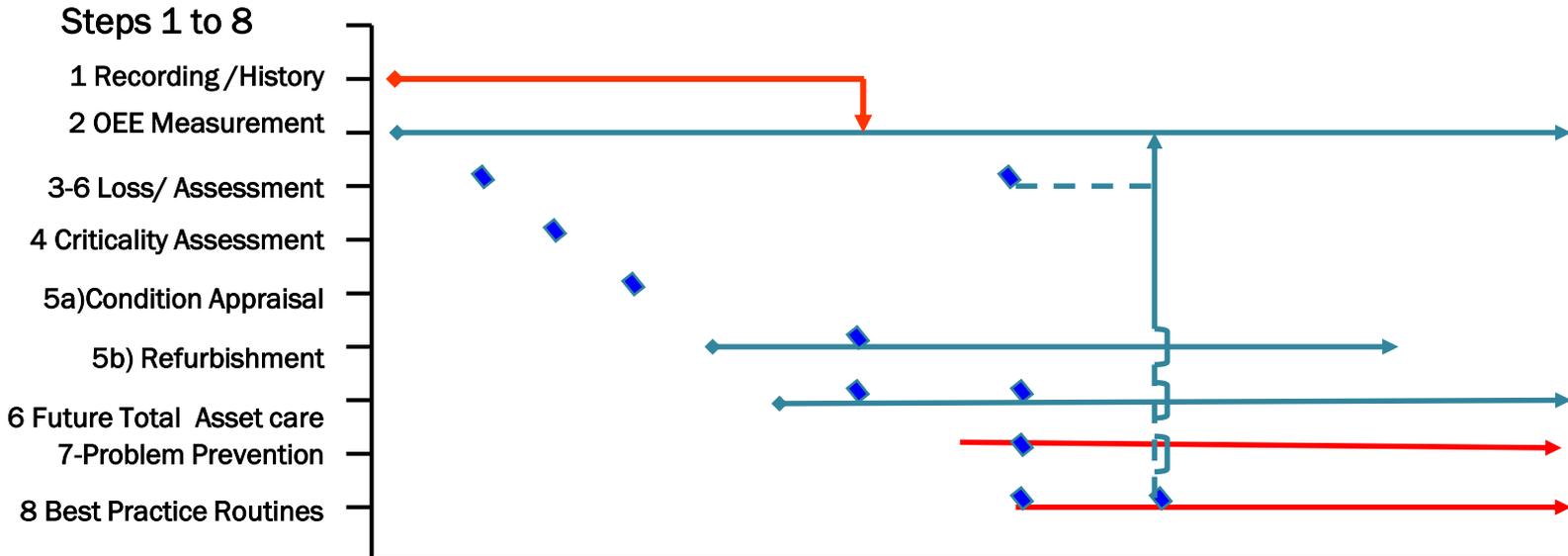
## Line 6- TPM Pilot Project Activity Schedule to MS1

| Date                      | 24/07 | 07/08 | 21/08 | 04/09  | 18/09 | 02/10       | 16/10   | 30/10 | 13/11 | 27/11 | 11/12        |  |
|---------------------------|-------|-------|-------|--------|-------|-------------|---------|-------|-------|-------|--------------|--|
| Week No                   |       |       |       |        |       |             |         |       |       |       |              |  |
| Audits                    |       |       |       |        |       | Trial 1a/1b |         |       |       |       | Actual 1a/1b |  |
| <b>MEASUREMENT CYCLE</b>  |       |       |       |        |       |             |         |       |       |       |              |  |
| 1 Sources of Info         |       |       |       |        |       |             |         |       |       |       |              |  |
| 2 OEE Av / BoB / WC       |       |       |       | Record |       |             |         |       |       |       |              |  |
| 3 Six Loss assessment     |       |       |       |        |       |             | Revisit |       |       |       |              |  |
| <b>CONDITION CYCLE</b>    |       |       |       |        |       |             |         |       |       |       |              |  |
| 4 Criticality assessment  |       |       |       |        |       |             |         |       |       |       |              |  |
| 5a Condition appraisal    |       |       |       |        |       |             |         |       |       |       |              |  |
| 5b Refurbishment Program  |       |       |       |        |       |             |         |       |       |       |              |  |
| 6 Future Asset Care       |       |       |       |        |       |             |         | FLOAC | PM's  | CBM   |              |  |
| <b>PROBLEM PREVENTION</b> |       |       |       |        |       |             |         |       |       |       |              |  |
| 7 RCA / Problem solving   |       |       |       |        |       |             |         |       |       |       |              |  |
| 8 Best practices routines |       |       |       |        |       |             |         |       |       |       |              |  |
| Prepare Level 1a / 1b     |       |       |       |        |       |             |         |       |       |       |              |  |

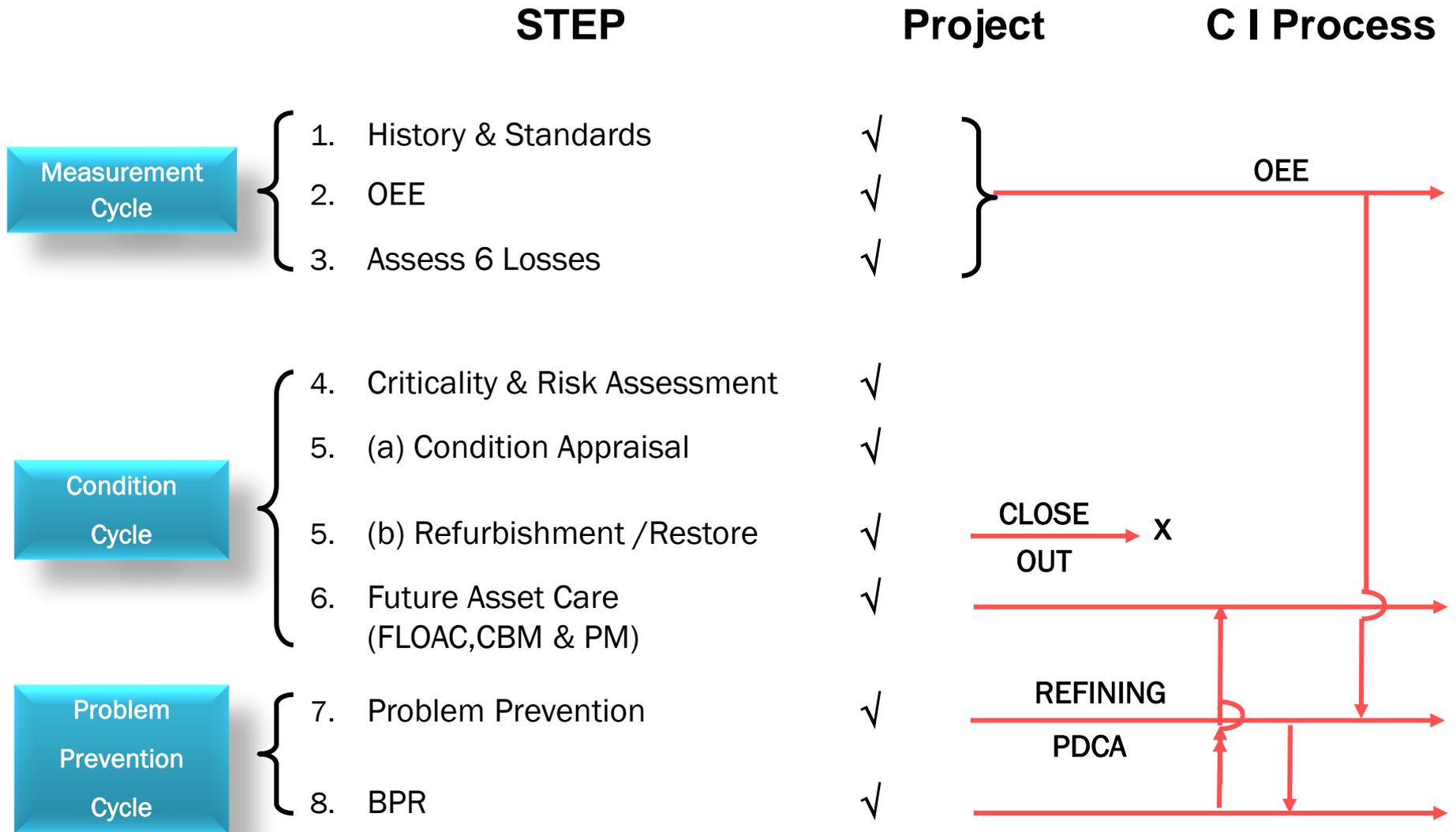
# Example of TPM Pilot Project structure 'foot-print' over 16 weeks



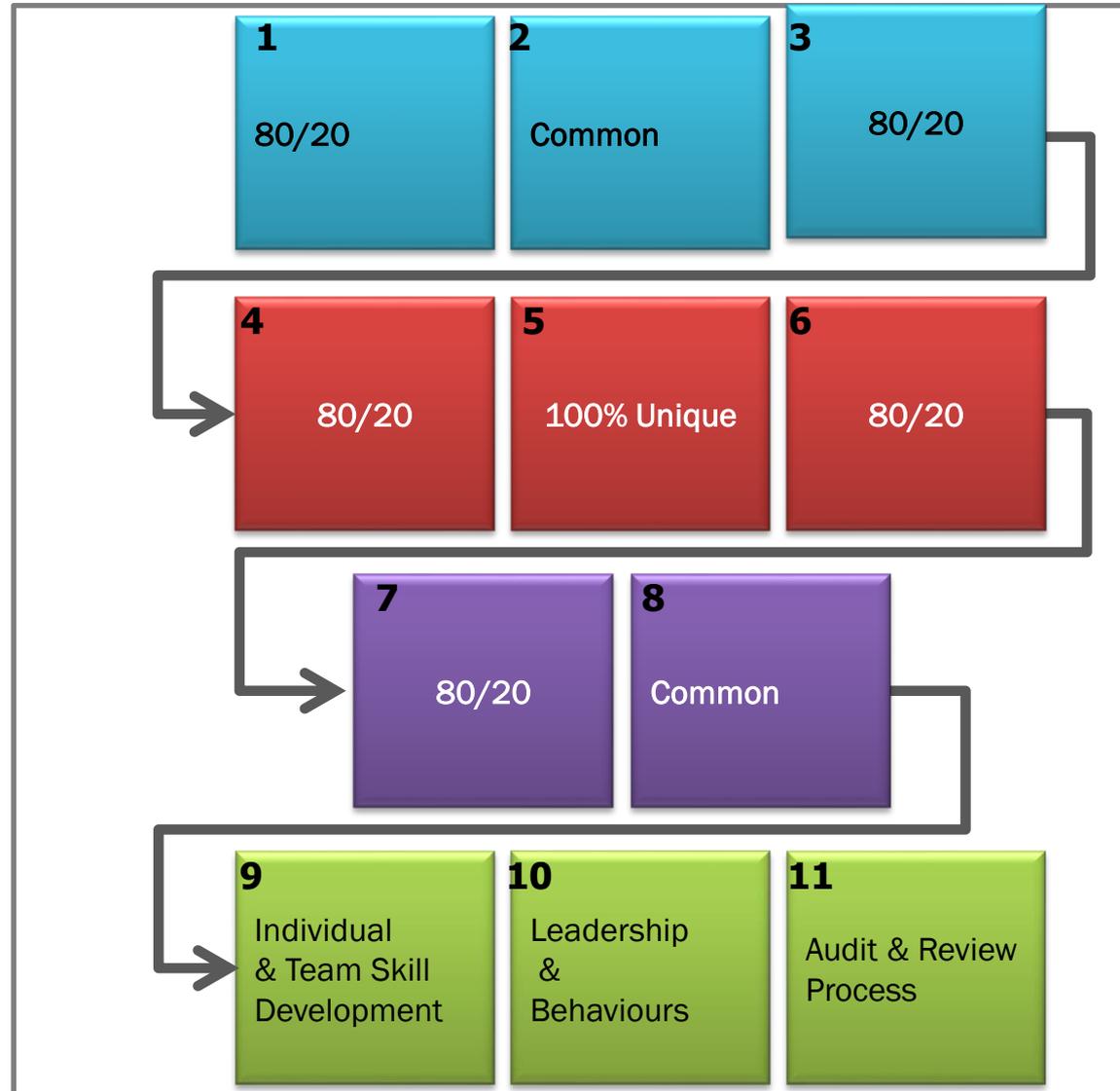
Typically 2 x Shift Based Teams consisting of Operators & Technicians and the Facilitator meet every 2 weeks for an 8 hour Asset Optimisation Activity Session, subject to shift logistics .over c.16 calendar weeks



# ..... to four Step CI Process after MS 1a/1b audit close out



# Three Cycle-8 Step TPM for Replicated Equipment (ie controlled fast track)



# Warwick Speciality Chemicals Case Study-Background

## Constrained by 'Pinch Point' Output in its Sodium Acetate (SA) Plant

### •The Challenge:

**To unlock installed Productive Capacity of the SA Asset  
in order to avoid multi million \$ Capital Cost of  
replicating Capacity in order to cope with single  
customer doubling demand...**

# Background continued...

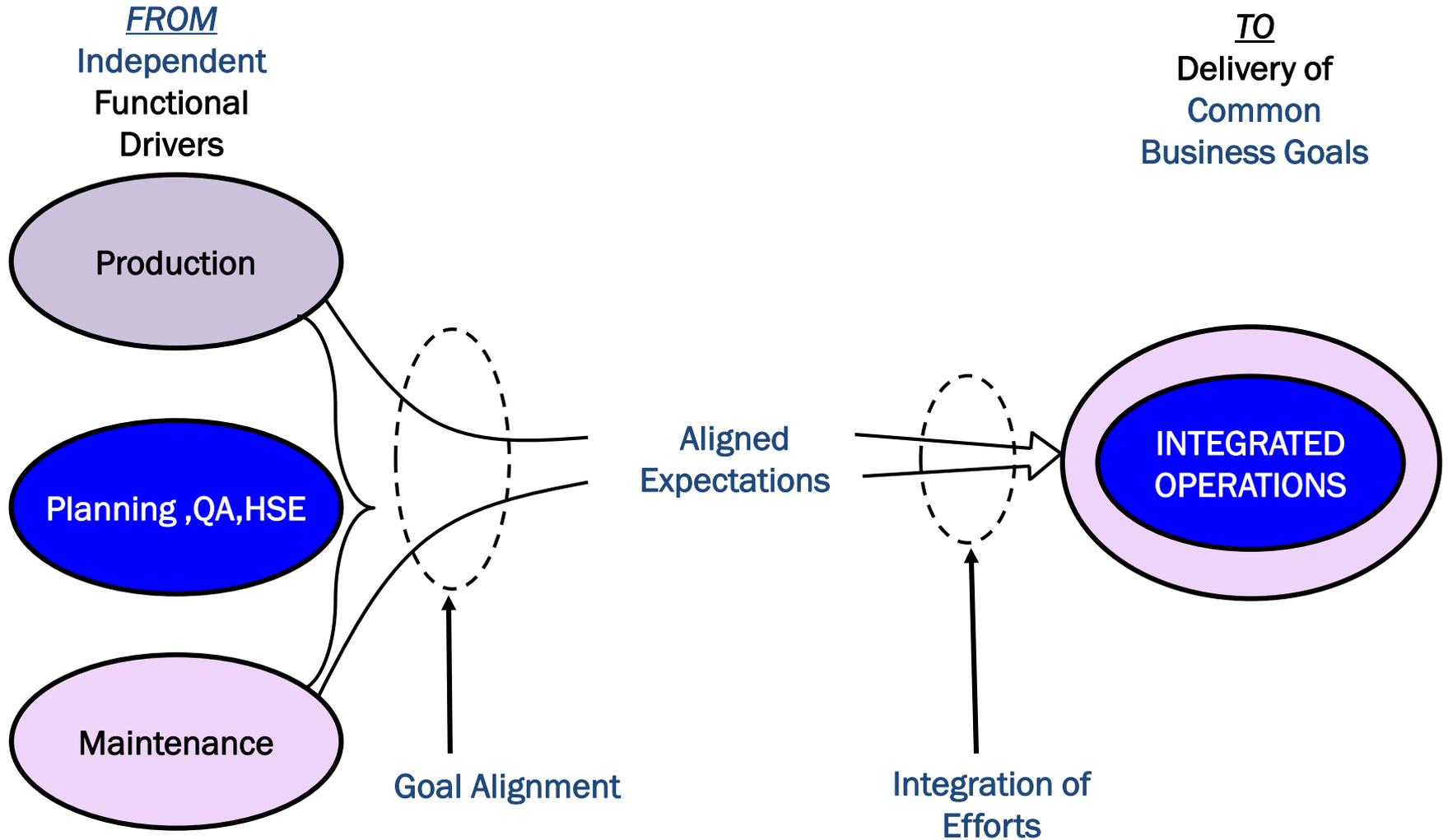
- A leading manufacturer of Speciality Chemicals for the detergent industry
- 182 Employees running a Highly regulated site.
- **Pressing need to improve the effectiveness of a new (3 year old) chemical plant producing Sodium Acetate**
- Implemented a Total Productive Maintenance (TPM) training programme and methodology that encourages close, cross-functional teamwork to effectively manage the plant and its equipment through the Operators and Maintainers Teamwork

# Site Leadership 'Buy-in' Workshop

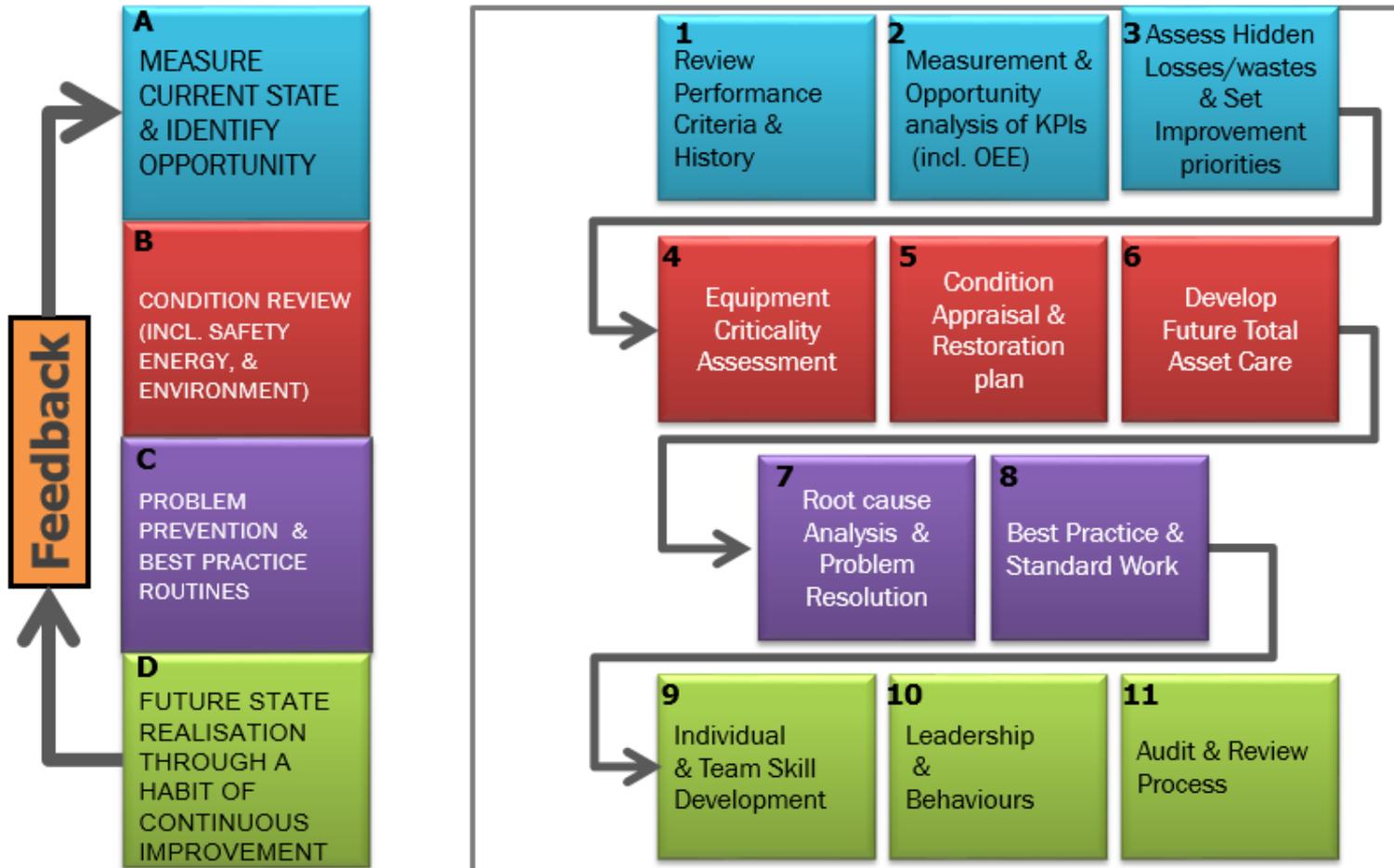
| <b>Business Drivers</b>                    | <b>Potential Impact of TPM</b>         |
|--|--|
| <b>Improved Profitability</b>              | <b>3</b>                               |
| <b>Increased Sales</b>                     | <b>3</b>                               |
| <b>Customer Credibility</b>                | <b>3</b>                               |
| <b>Staff Involvement &amp; Engagement</b>  | <b>3</b>                               |
| <b>Safety Performance</b>                  | <b>3</b>                               |
| <b>Environmental Conformance</b>           | <b>2</b>                               |
| <b>Diversification</b>                     | <b>2</b>                               |
| <b>Stake Holder Value</b>                  | <b>2</b>                               |
| <b>Reduction in Asset Maintenance Cost</b> | <b>1</b>                               |
| <b>TOTAL</b>                               | <b>22 / 27 = 81 %<br/>Significance</b> |

Rating Scale Used... 0 = No Impact 1 = Some Impact  
2 = Significant Impact 3 = Major Impact

# Working in Partnership –our *End Game* vision

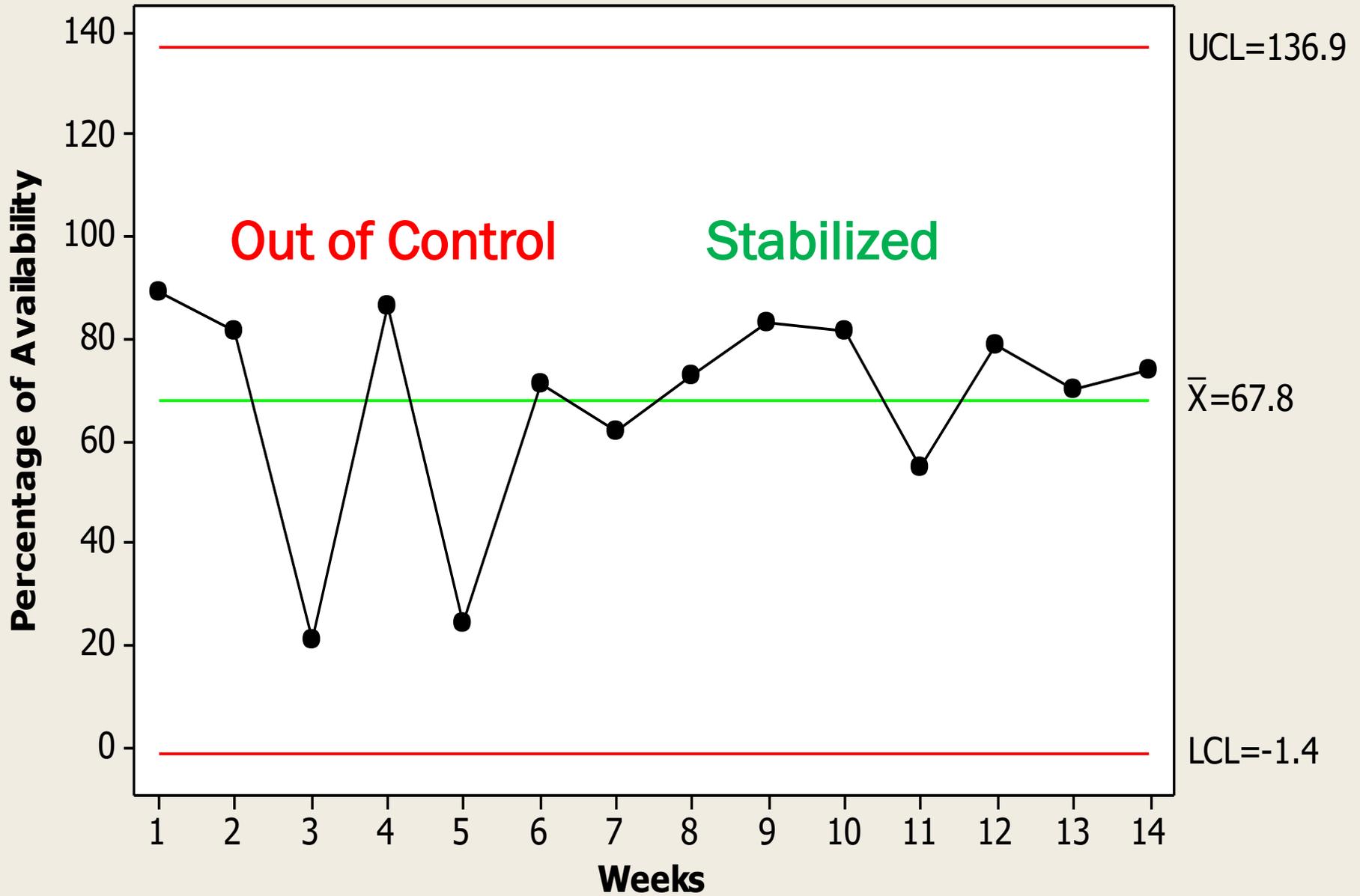


# Four Cycle 11 Step TPM model™

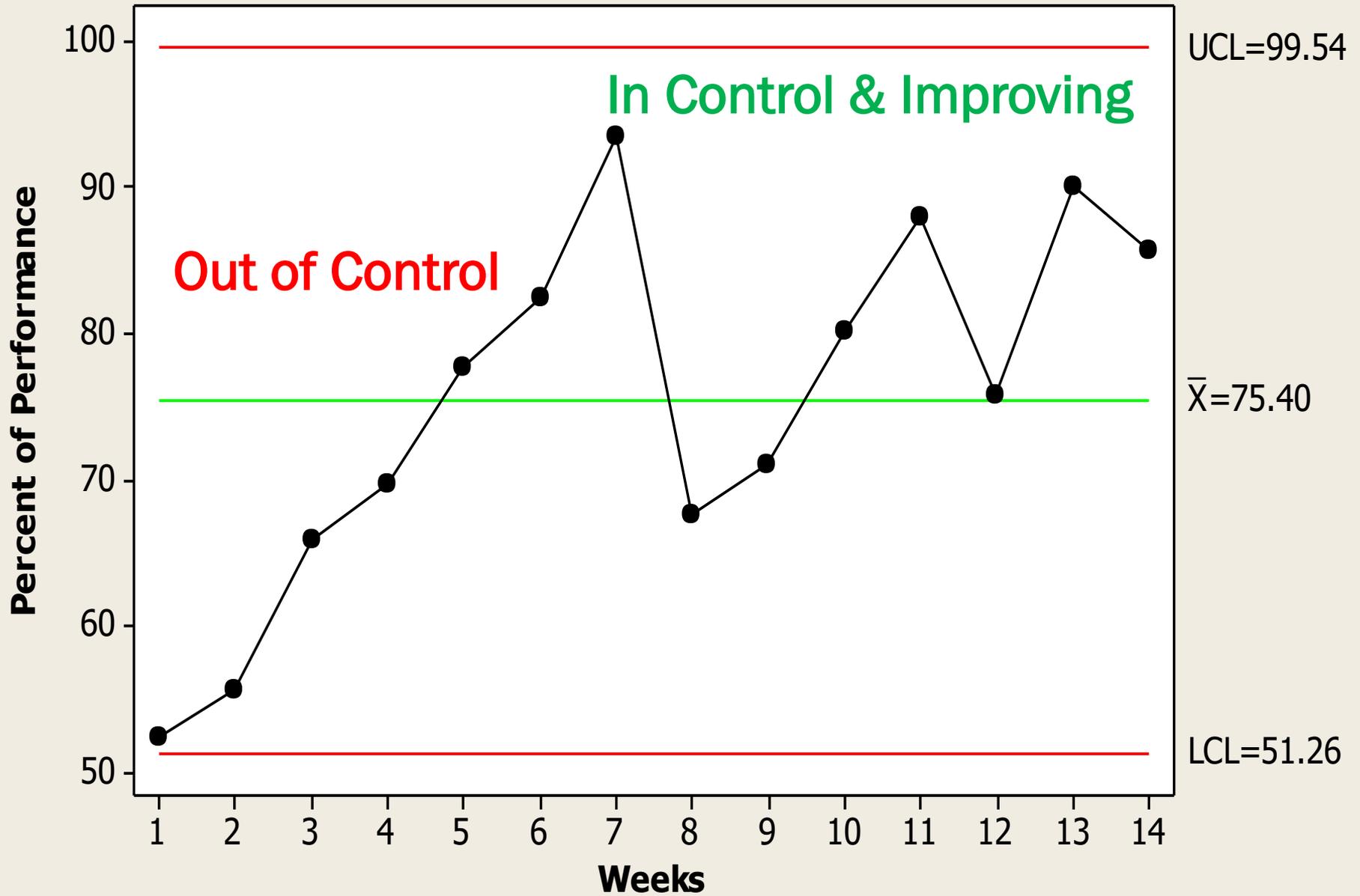


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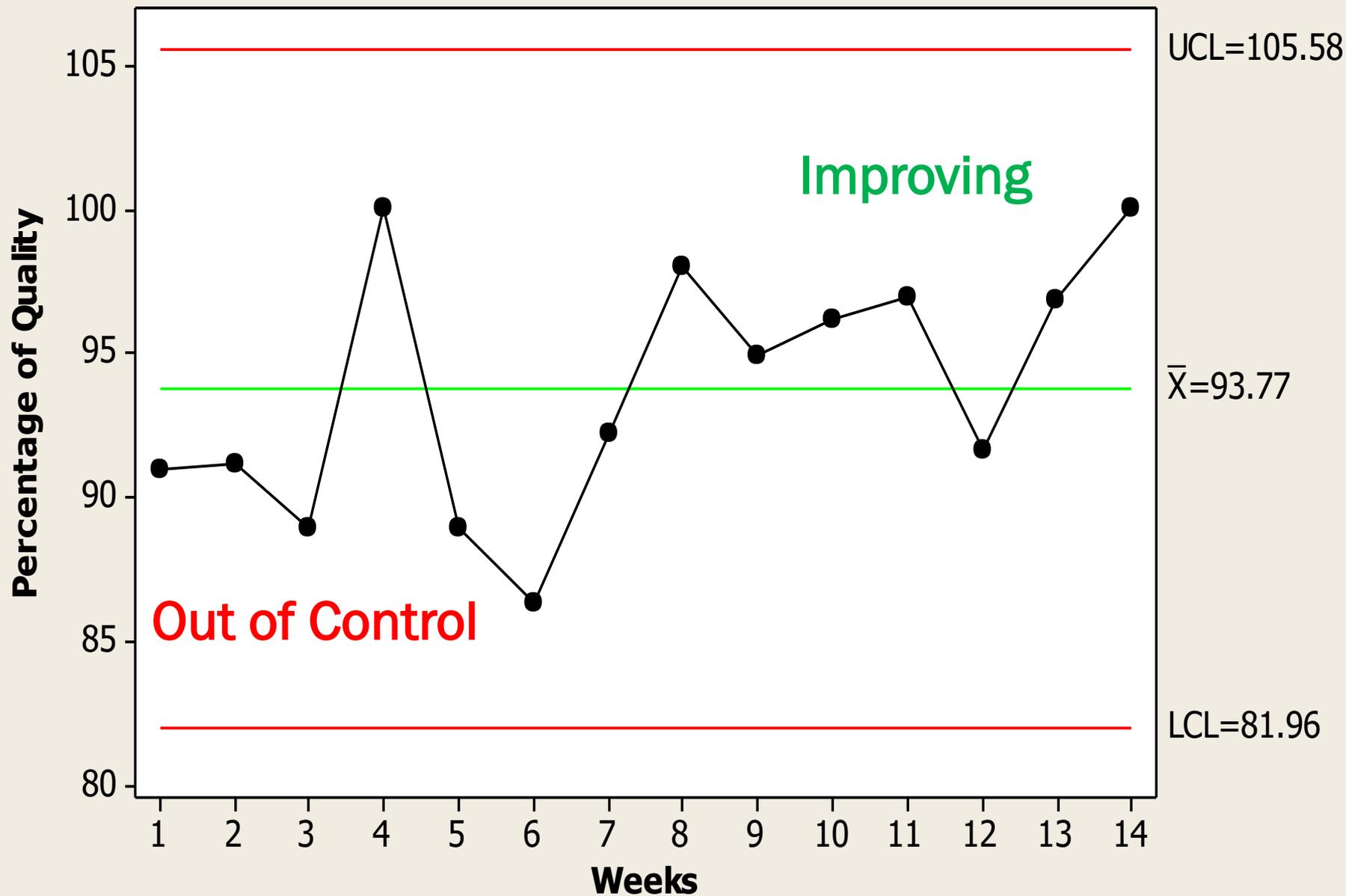
# Availability



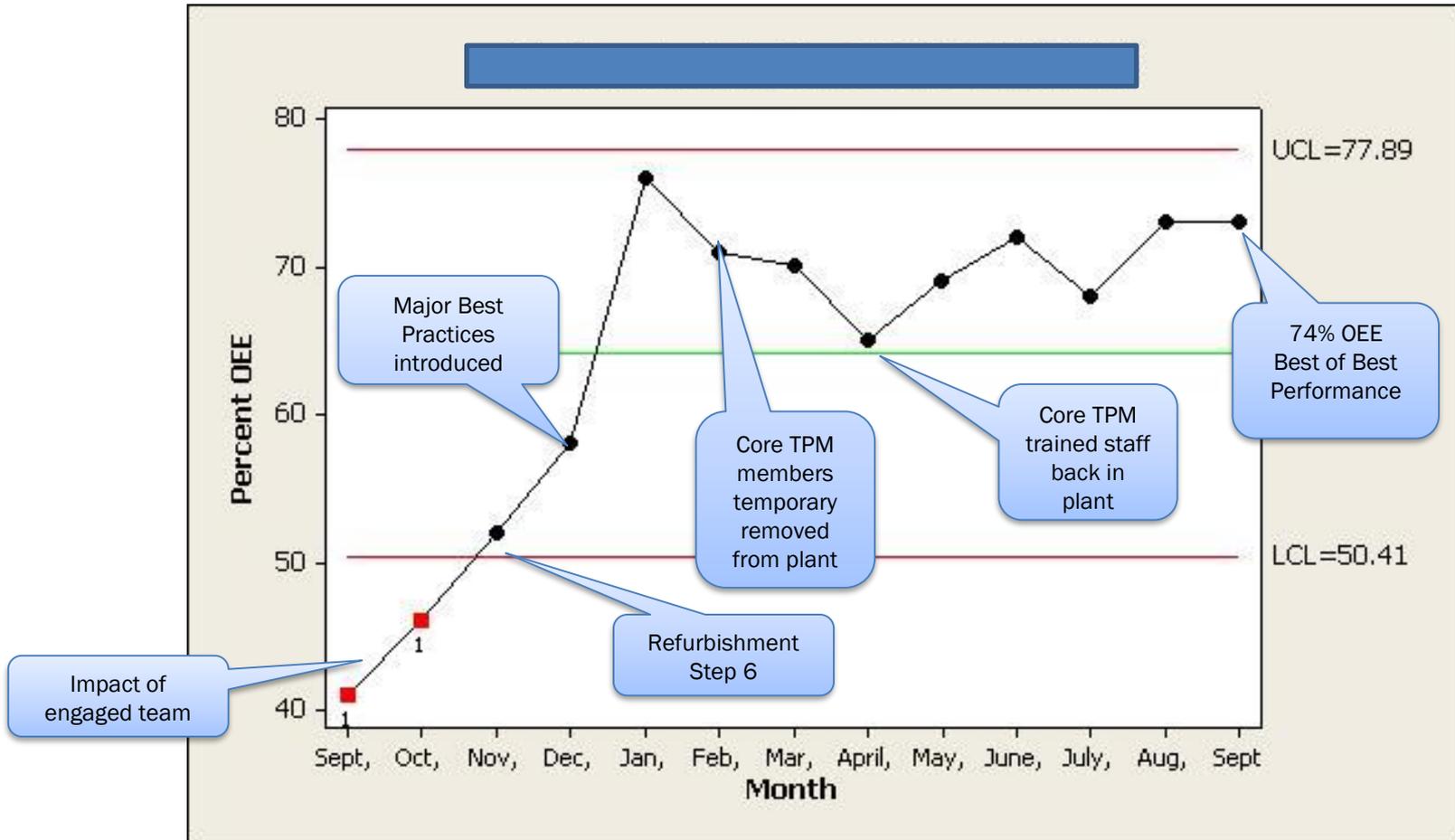
# Performance



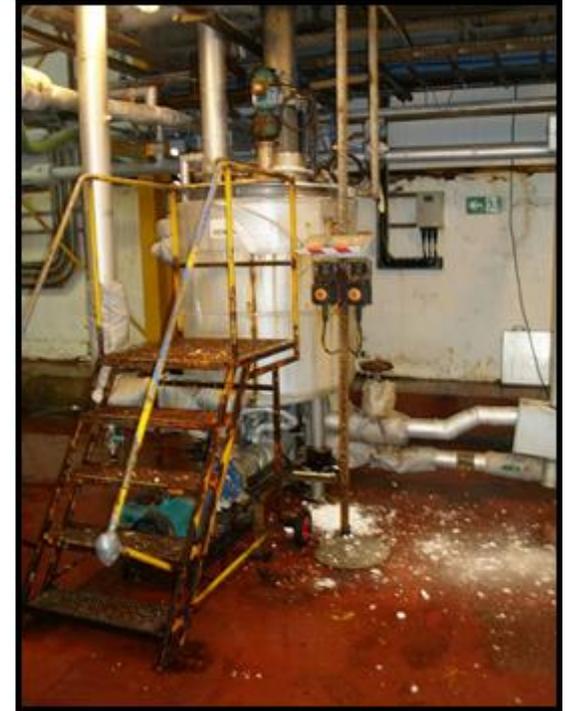
# Quality



# The OEE results after 12 months



# Before Launching TPM....Where would you prefer to work? With an OEE of 33%?



# Before Launching TPM...Where would you prefer to work? With an OEE of 33%?



After Launching TPM....Where would  
you prefer to work?  
With an OEE of 74%?



In a plant with well designed, fit for purpose, safe, reliable and with  
well maintained equipment?

# After Launching TPM...Where would you prefer to work? With an OEE of 74%?



# Quotable Quotes from the Shift -based TPM Teams of Operators & Maintainers

- We are being listened to & encouraged’
- ‘We are all buying into it...’
- ‘There’s only one best way’
- ‘We have not had to compromise our values...’
- ‘We not only know the ‘*What*’ but also the ‘*How*’ and the ‘*Where*’ to get help’
- ‘Who would have thought we could double our batches !!’

# Result

- Additional c. **\$ 1.5 m t/o** with net margin of **10%**
- Total training and refurbishment costs of **\$ 60k**
- **6 months Pay-back**
- Result ? **WIN /WIN !**

**Also Winner of UK National Training Awards**  
for internal training and development of front line  
staff using our 11 step TPM model

# Warwick Chemicals Case Study

Also described in Chapter 10 of recently published book obtainable on Amazon.....

## ***TPM – a foundation of operational excellence***

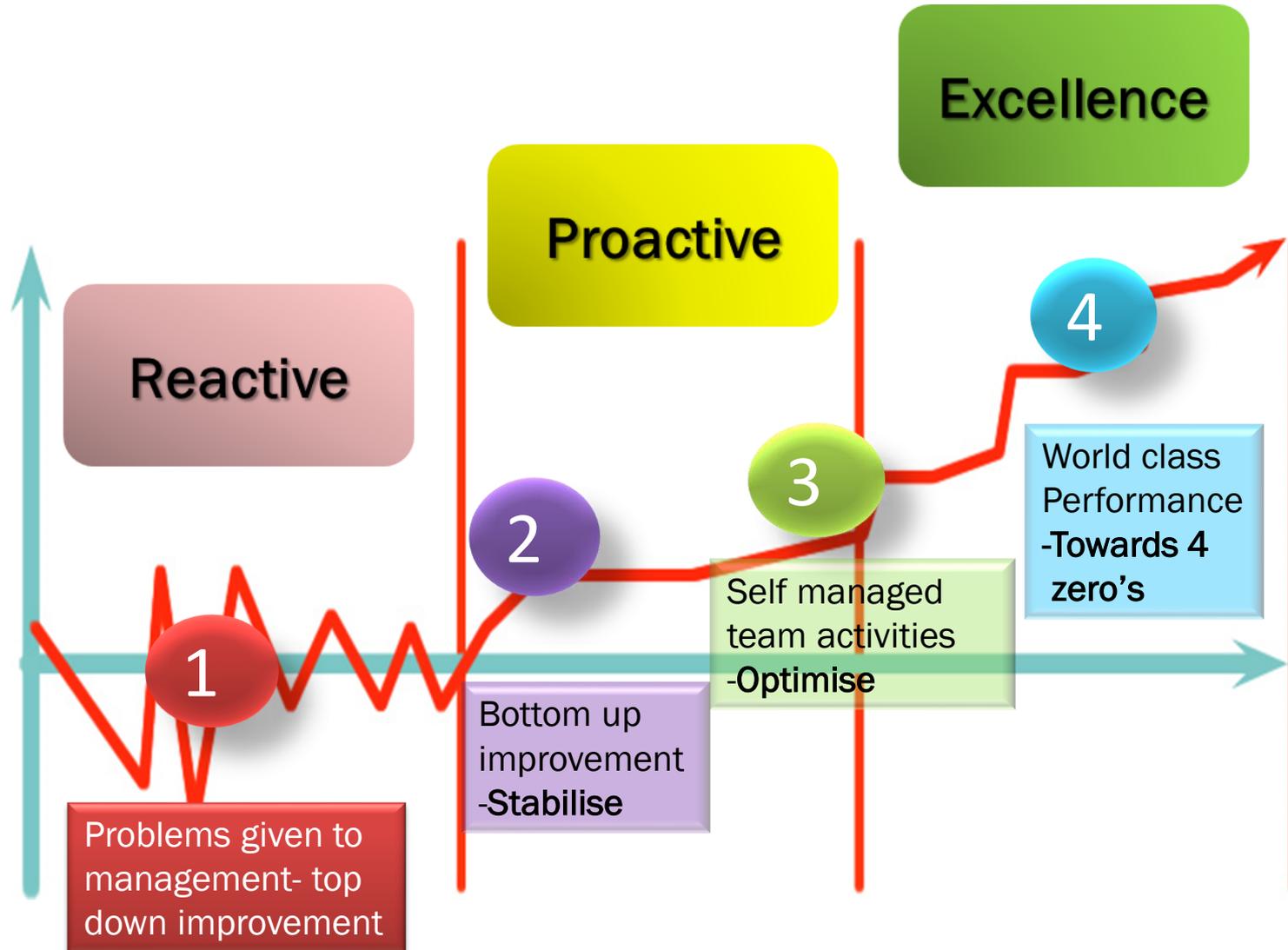
Co authored by Peter Willmott, John Quirke and Andy Brunskill.

Published by SA Partners, 2019. ISBN 978-1-9993748-1-5.

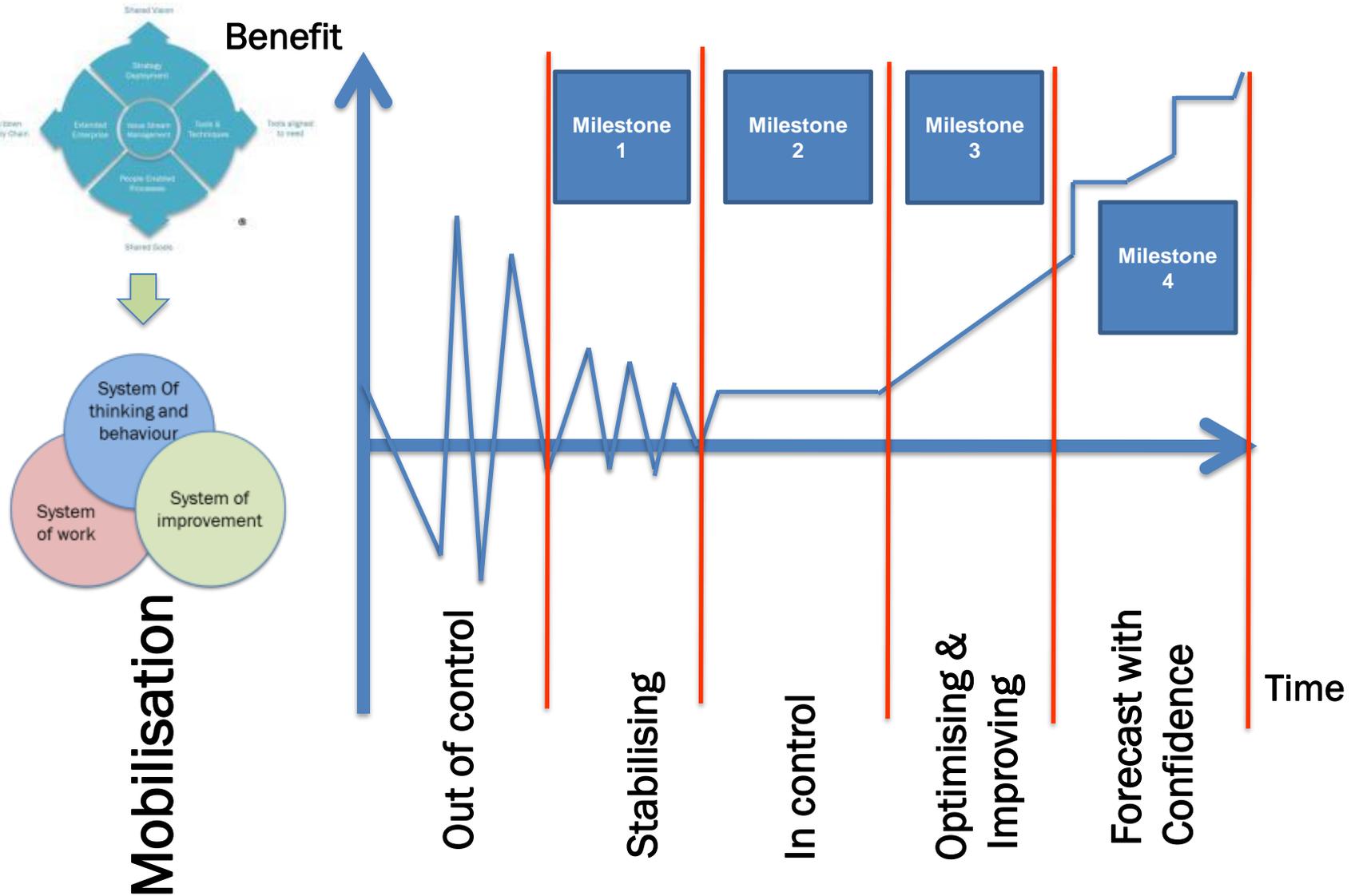
Obtainable on Amazon @ £39.99 with a £2 donation shared between Friends of Chernobyl's Children and The Prince's Trust for each copy sold.



# 4 milestones of TPM on the journey to excellence



# Steps 4 to 6- Journey to TPM Excellence over 4 x Milestones



# Defined evidence based review criteria at each of 4 maturity levels

.Transferred to local CI /TPM teams over agreed time timeframes

| IMPROVEMENT ZONE AUDIT/REVIEW |  |             |   |
|-------------------------------|--|-------------|---|
| Milestone: Introduction       |  | Level: 18   |   |
| Department: _____             |  | Zone: _____ |   |
| Auditors: _____               |  | Date: _____ |   |
| Review Point                  | Assessment   | Score       | Evidence  |
|                               |  |             |   |
| 1                             | Workplace neat and tidy (5S Step 2)  |             | Audit Results   |
| 2                             | Have sources of contamination been identified and dealt with   |             | 3 = identified, 4 = contained, 5 = eliminated                           |
| 3                             | Are cleaning methods and standards self/applied (includes difficult to access areas on equipment identified and addressed) |             | 4 = cleaning time reduced, 5 = significant continuous improvement trend |
| 4                             | Are equipment operating standards established for critical equipment (see standards list)                                  |             | 2 = documented, provisional standard, 3 = full standard, 5 = improved   |
| 5                             | Condition appraisal and refurbishment of critical items  |             | 3 = completed, 5 = long term provision                                  |
| 6                             | Refurbishment plan to raise equipment condition  |             | 3 = planned, 4 = completed  |
| 7                             | Single Point Lessons for correct operation, key parameters, set up, interlocks, safety, visual inspection                  |             | 2 = training started, 3 = in use, 5 = improved                          |
| 8                             | Use of Visual Indicators for detecting abnormalities   |             | 3 = in use, 4 = improved  |
| 9                             | Joint operator & maintainer improvement actions  |             | 2 = started, 3 = examples, 5 = history of success                       |
| 10                            | Training in basic maintenance techniques (eg lubrication, hydraulics, belt tightening)                                     |             | 2 = content identified, 3 = entry training complete                     |

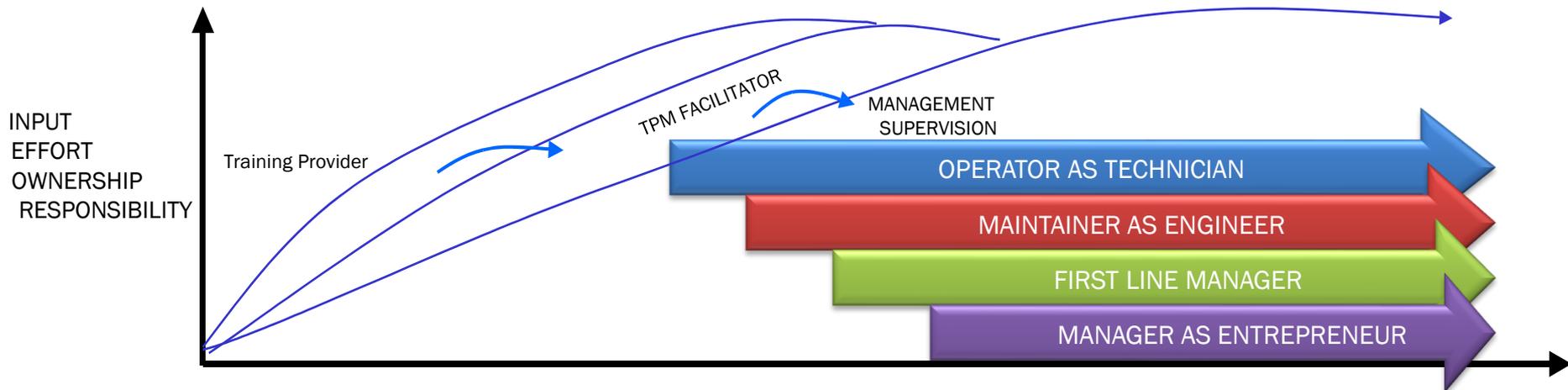
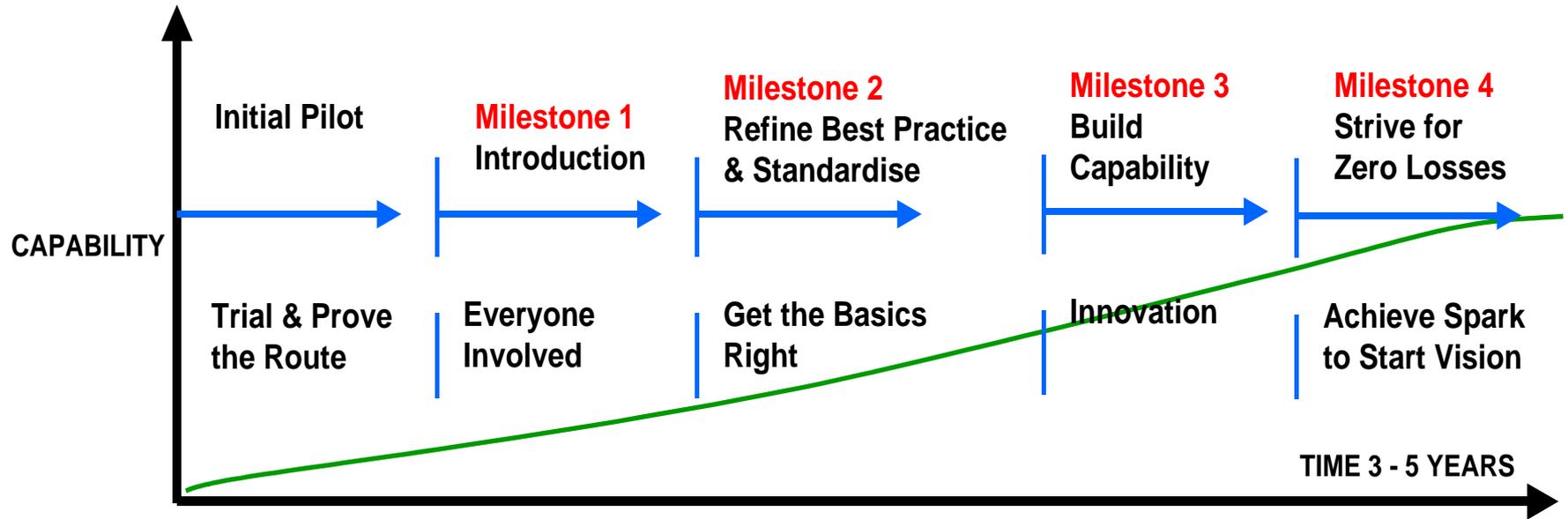
Minimum score 30 = Pass level 15, 40 = proceed to level 24

Rating based on procedures/systems which are:-

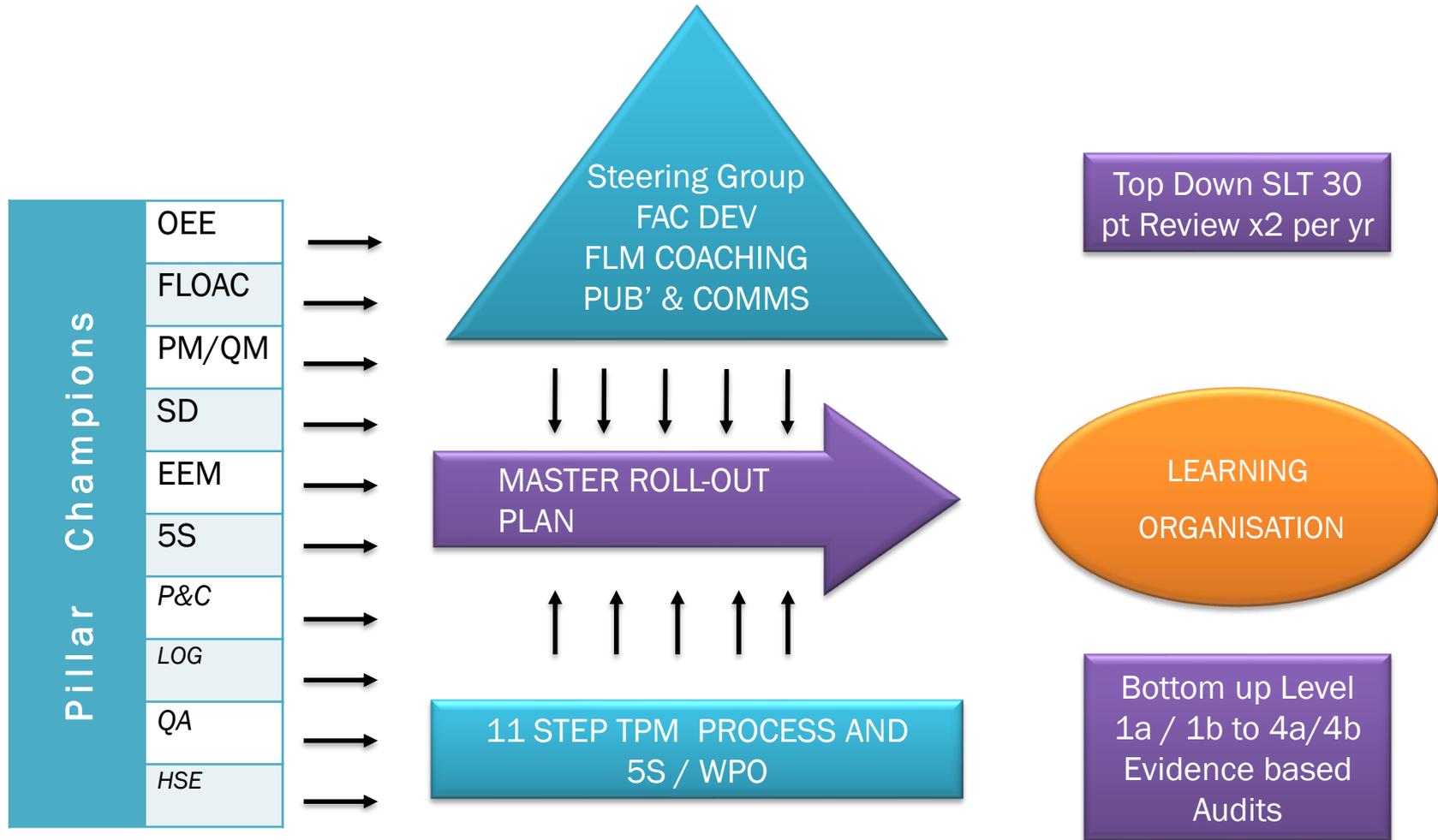
|  |   |
|--|---|
| 1. Not in place with no plans to address.                    | 4. Well defined, executed and understood                      |
| 2. Weak/deficient  | 5. Well defined with a track record of continuous improvement |
| 3. Able to meet department/plant goals with plans to improve |   |



# Steps 4 to 6- TPM Roll Out Evolution



# Steps 4 to 6 -CI Infrastructure for the TPM Journey

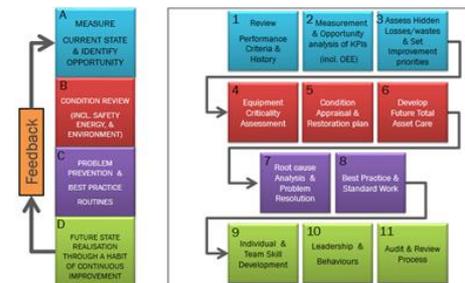


# TPM provides clear accountabilities, responsibilities and expectations

- **TPM** provides a structured system in which **Leaders** can coach on the appropriate behaviours and provide focus on strategic direction & imperatives.
- For **Managers & Supervisors**, **TPM** provides a structure to identify and focus effective process improvement and gives opportunities to coach on effective problem solving and process performance through the effective use of visual management tools.
- For the **Operator and Maintainer team**, **TPM** provides opportunities to work within teams, grow personal skills and open wider opportunities.

# Four Cycle 11 step TPM model <sup>TM</sup>

- The application of eleven step TPM model is applied through a defined sequence of team based '*learning by doing*' activities with their process equipment.
- The team work through eight equipment based steps, they measure and identify opportunities for improvement of equipment condition and performance.
- With a further three behaviour and sustainment steps, the team in conjunction with the leadership team define necessary behaviours and review activity necessary to sustain the gains into the future with evidence based audits



© S A Partners

## What can this approach give you?

- Provides a structured, proven & systematic approach
- Which is time-tabled and scheduled
- Encourages wide-engagement
- With clear roles & responsibilities
- Capable of delivering significant business benefits
- Proven to be sustainable in the right hands
- Above all-It's very practical

## Session 2-Making Partnership work

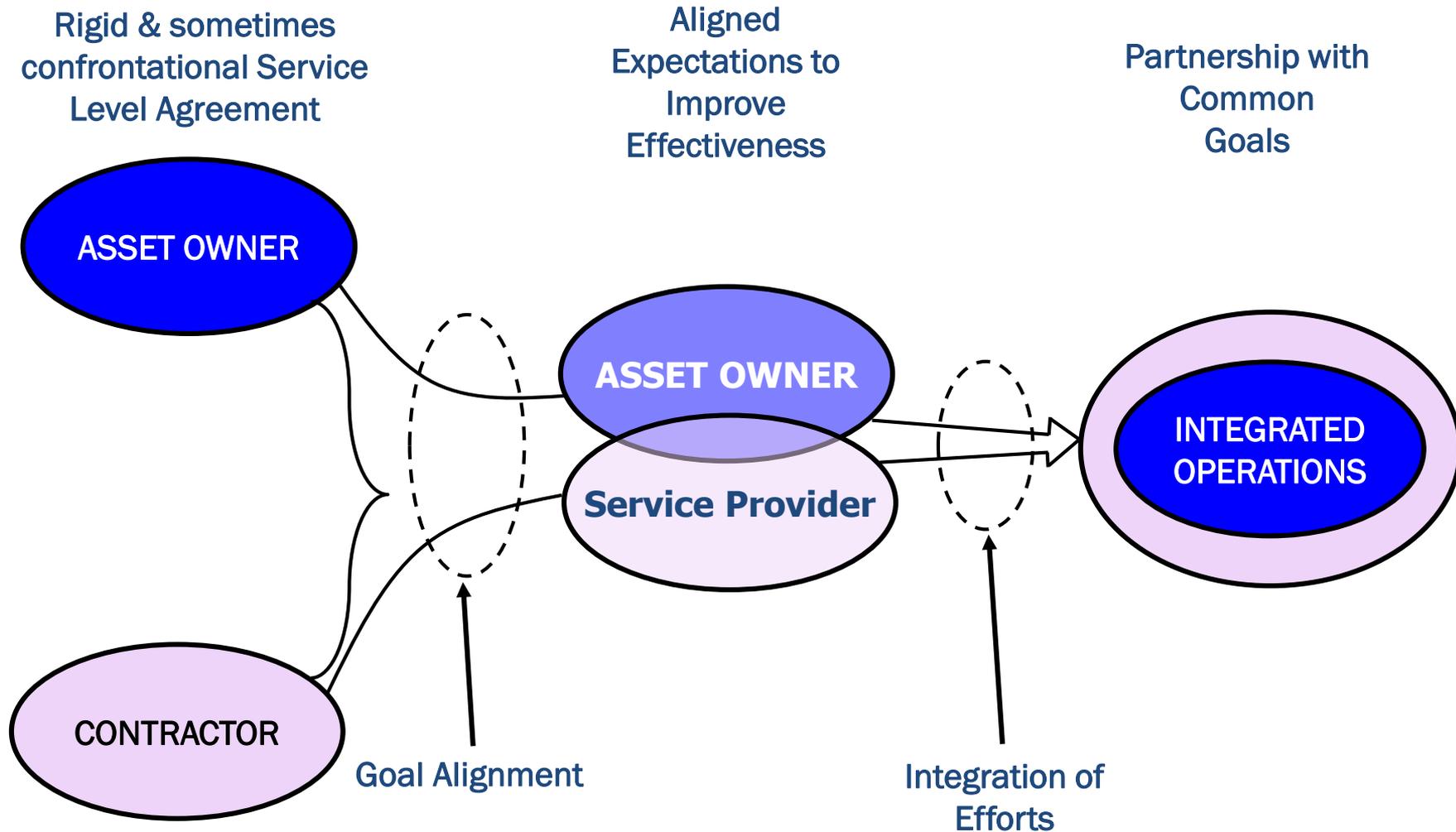
- Some guidance on delivering a culture of Partnership between Asset Owners and their O&M Service Providers

# Evolution of Outsourcing

- **1<sup>st</sup> generation:** Characterised by rigid Service Level Agreements and hands off relationships-essentially adversarial with a ‘them and us’ atmosphere
- **2<sup>nd</sup> generation:** With a move away from the business driver of pure cost cutting to one of improving effectiveness of resources and physical assets;
- **3<sup>rd</sup> generation:** Partnership based agreements with a win/win foundation based on building trust and where a significant part of the reward structure is variable according to pre-determined performance levels

Successful outsourcing relationships are often able to progress from 2<sup>nd</sup> to 3<sup>rd</sup> type reward structures.

# The Evolution Of Partnership working



# Typical Outsourcing “Partnerships”?? Some of the Issues.....

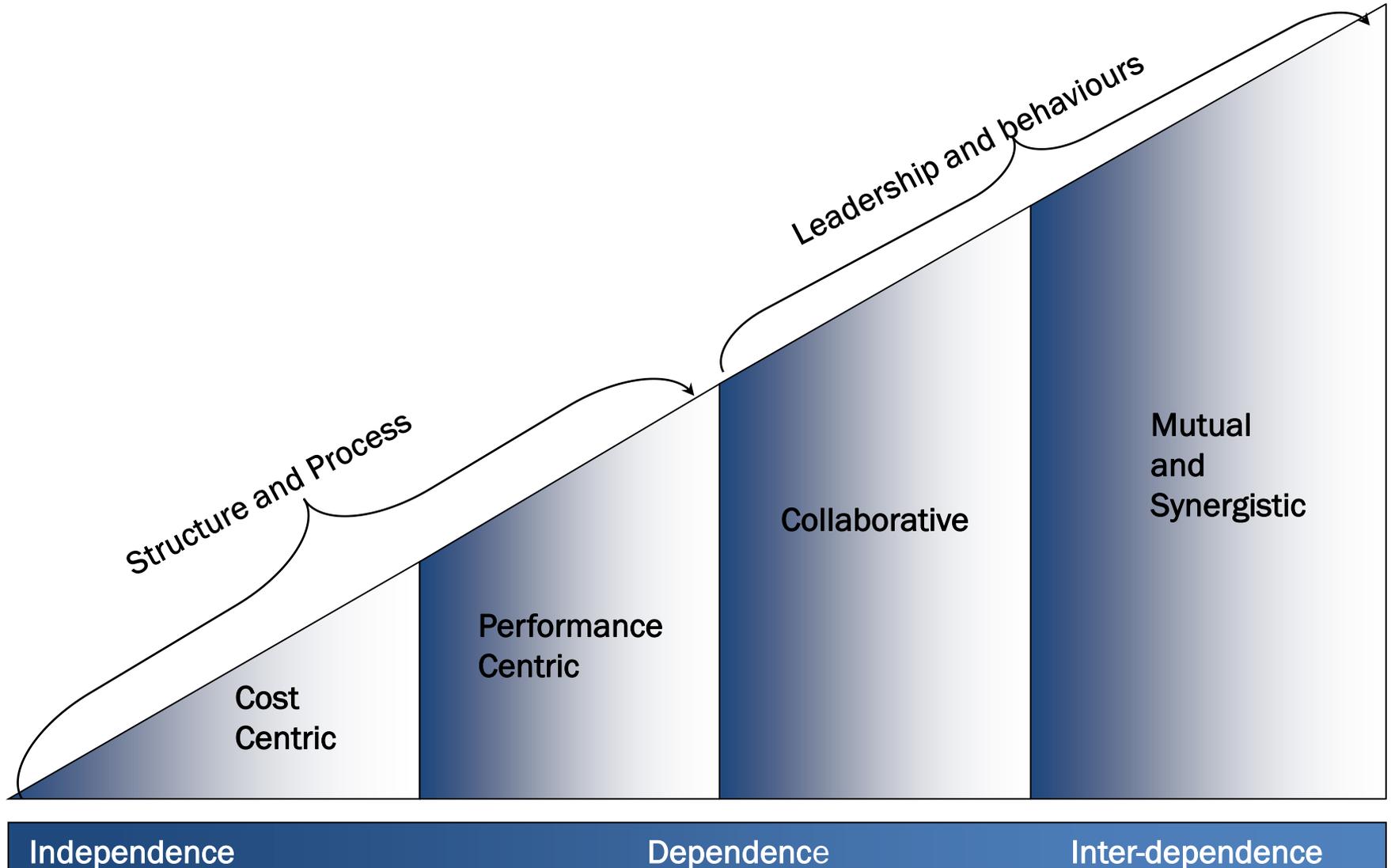


??????



- ***What is typically missing***
  - Developing Trust
  - Long term Commitment
  - A true culture of win-win and maximising benefit for both parties
  - Medium/Longer term aligned and deployed strategy
- ***What we typically observe***
  - Rigid SLA's
  - No Mgt framework to review SLA performance
    - Set by Purchasing, not owned by Operations
  - Adversarial relationships
  - Short term focus
  - Playing games/politics resulting in
    - Win/lose tactics
  - Poor leadership behaviours at various levels

# Developing Sustainable Partnerships – underpinning principles



# A key learning point

**Recognising the importance of the key stakeholders and joint party's cultural and behavioural alignment**

# The Partnership Idea

## Maximum Benefit

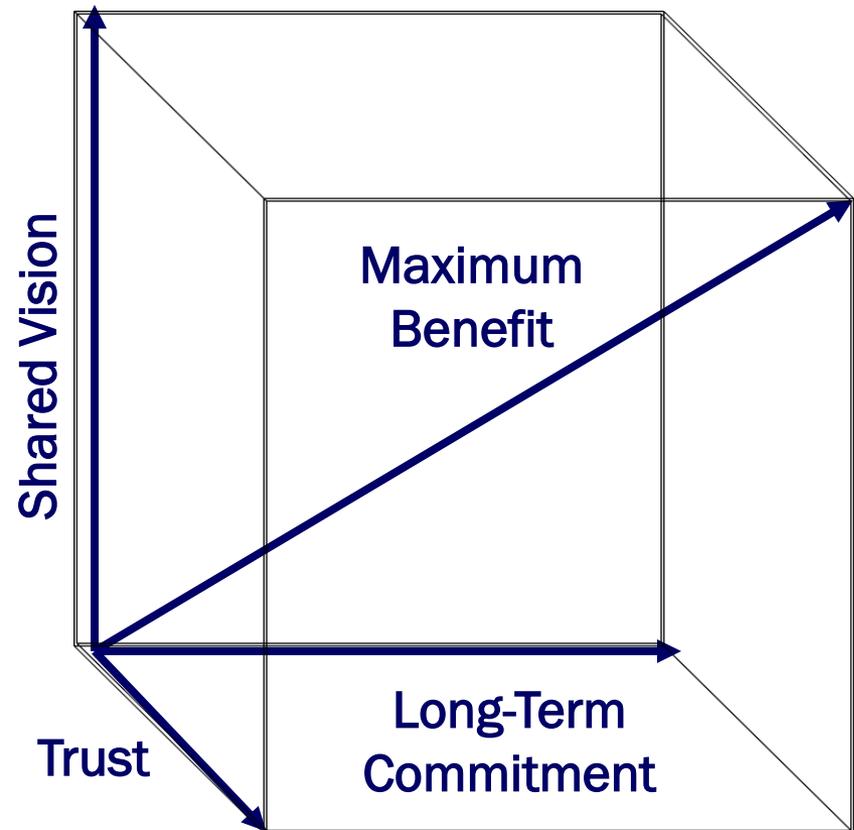
A contractual arrangement in which the Asset Owner & Service Provider agree to work closely together for the increased benefit of both.

## Long Term Commitment

It is a long term commitment between two or more organisations for the purpose of achieving specific objectives by maximising the effectiveness of each party's resources.

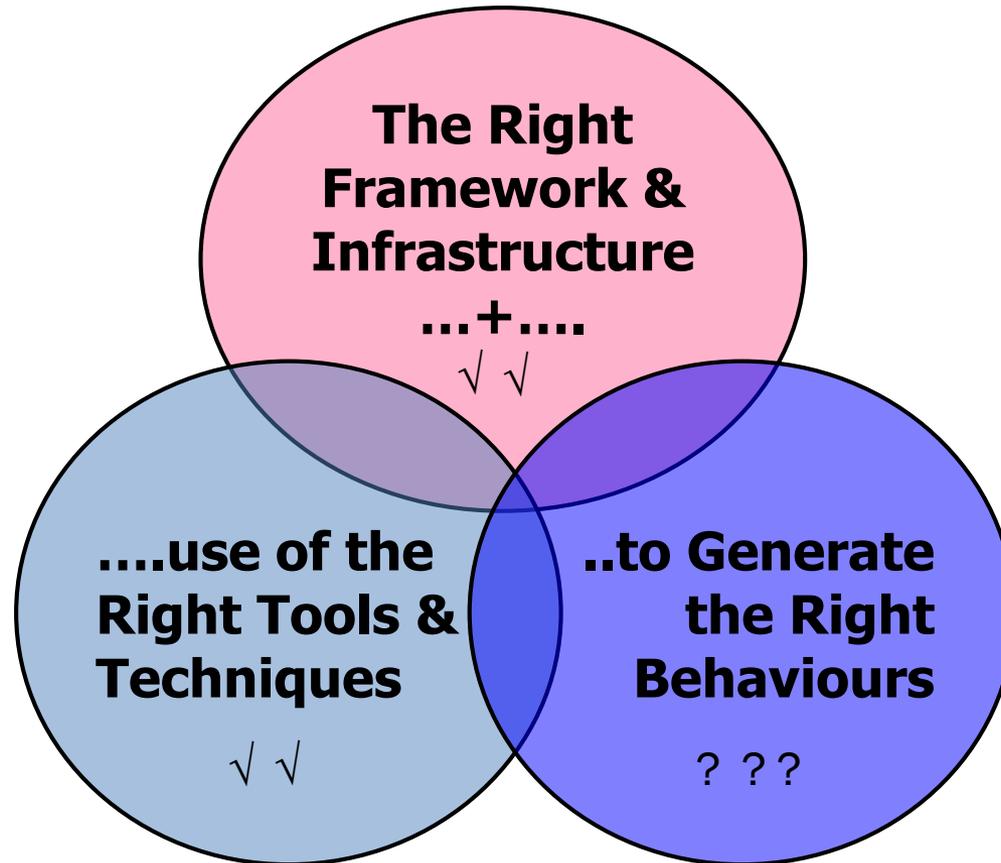
## Trust and Shared Vision

The relationship is based on trust, dedication to common goals and an understanding of each other's expectations.

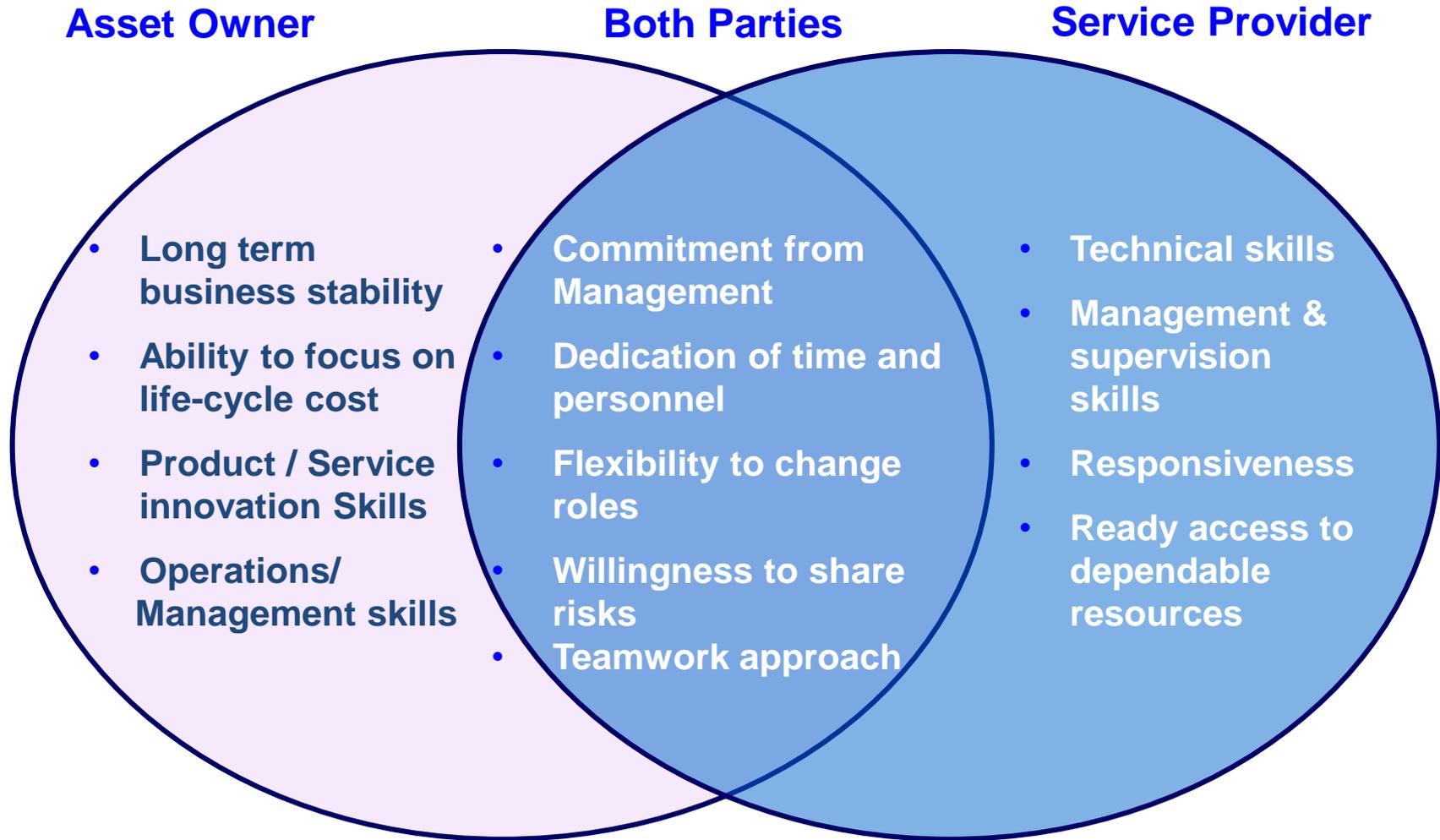


# Partnership principles

A **Sustainable** Partnership Environment Demands:-

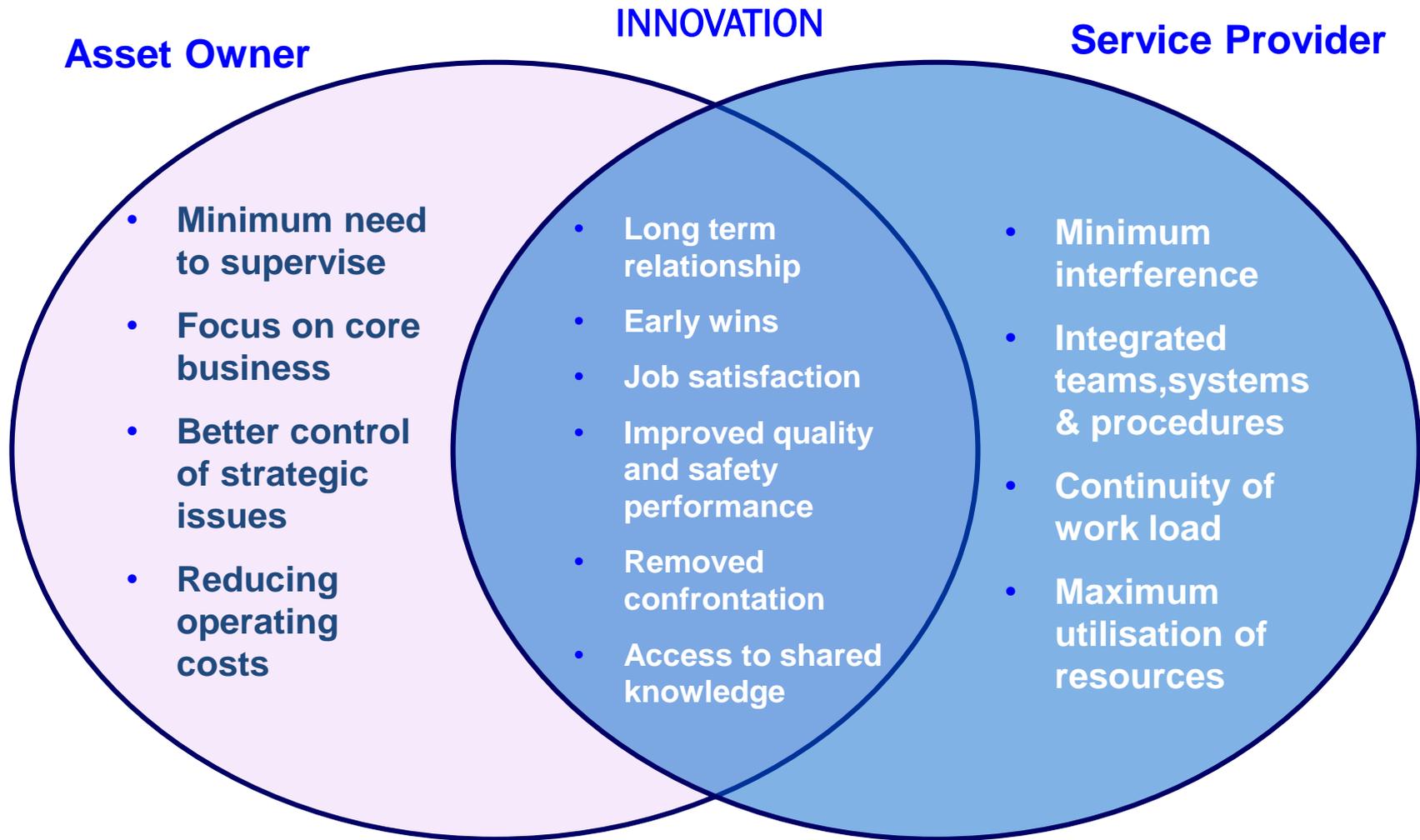


# Typical Win/Win Partnership Features



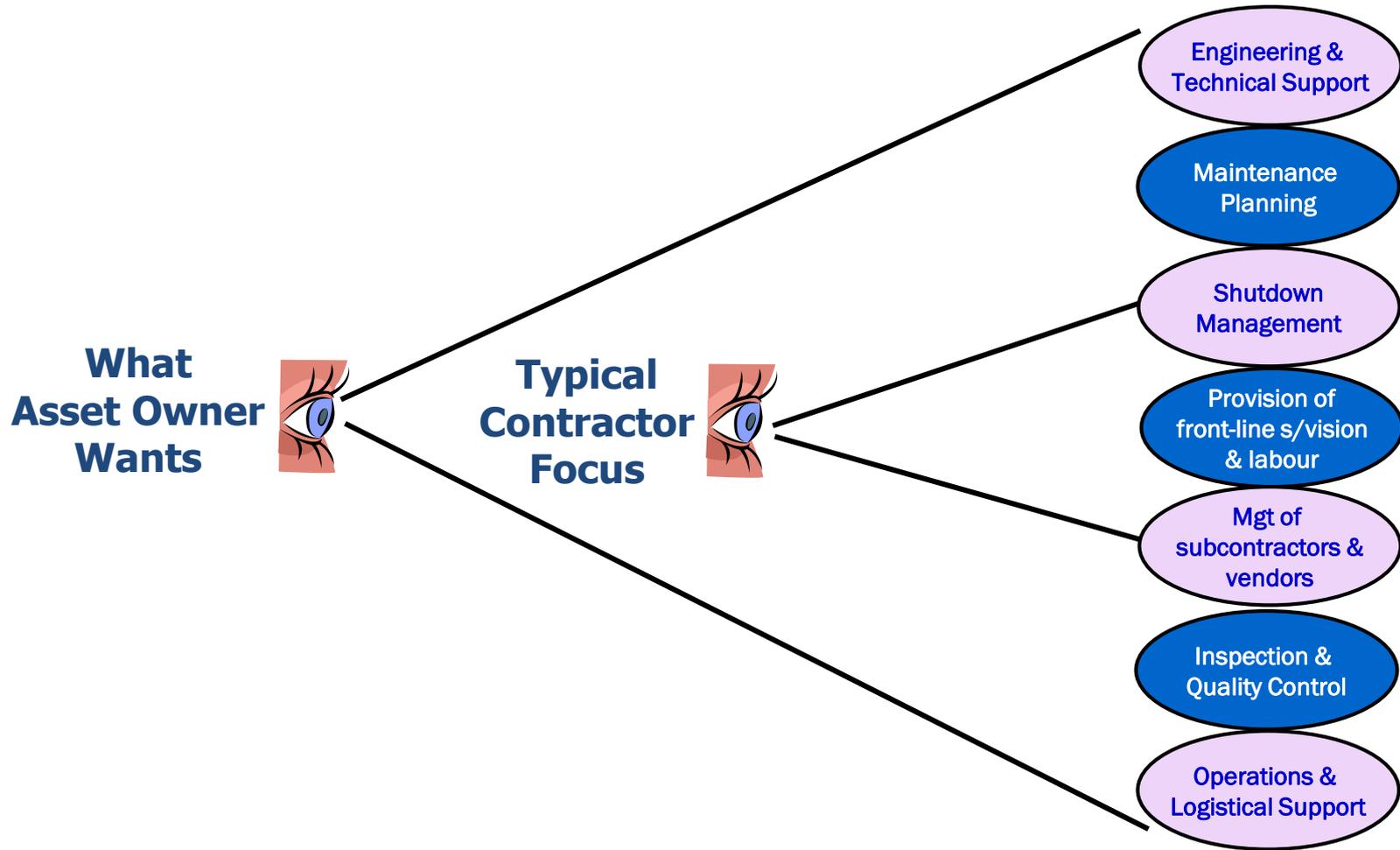
**A real appetite and desire to contribute**

# Creating a Win-Win Relationship

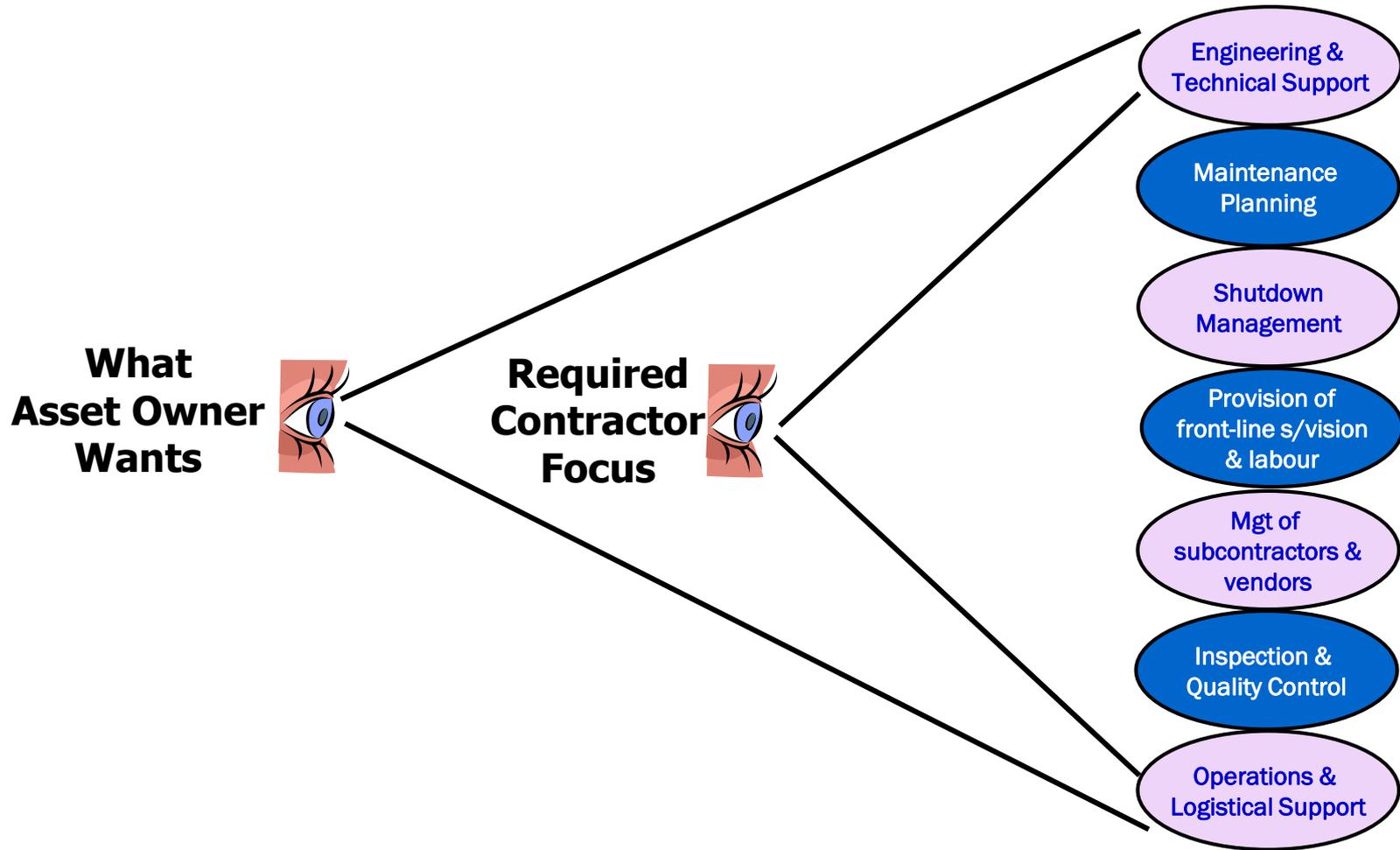


**Safety is our no. 1 Priority**

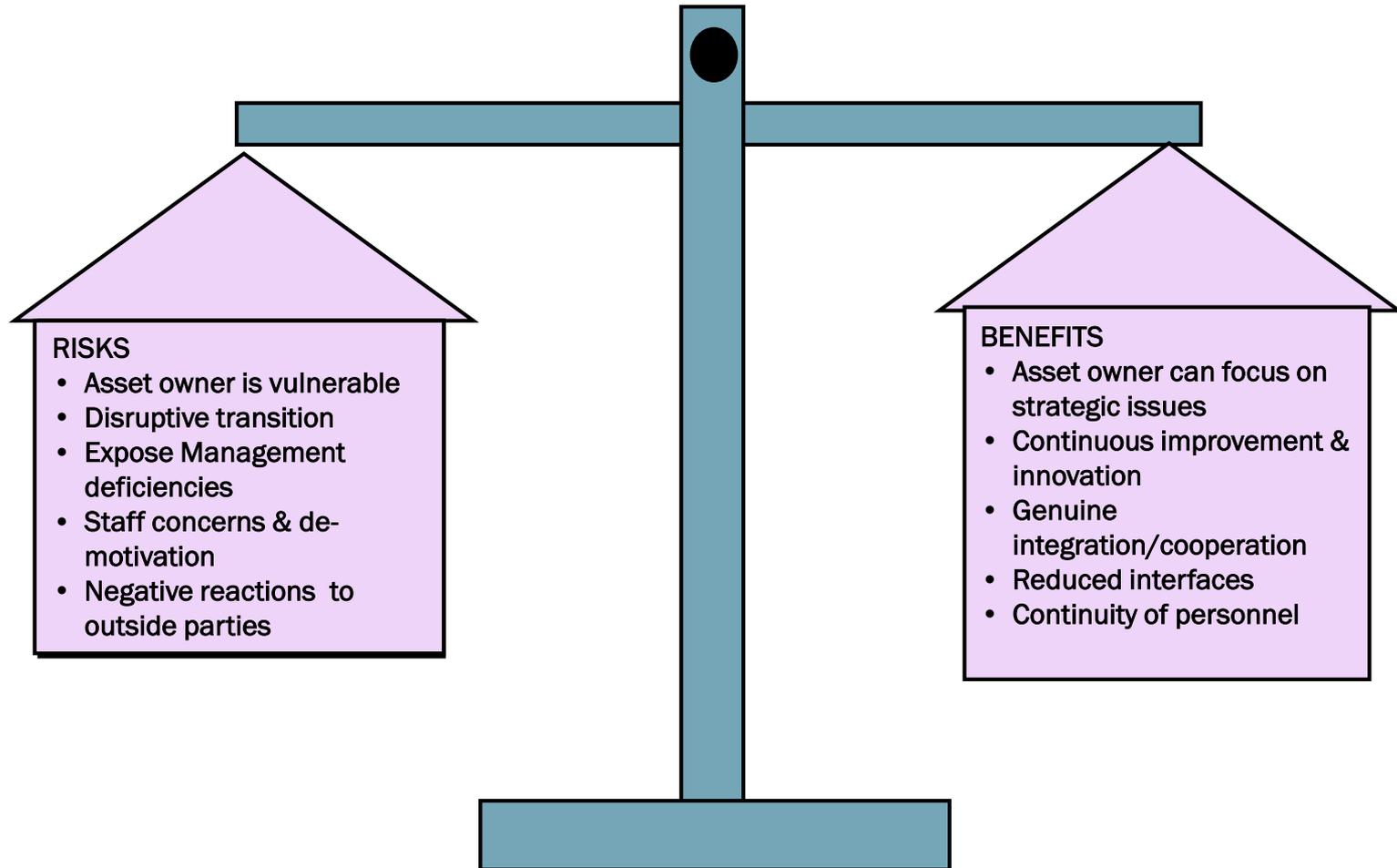
# Establishing the boundaries - The narrow spectrum



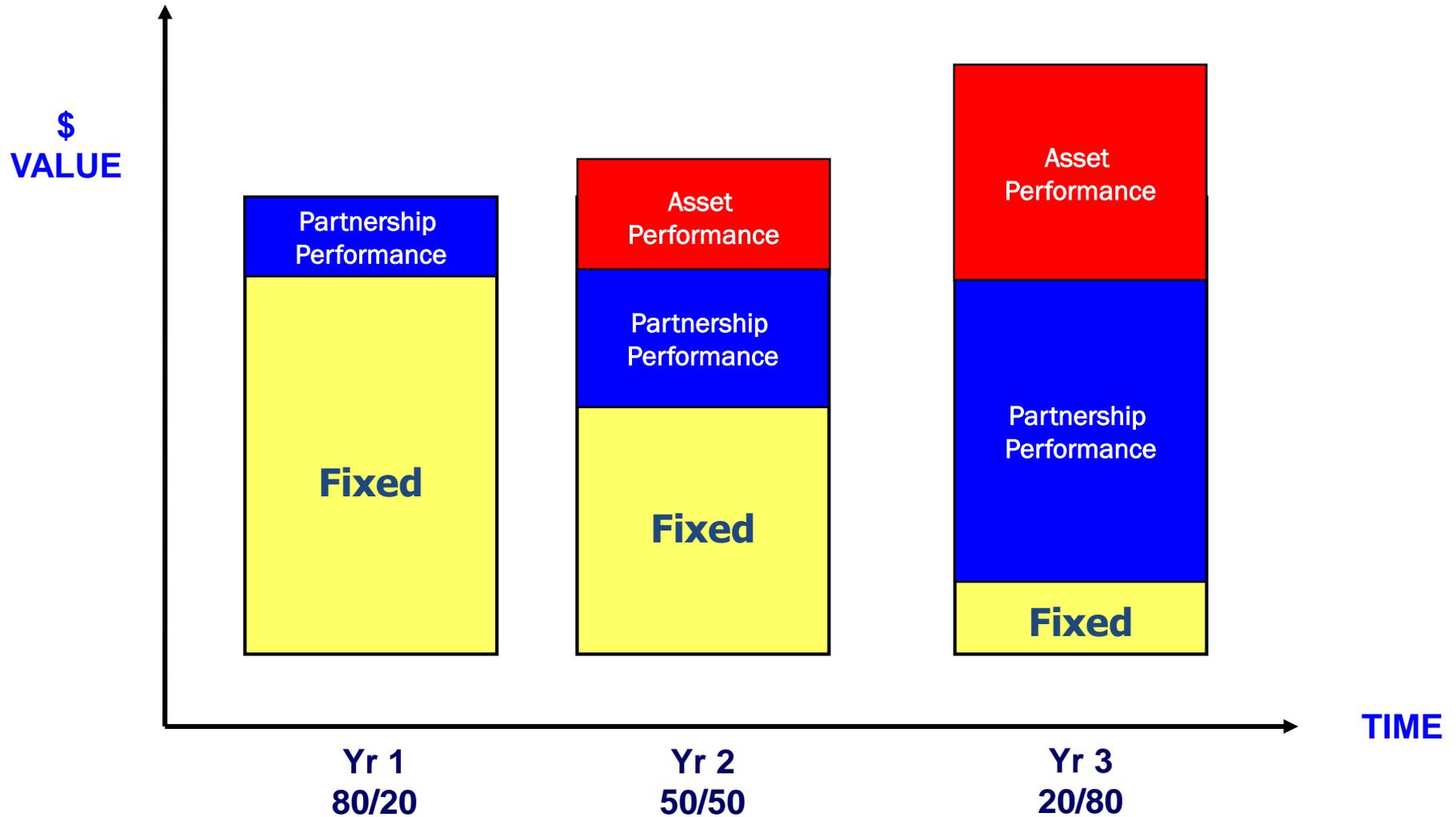
# Establishing the boundaries - The full spectrum



# Weighing Up the Pros and Cons



# Developing the Reward Structure

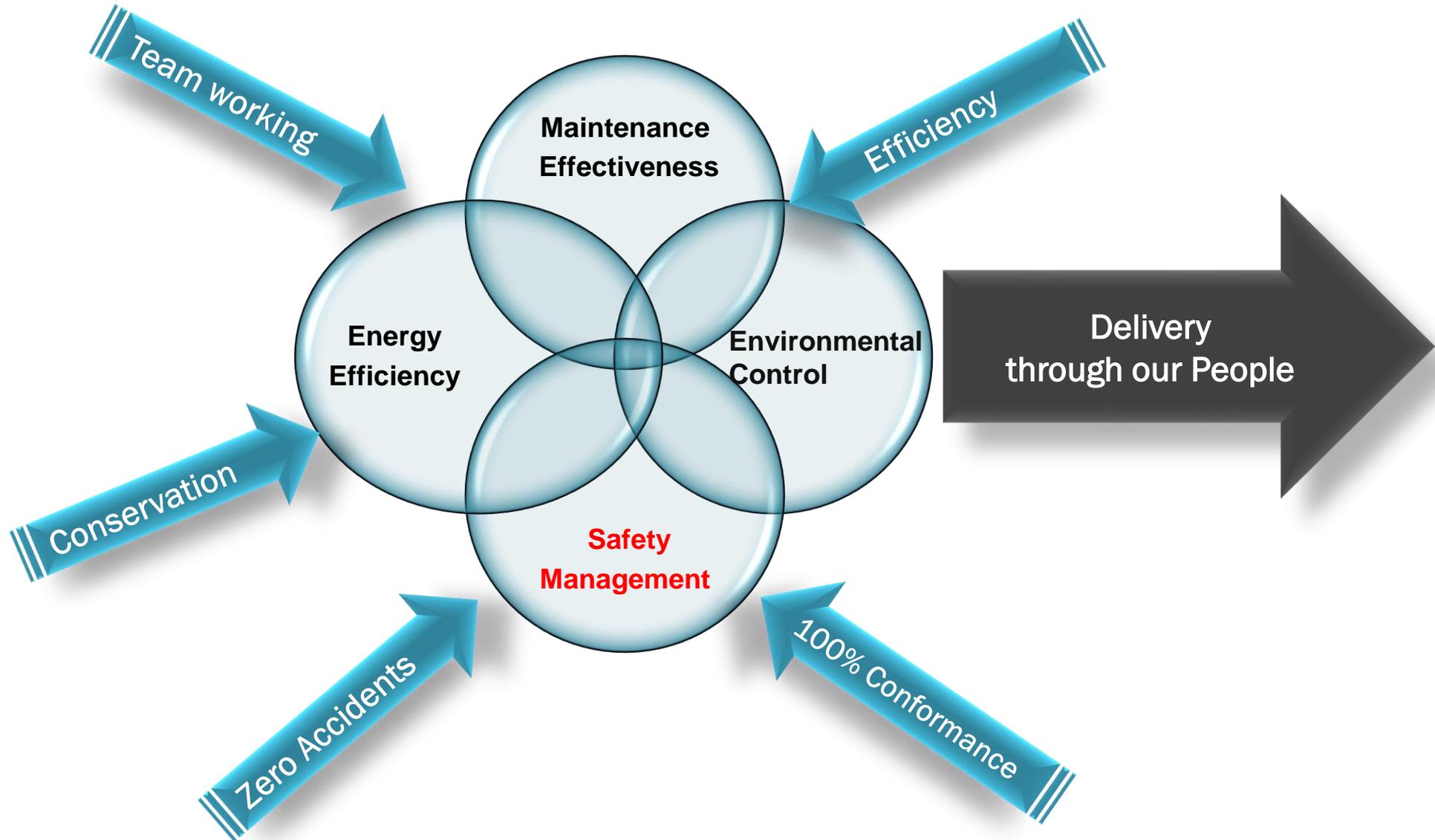


# Essential Foundations for Sustainable Partnership

- Visible and consistent Leadership\*
- A Desire to Challenge and Improve\*
- A Real Interest in Performance\*
- Team-Based Working\*
- Consistent Use of Data and Information
- Continual Check of Understanding to Target Improvement Effort
- Team-Based Working
- Focus and Enthusiasm
- Ability to Take Action and be Accountable
- Facilitated and Dedicated Improvement Time

**NOTE! The first four\* are Non-Optional Attributes/Behaviours of the Joint Partnership Leadership Team**

# Making Your Plant a 'World Class' Facility, Where the Future Drivers are:



# Stating the Obvious -

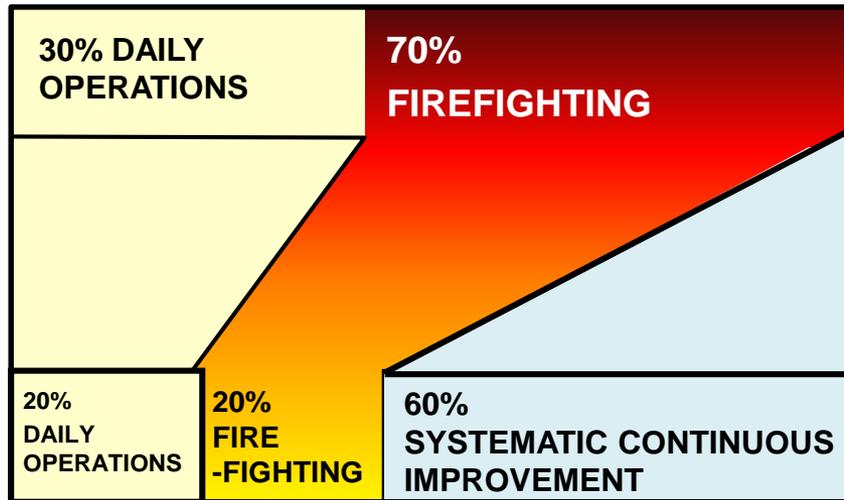
## **But sometimes the obvious needs re-stating!!**

- Maintenance and Energy are tied partners:
  - Maintenance Effectiveness = Energy Efficiency
- Maintenance and Environment are tied partners:
  - Less Spillage and Emissions = Less Environmental damage.
- Maintenance and Safety are tied partners:
  - Less Interventions = Less Accidents + Proper Guarding & Protection

# Development of maintenance 'Culture'



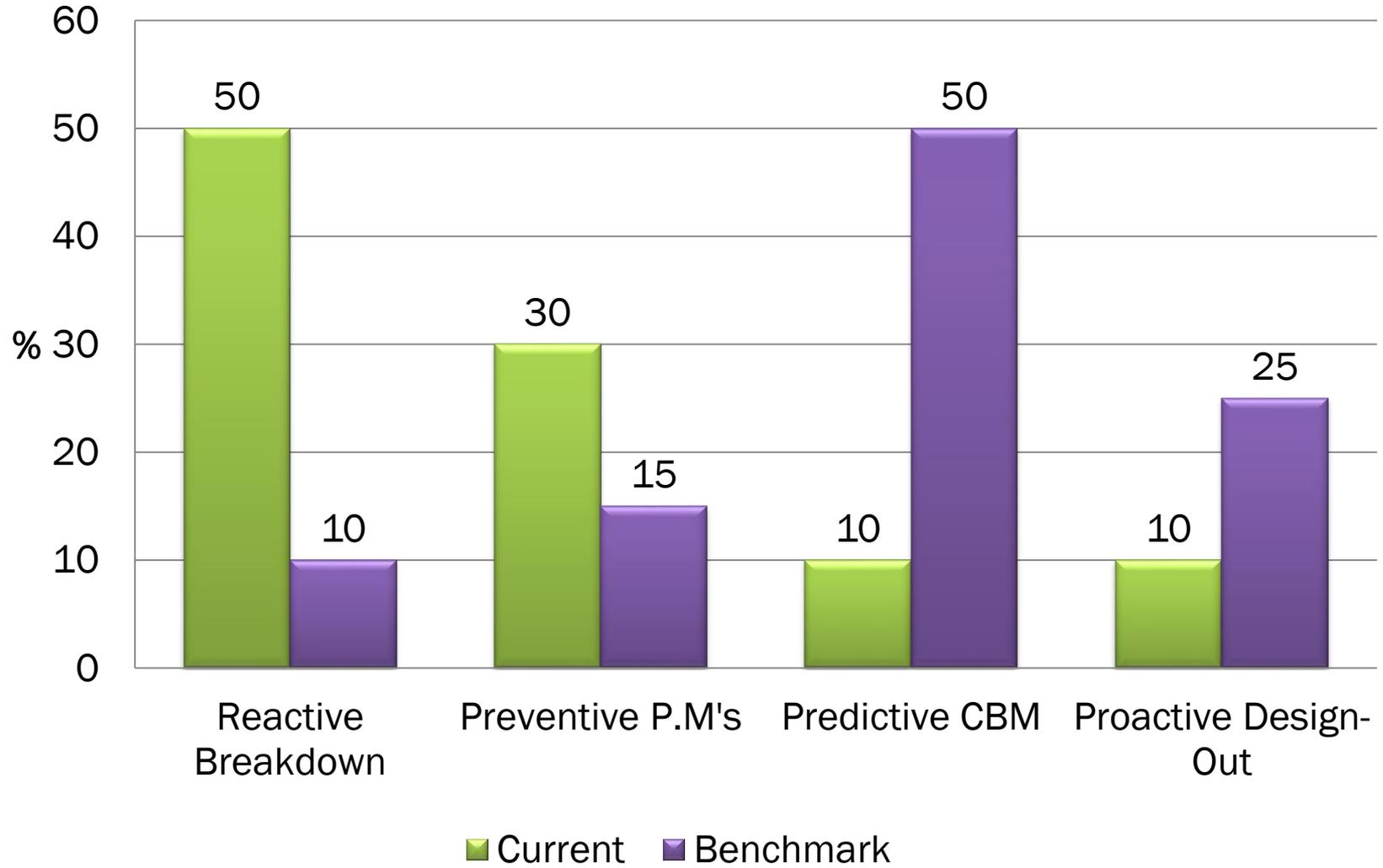
# Developing Best Practice



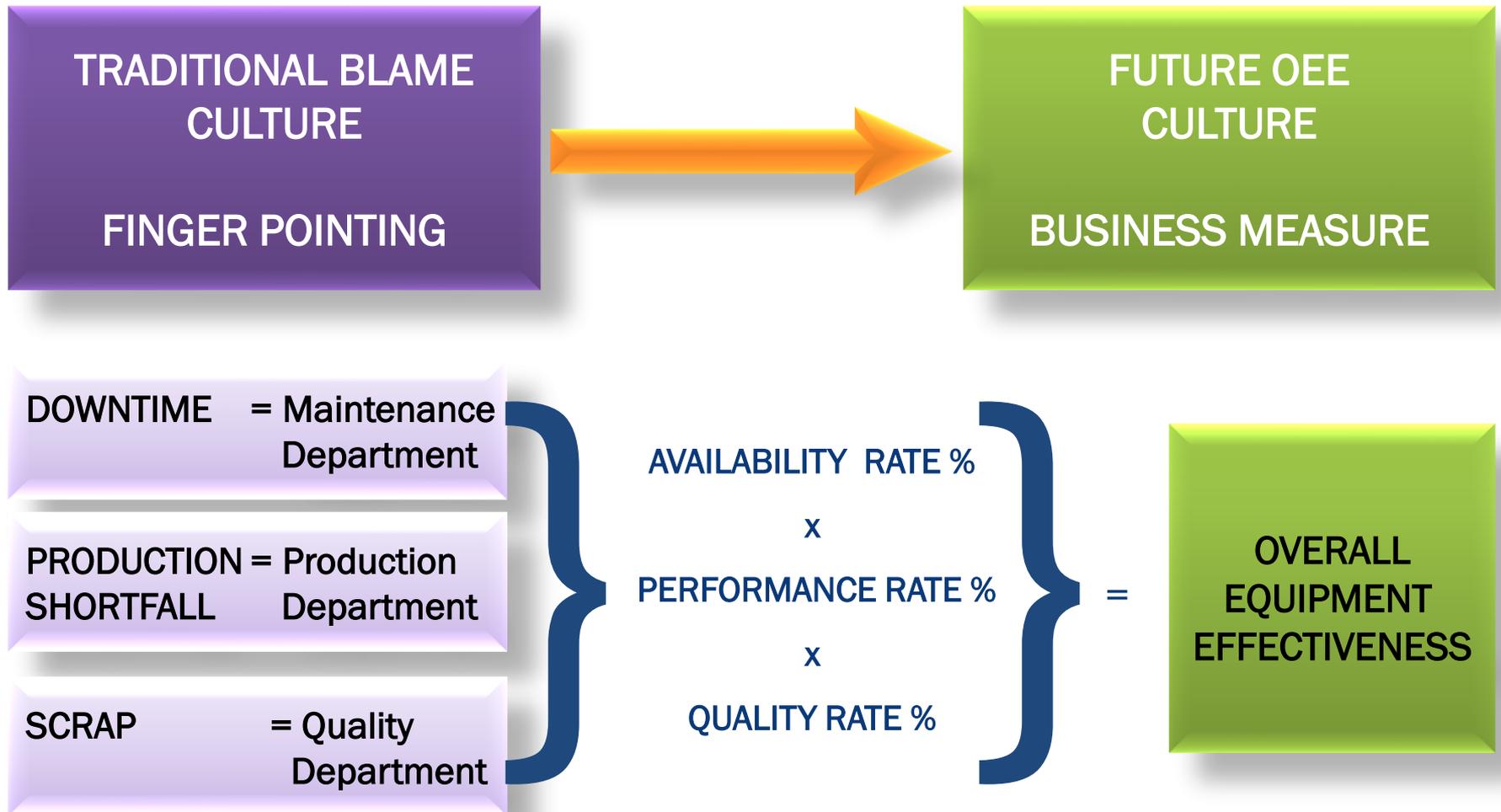
In any Company, 70% fire-fighting is caused by two main phenomena:

|   |                   |
|---|-------------------|
| <p>Lack of Effective Communication-(Cause)<br/>         Lack of Adherence to Standards-(Cause)<br/> <b>No Standards Exist (Solution)</b><br/> <b>No Time to Deliver 100yr fix(Solution)</b></p> | <p>} &gt; 95%</p> |
| <p>Leaving only Unknown, Novel Issues of.....<br/>         (This is the 1<sup>st</sup> time this has ever happened !!)</p>  | <p>} &lt; 5%</p>  |

# Current vs. (say, 3yr) Benchmark Maintenance Time Allocation



# So, Why the need to Change?



# Measuring Equipment Effectiveness Floor to Floor Losses

**Overall Equipment Effectiveness =** **Availability** x **Performance Rate** x **Quality Rate**



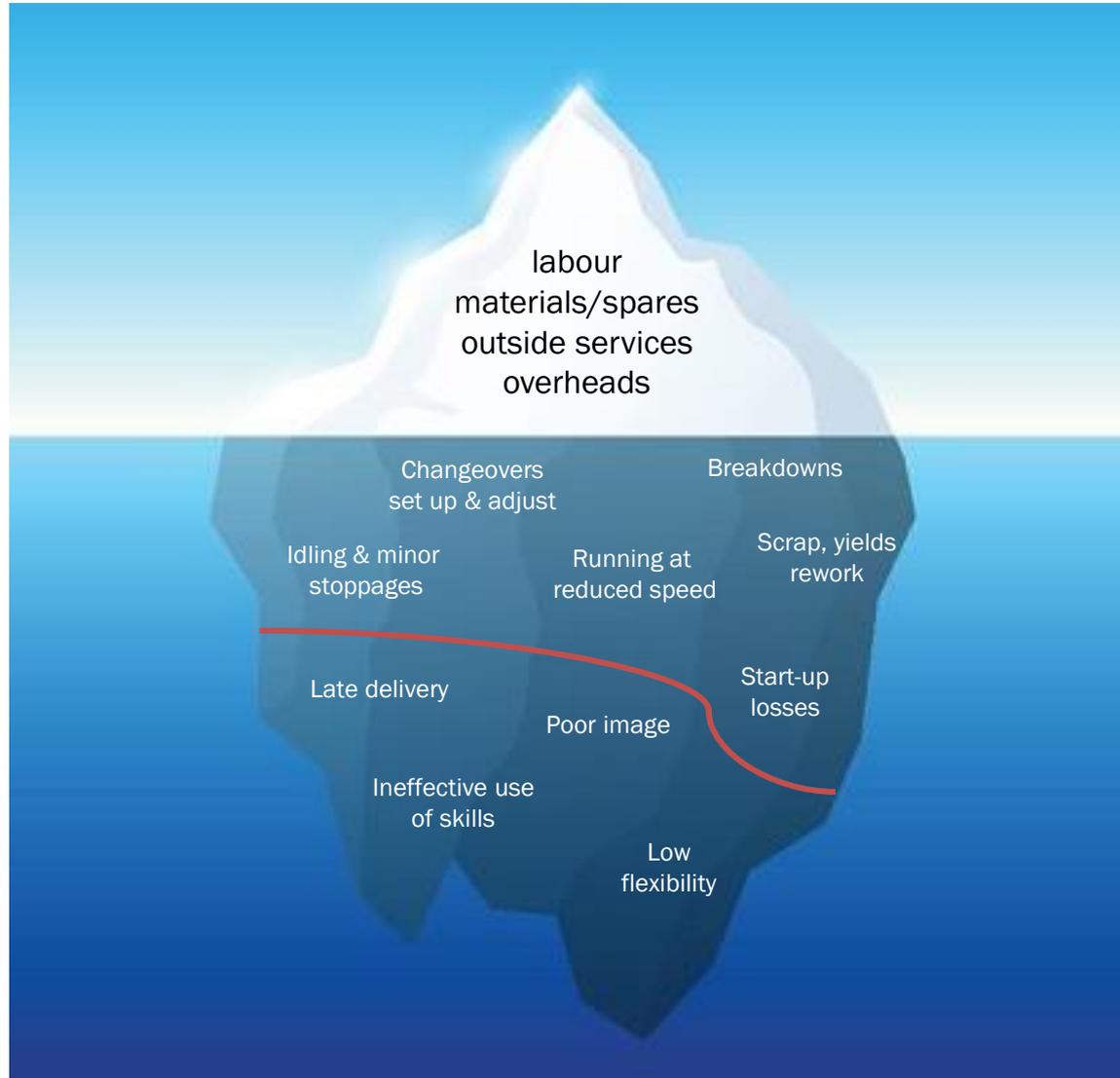
**The 6 x Classic Equipment Based Losses-(Floor to Floor)**

# The true cost of maintenance is 7/8 hidden...

Easy to measure



Difficult to measure



Low impact on profit



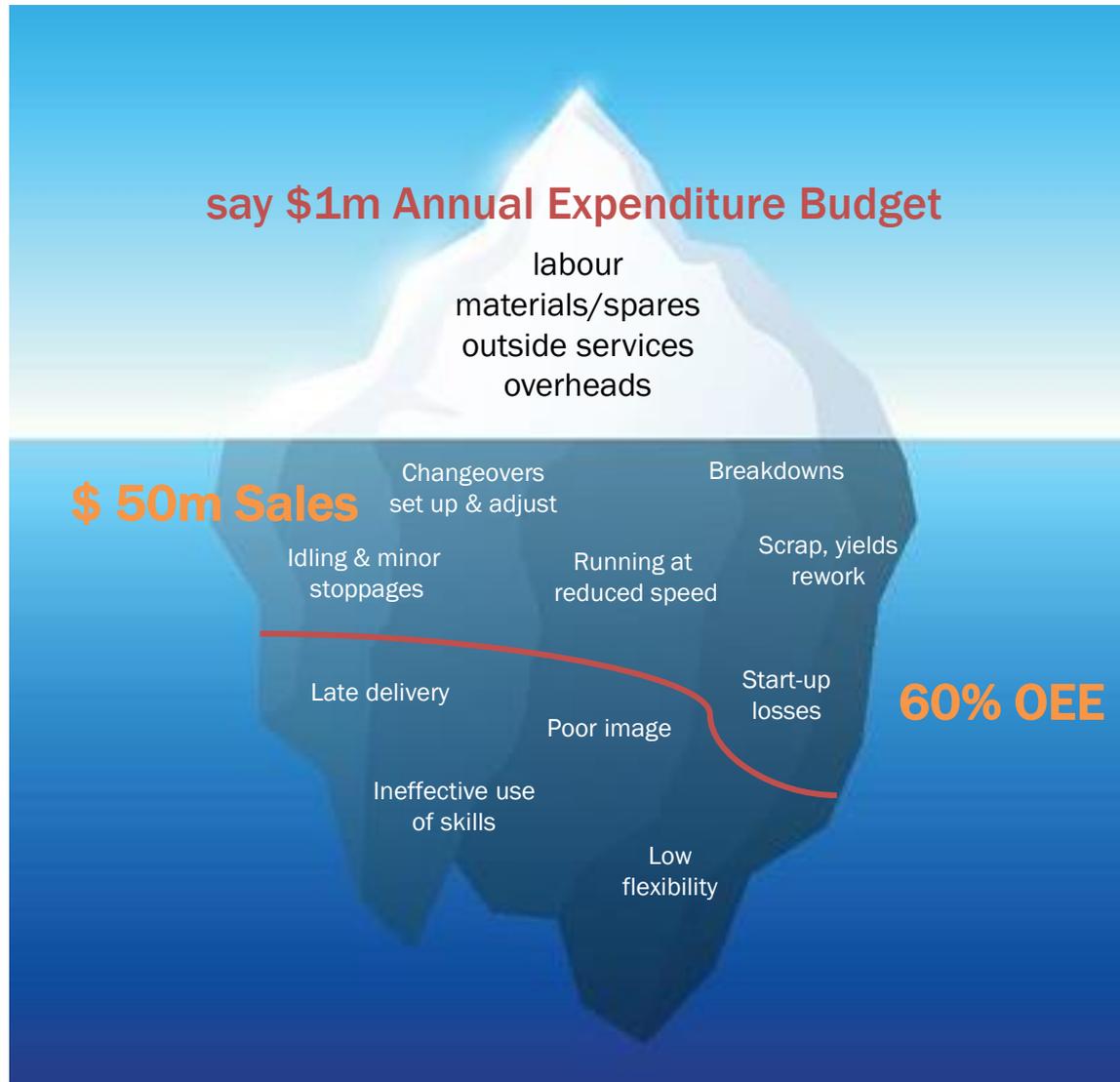
High impact on profit

# The true cost of maintenance is 7/8 hidden...

Easy to measure



Difficult to measure



Low impact on profit



High impact on profit

# You can be very efficient, but totally ineffective!



(12 points =  
20% real  
increase in  
productive  
capacity)

# You can be very efficient, but totally ineffective!



# Some final thoughts as ingredients for success-

## **Outsourcing Operations and /or Maintenance**

*When selecting your 'partnership' partners*

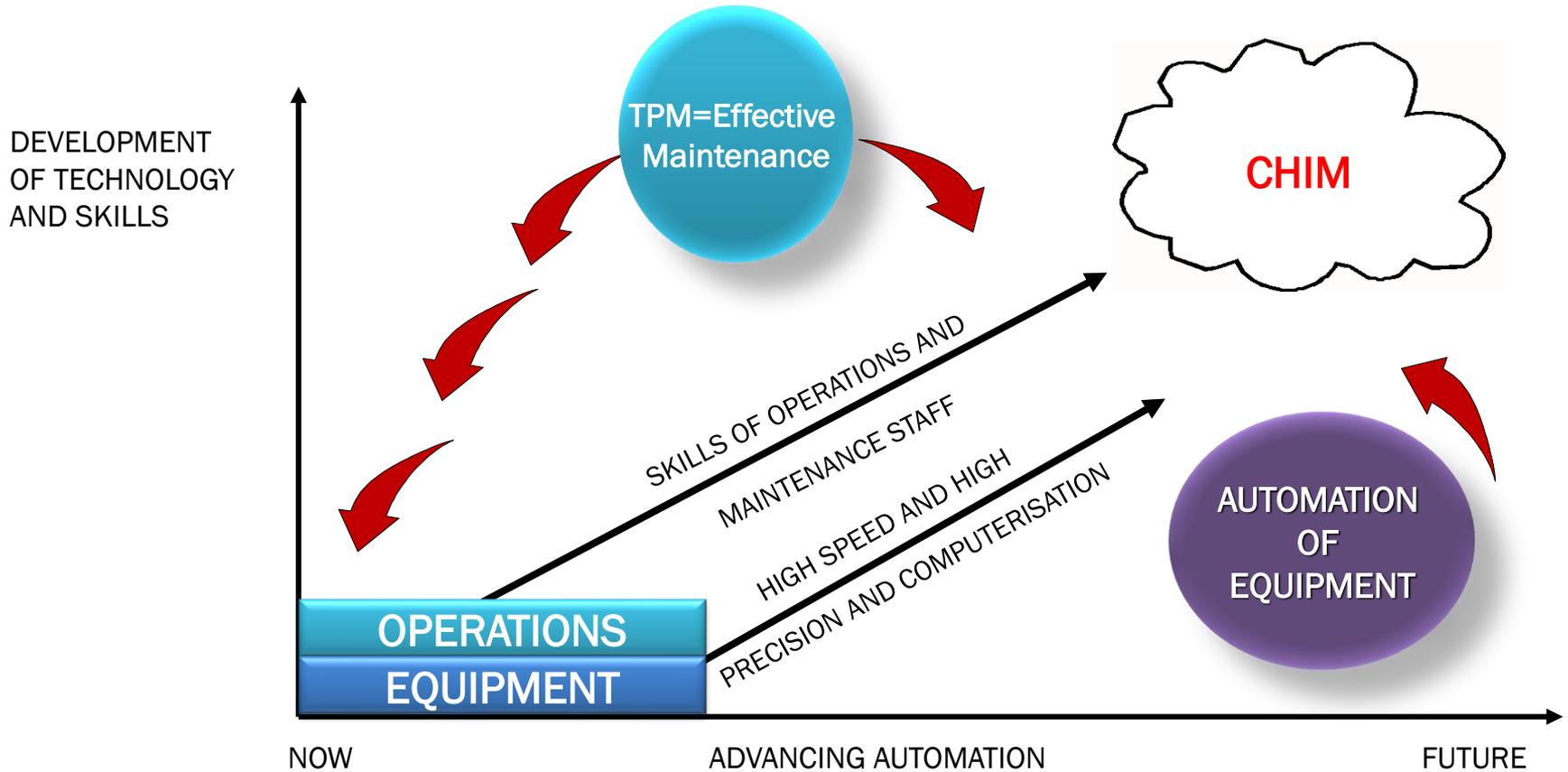
- Performance driven and not cost down only.
- Clarify and identify non-core v. core activities
- What are the risks and hence countermeasures
- Be prepared to change your ways of working
- Be thorough.
- Go see their track record
- Create a win/win situation.
- Be flexible & adaptable.
- Treat it seriously.

# Day 2- Session 4 –Understanding the Implications of Industry 4.0 within an O&M Environment

# Japan 1992-Light Bulb Moment !

| <b>Key Performance Indicator</b> | <b>Start Point Reference</b> | <b>6 Years Later</b> |
|----------------------------------|------------------------------|----------------------|
| Breakdowns per month             | 250                          | 5                    |
| Overall Equipment Effectiveness  | 65%                          | 88%                  |
| Productivity Index               | 100                          | 180                  |
| Return on Investment             | \$1.00                       | \$4.50               |

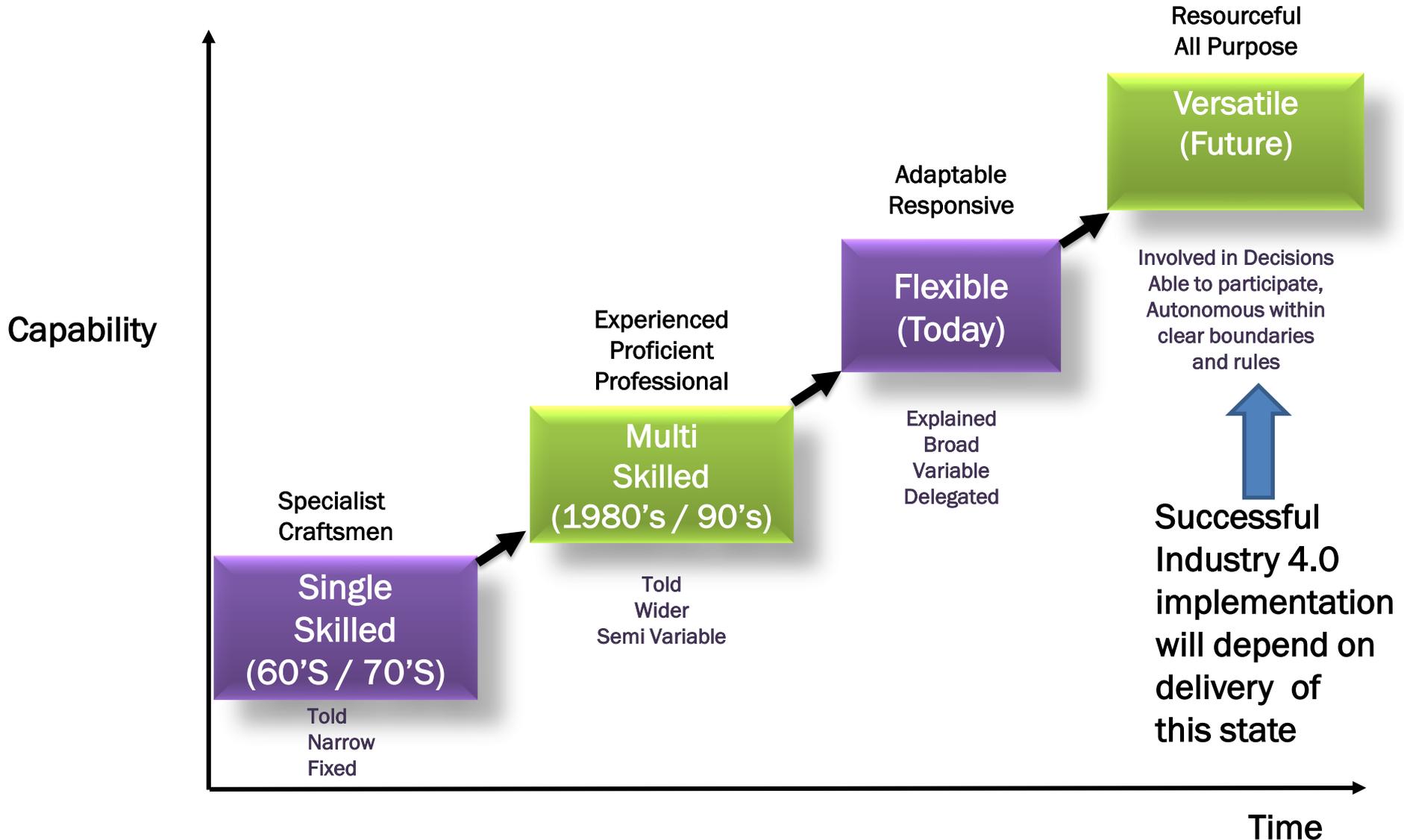
# The Future Vision & Impact of Industry 4.0 on Maintenance



**Computer/Human Integrated Manufacture**  
Is No **Dream** But Reality !

# The Learning Organisation & Industry 4.0

## The European history and experience



## **BCG Industry 4.0 Report- 5 x Lessons for Implementing Industry 4.0 (Nov 2017)**

- **Use Industry 4.0 to accelerate operational improvements.**
- **Integrate new and existing capabilities and technologies.**
- **Manage information architecture as a critical enabler.**
- **Thoughtfully design the transformation roadmap.**
- **Approach Industry 4.0 as a change management project.**

# Industry 4.0 Emerging Enabling Tools

## Nine Technologies Are Reshaping Production



Advanced robots



- Autonomous, cooperating industrial robots, with integrated sensors and standardized interfaces



Additive manufacturing



- 3D printers, used predominantly to make spare parts and prototypes
- Decentralized 3D printing facilities, which reduce transport distances and inventory



Augmented reality



- Digital enhancement, which facilitates maintenance, logistics, and SOPs
- Display devices, such as glasses



Simulation



- Network simulation and optimization, which use real-time data from intelligent systems



Horizontal and vertical system integration



- Data integration within and across companies using a standard data transfer protocol
- A fully integrated value chain (from supplier to customer) and organization structure (from management to shop floor)



The Industrial Internet of Things



- A network of machines and products
- Multidirectional communication among networked objects



Cloud computing



- The management of huge volumes of data in open systems
- Real-time communication for production systems



Cybersecurity



- The management of heightened security risks due to a high level of networking among intelligent machines, products, and systems



Big data and analytics



- The comprehensive evaluation of available data (from CRM, ERP, and SCM systems, for example, as well as from an MES and machines)
- Support for optimized real-time decision making

**Source:** BCG analysis.

**Note:** SOP = standard operating procedure. CRM = customer relationship management. ERP = enterprise resource planning. SCM = supply chain management. MES = manufacturing execution system.

# Lean Maturity v. Industry 4.0

## Maturity-BCG Research suggests..

| <b>Focus</b>                                  | <b>Reduced Conversion Costs</b> |
|---|---------------------------------|
| Independent Lean Initiative                   | Around -15%                     |
| Independent Industry 4.0 Application          | Around -15%                     |
| Integrated Lean & Industry 4.0 Transformation | Up to - 40%                     |

Major proviso to the above potential is the full engagement and empowerment of your front line staff, their managers and leadership team-in that order

## *Next level of Operational Excellence via Industry 4.0 opportunities*

- **Flexibility** - Sensors & software enable more efficient customer response times
- **Productivity** - Predictive algorithms improve Autonomous Front Line Maintenance checks
- **Speed** - Real time data accelerates Production Management
- **Quality** – Data driven QC supports self-inspection
- **Safety** - Sensors & training in virtual reality improve working conditions

# The Problem and hence Opportunity facing Businesses

## Survey of over 400 UK based businesses

- 68% are concerned the education system will not deliver skills required for technological change implied in Industry 4.0.
- Only 51% say they are taking steps to influence the content of degrees and the technical training engineers undertake

## McKinsey survey findings

- 7 out of 10 companies have yet to define their STEM skills gaps
- Only 1 in 10 are implementing a plan aimed at bridging the skills gap impact.

## 5 Key Questions to Ask.....

- Q1-Is your Company keeping pace with the emerging Technologies of Industry 4.0?
- Q2-What percentage of time spent by your current staff is fully productive and hence ‘value adding’?
- Q3-How good or effective are your Systems of Work and supporting processes to systematically improve on your answer to Q2?
- Q4-How well does your organisation encourage a positive attitude to learning in the workplace?
- Q4 -How well defined is the ideal engineering team skill profile, where are the gaps and how good is your company at developing the skills it needs?

# Question 1

Is your Company keeping pace with the emerging Technologies of Industry 4.0?

- The rapid pace of technological progress means traditional academic education cannot keep up with developments in eg memory capacity, sensors and artificial intelligence.
- In-house practical hands-on '*Learning by Doing*' projects is essential. Organizations that do this well focus on pockets of automation using multi-disciplined teams

# Question 1 Continued

Is your Company keeping pace with the emerging Technologies of Industry 4.0?

- The European experience shows that front-line operators with training and combined with routine cleaning and inspection checks pays big dividends acting as the early warning system for their maintenance colleagues to take preventive action and avoid catastrophic breakdowns.
- This approach is at the heart of the well proven TPM philosophy.

## Question 2

What percentage of time spent by your current staff is fully productive and hence ‘value adding’?

- Let’s take an example of the typical Maintainer’s use of time in response to a Breakdown
- With the interactive nature of real time data collection within Industry 4.0 digitalization, this allows our CMMS systems to report each of the 11 sequential steps below.

# How much of a Maintainer's time is actually 'value adding'?

- An Equipment Breakdown occurs. (The clock starts ticking....)
- Break down is Reported to Maintenance Planning
- Planning allocates a 'Maintainer' & informs that resource
- Maintainer goes to see equipment broken down at its source
- Isolate ,initial Inspection, appraisal, discussion, decision
- Leaves source equipment to get necessary tools, parts, kit
- **Return & carry out Repair (*this Value Adding part is typically only 15% of total elapsed time*)**
- Test / check/ start up & adjust
- Confirm to the user as satisfactory
- Formally hand back to 'asset owner'
- Sign off job as complete to Maintenance planning

**Classic Mean Time to Repair (MTR) needs to become MTT Respond & Repair (MTTRR)**

## Question 3

- How good or effective are your Systems of Work and supporting processes to systematically improve on your answer to Q2?

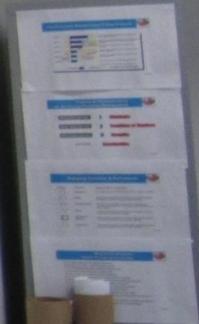
# What Can We ECRS?

**Produce a Current State Map of the 11 Steps  
And set a Challenge for the Future State, by asking  
what steps can we:-**

- *Eliminate ?*
- *Combine ?*
- *Replace ?*
- *Simplify ?*

***And then Implement and then...  
Standardise that Future State***

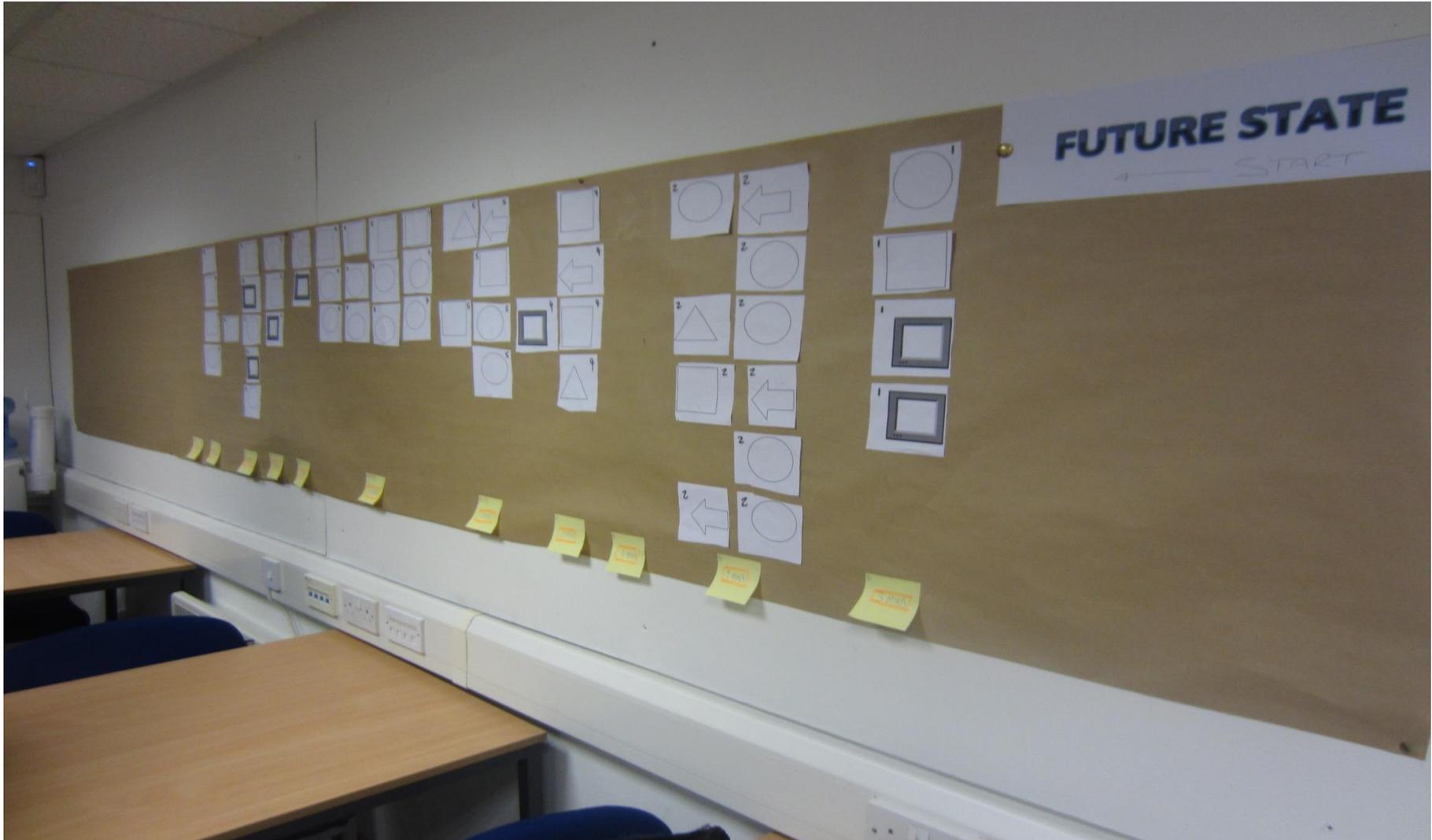
# Current State (Top)-Future State (Bottom)



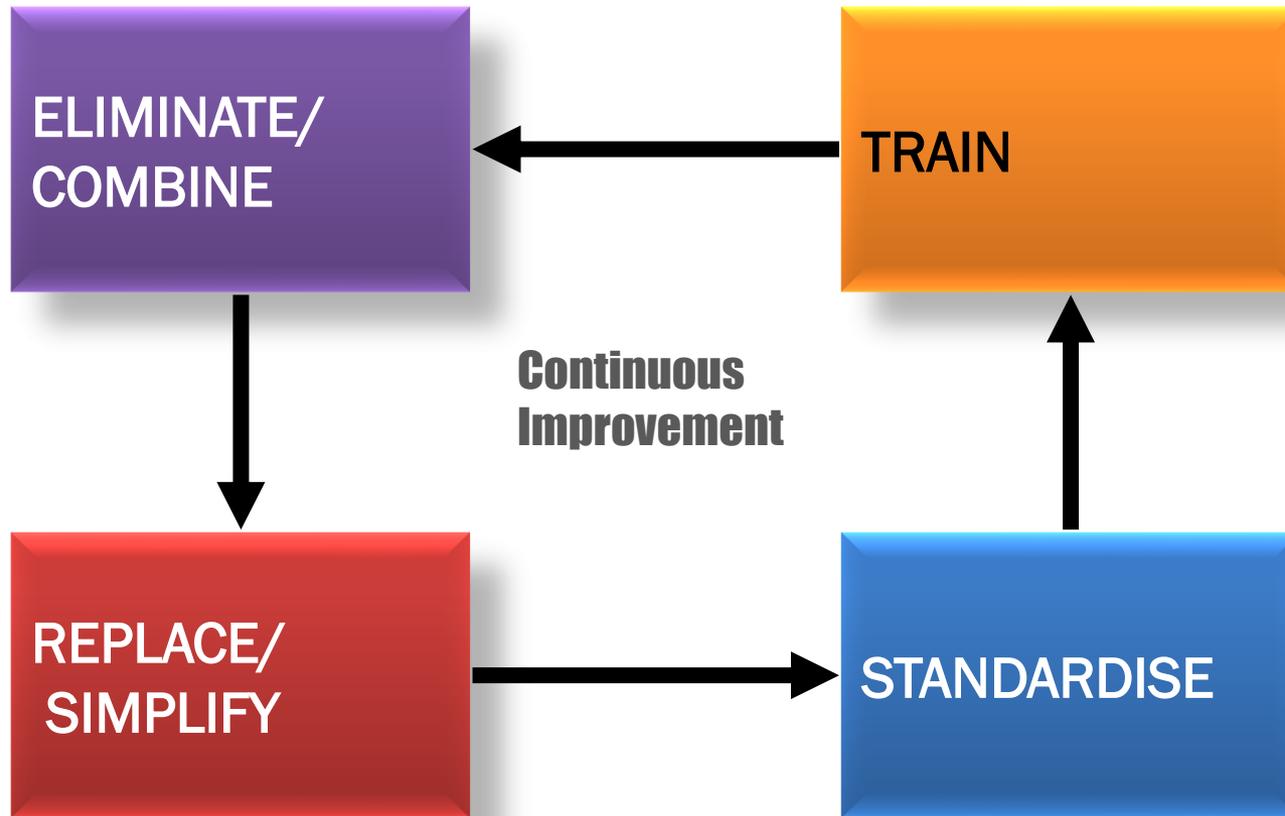
# Current State Maintenance Response time of 145 mins



# Future State Maintenance Response time of 72 mins (50% Reduction via 34 opportunities)



# Continuously Review and Improve Through.....



## Question 4

How well does your organisation encourage a positive attitude to learning in the workplace?

- Skilled personnel are not usually tempted to change jobs for just personal development opportunities and / or financial reasons alone. They tend to be motivated by in-house opportunities for self-development and job satisfaction. European Surveys show that training and development are key job satisfaction factors for nearly 70% of STEM workers. Food for thought if you want to keep the engineers you have!

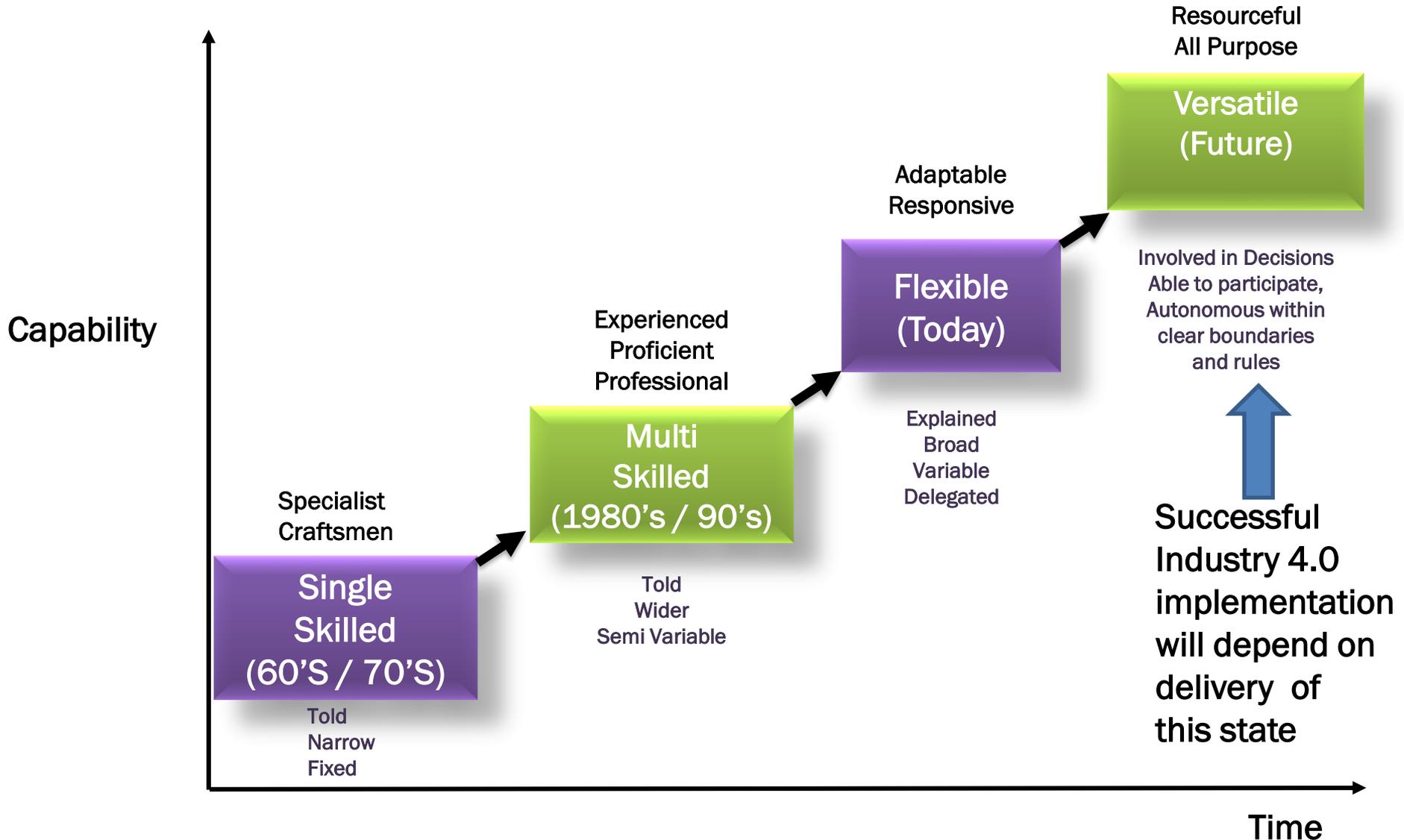
## Question 5

**How well defined is the ideal engineering team skill profile, where are the gaps and how good is your company at developing the skills it needs?**

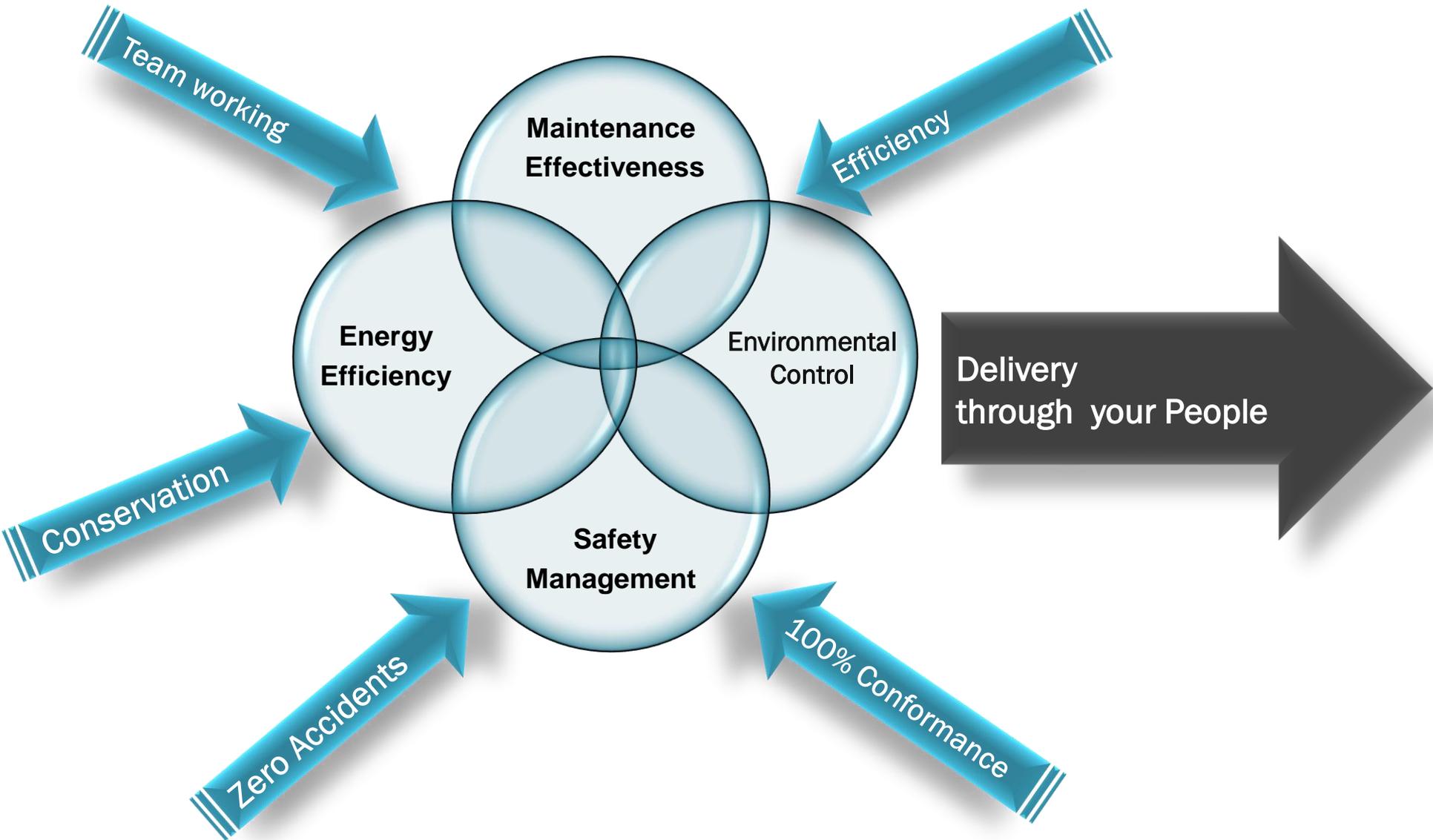
- This includes transferring lessons learned and helping engineers to acquire new capabilities. Organisations that do this well can reduce the time to achieve local site specific competency levels by as much as 75%.
- The European experience of Skills Capability Development over the last 40 years have been driven by enlightened attitudes from both Trade Unions and Management **working in partnership**

# The Learning Organisation & Industry 4.0

## The European history and experience



# Making Your Plant a 'World Class' Facility, Where the Future Drivers for Industry 4.0 are:

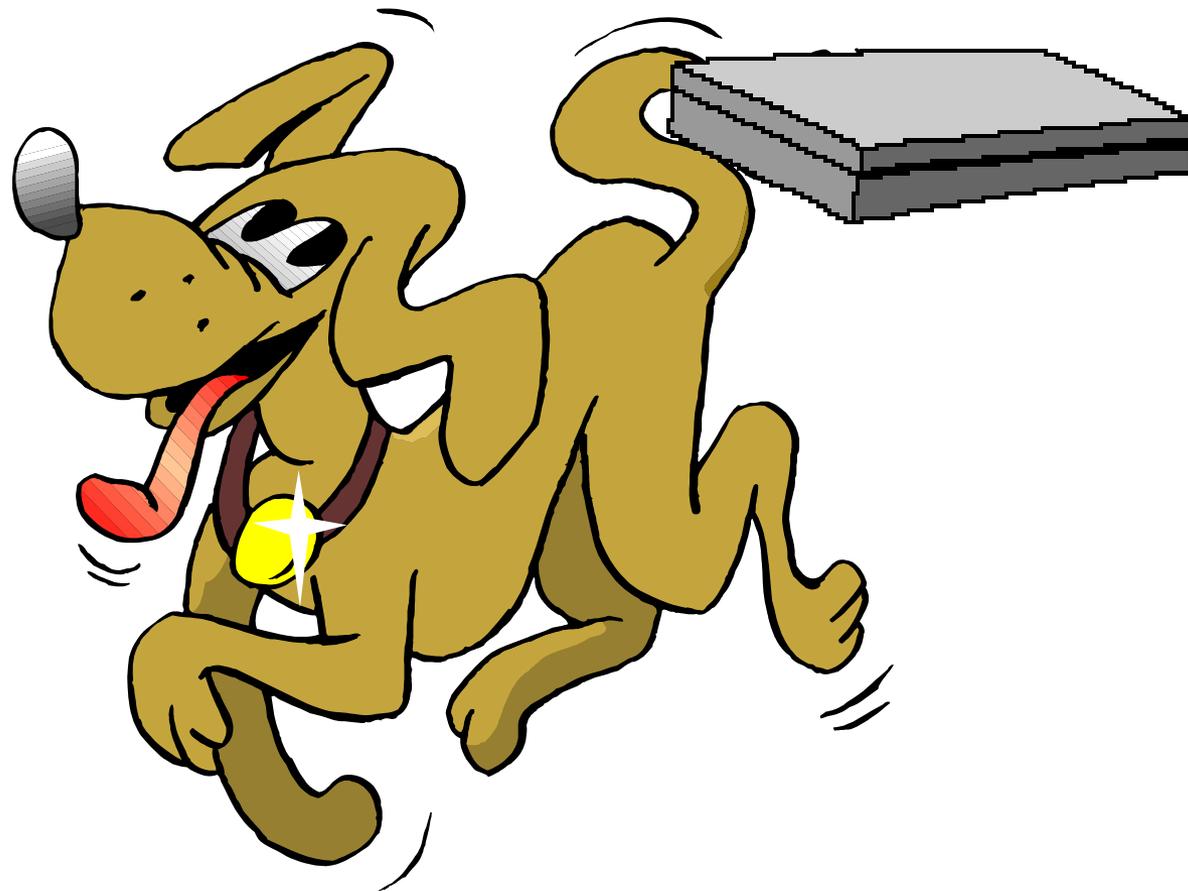


## A Key Message to Remember.....



**“ ..... The Quality of Our Maintenance will assure the Maintenance of the Quality of your Product and Processes”**

# Finally-a health warning..... Do not let the Technological Tail of Industry 4.0 Wag the Dog!



# Session 5 -Digging Deeper with the 3 P's

- Case Study to illustrate application of TPM System of Work within a Waste Water Treatment Facility

# Welsh Water Case Study

Described in Chapter 10 of recently published book obtainable on Amazon.....

## ***TPM – a foundation of operational excellence***

Co authored by Peter Willmott, John Quirke and Andy Brunskill.

Published by SA Partners, 2019. ISBN 978-1-9993748-1-5.

Obtainable on Amazon @ £39.99 with a £2 donation shared between Friends of Chernobyl's Children and The Prince's Trust for each copy sold.



## Waste water utility TPM application program-primary objectives

- To reduce operating expenditure by the elimination of waste in all its forms through the proactive engagement of its people using the TPM enabling tool adapted to a Utility operating environment which they rebadged as Asset Optimisation (AO).
- Ensure the gains are sustainable through a progressive CI partnership culture which is evidence based.
- To capture and share the lessons learnt for future capital expenditure projects

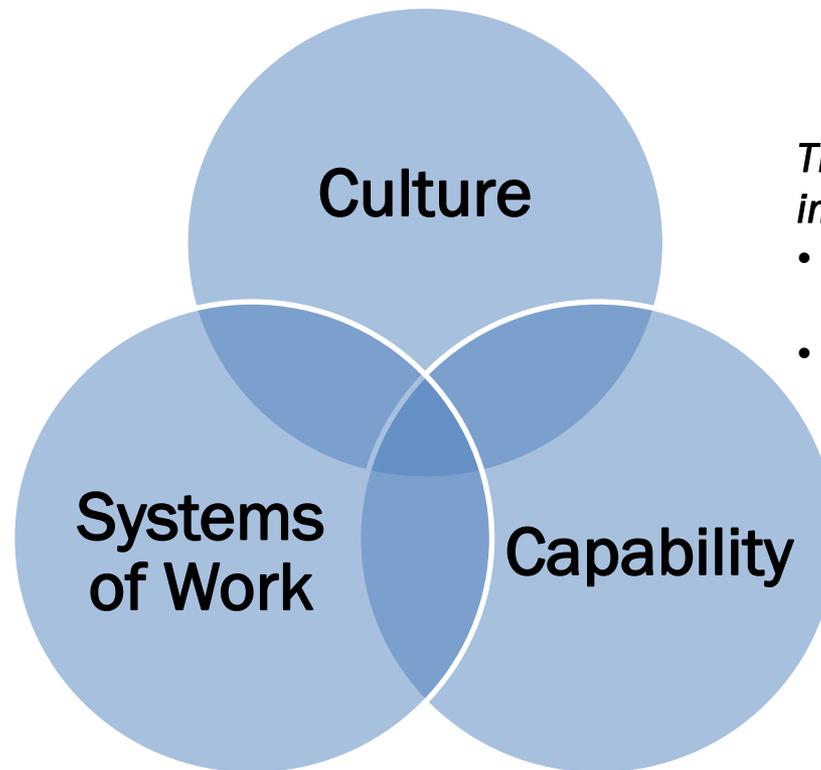
- To share this experience of working with a major UK Water Utility using TPM principles applied to two of their largest Sewage Treatment Plants.
- **Plant One** was identified as the first site for deployment because it was the most expensive site for reactive costs in the whole Authority. Plant One has approximately 200,000 customers, has a treatment flow of just over 2,000 litres per second and a storm flow of 4,300 litres per second.

- **Plant Two** was identified as the second site for deployment because of its large size and is the only gas-to-grid plant within the Authority. The waste water treatment plant receives and treats sewerage from a population of 120,000 people, with a permitted incoming flow of 800 litres per second. The flow is split into two directions
- 60% to an aeration process treatment
- 40% to a basic filtration treatment process, comprises of twelve filter

- As well as its own indigenous sludge to treat, the Plant 2 also receives eighty tankers per week from outlying areas. Sludge sewage which has already undergone primary treatment, is pumped from the tankers, directly into the digestion plant, if greater than 2.5 % dry solids. Thinner domestic sewage is discharged into the inlet works. In 2012, an anaerobic digestion system was installed to increase resilience for the sludge treatment.

# Our Lean Deployment Model

*Creating the environment to succeed:  
Lean Principles.  
Lean Leadership.  
Behaviours Embedded.*



*Systems of work to make the capability*

- **Operational Review:**  
*Deliver our day to day business goals.*
- **Productivity Roadmaps**  
*Define long term improvement goals.*

*The Tools and people to deliver improvement:*

- **Our Lean toolkit.**
  - *Core tools and approaches.*
- **Competent Workforce:**
  - **Lean Experts (1%)**  
*Can train.*
  - **Lean Champions (5%).**  
*Can facilitate.*
  - **Lean Practitioners (50%)**  
*Actively using.*

# Our Five Lean Principles and Highlighting why TPM

## Understand Customer Value

- What it is our internal and external customers value about what we do.

## Engage Colleagues

- Colleagues are the experts in the processes they use, they need to be involved in designing the solutions.

## Understand End to End Process

- The set of activities along the end to end process that delivers value to your customer while also meeting business needs.

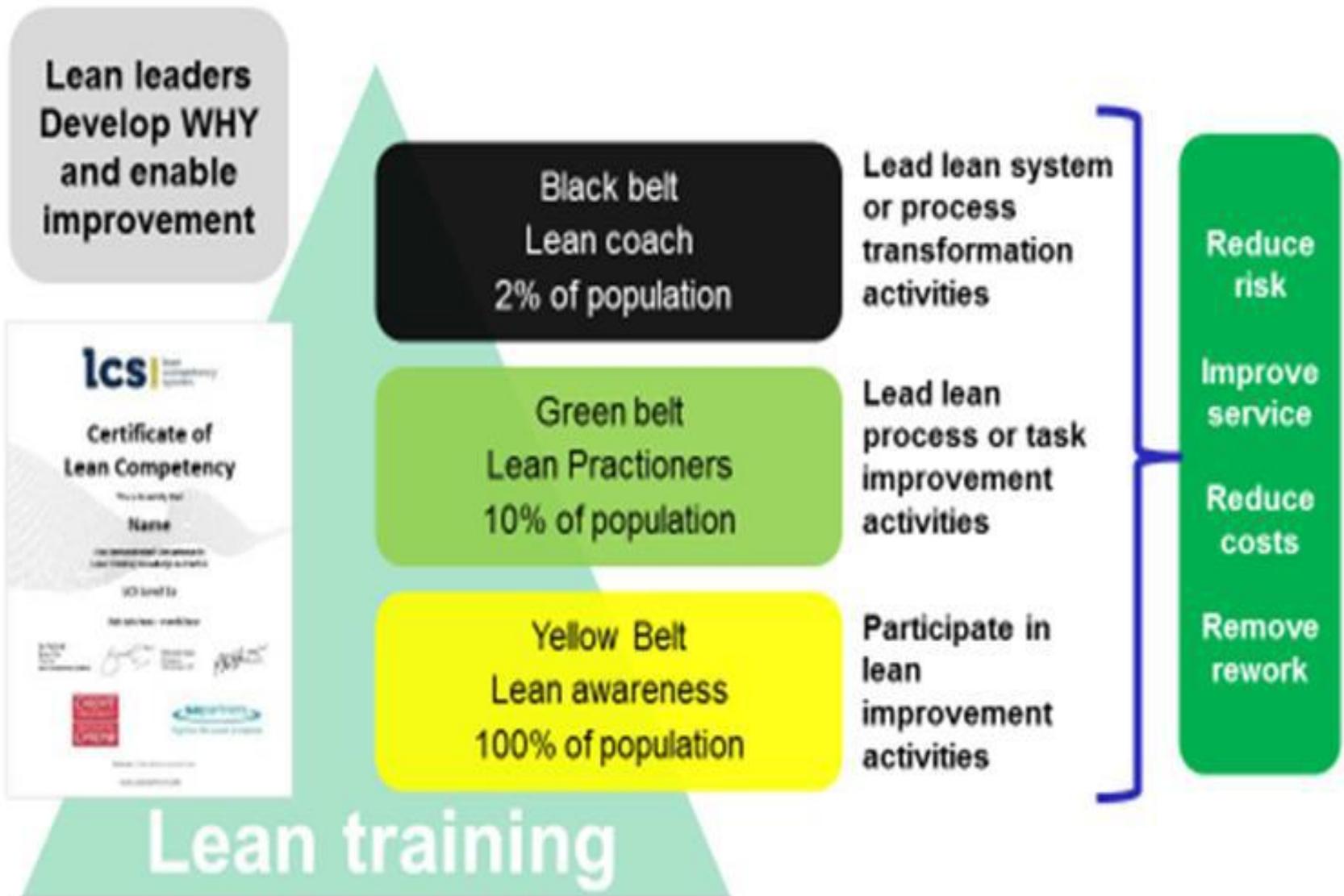
## Create Flow and Pull

- Removing the things that get in the way of us delivering what our customers value when they need it.

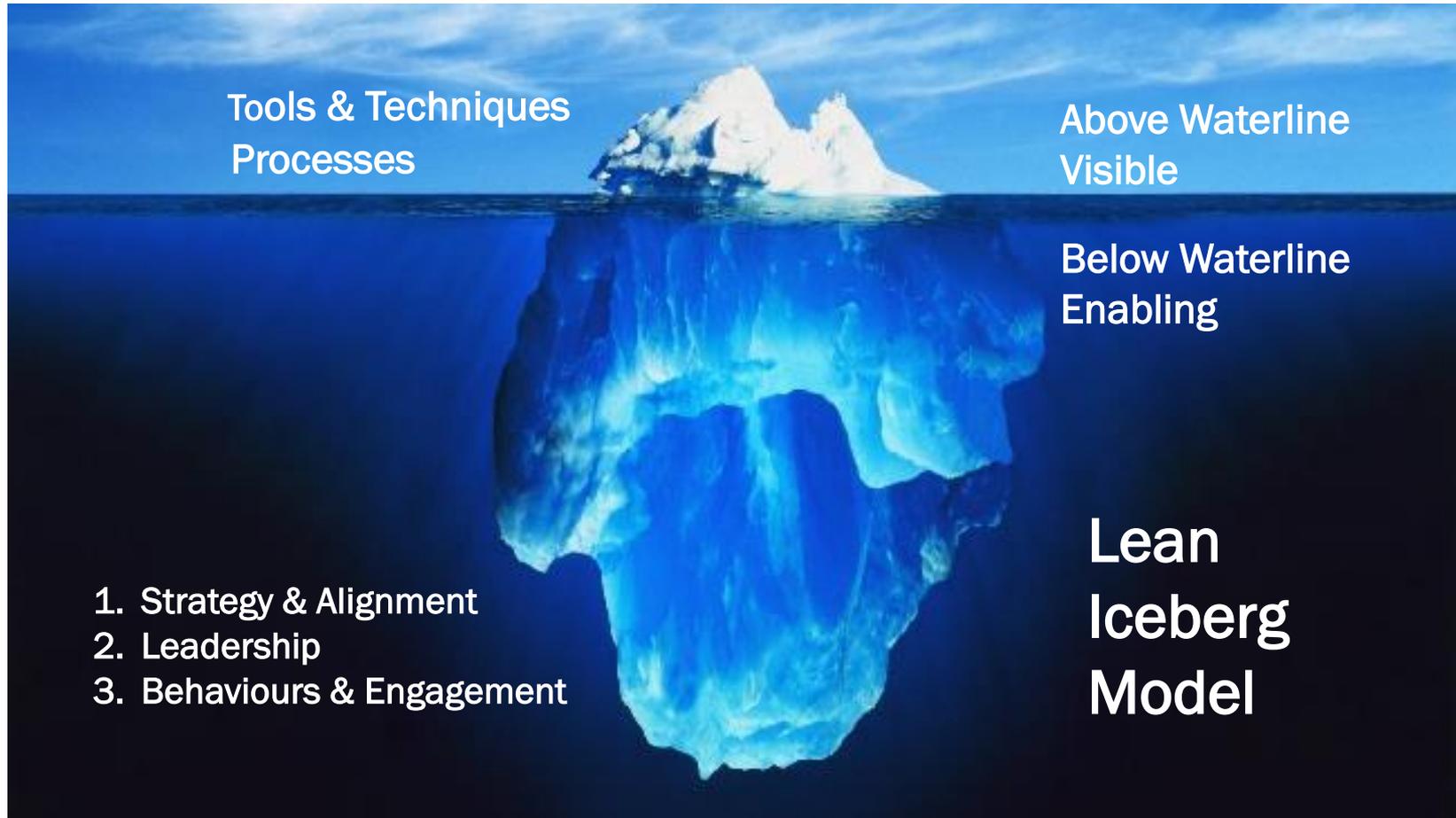
## Excellence in Everything We Do

- Constantly trying to be better at what we do.

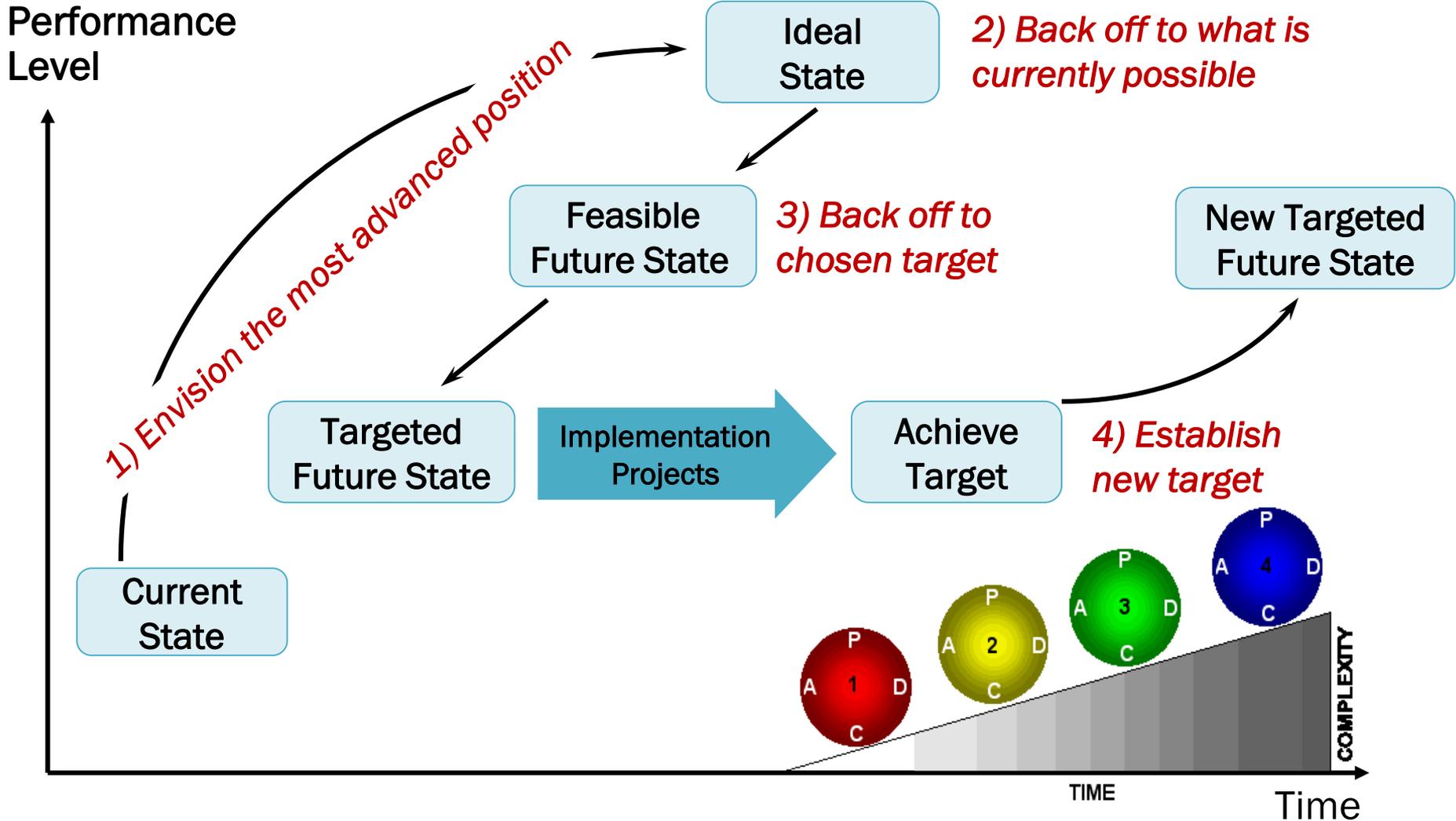
# Our Knowledge-based Learning Organisation for Skill Development & Recognition



# Our Lean Iceberg Model



# Our Value Stream Mapping Process & Purpose



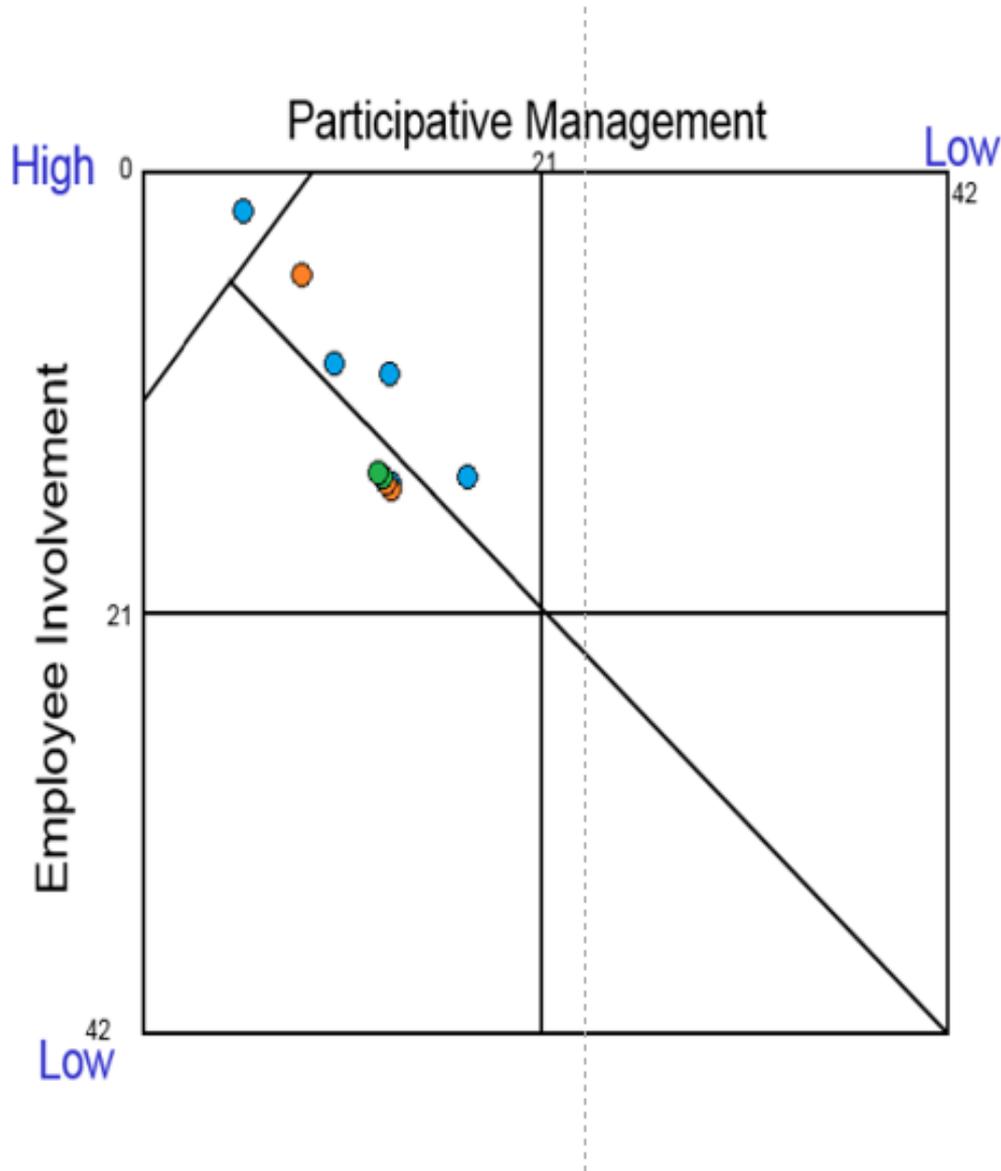
# Understanding our high level process map using VSM Before we start 8 Step TPM Deep Drilling



# Our TPM Asset Optimisation Charter

|   |
|---|
| <b>Project Scope Out</b>  |
| <b>Owner: Site supervisor</b>   |
| What is the title of your project?  |
| Gravity Belt Thickner Optimisation  |
| What is in scope and what is outside of scope?  |
| In the scope are the 3 GBTs, poly usage and primary tank de-sludge optimisation. Outside the scope will be everything downstream, (digesters feed etc)  |
| How will you measure success (Cost, Risk, Speed, Skills, Ways of Working etc)?  |
| Reduction in Poly and breakdown costs, less manual interventions, reduction in cost/ton of sludge, better flow and consistency of thickening/dewatering improved, reduction in Belt   |
| Who will be the project sponsor?  |
| Catchment(Area manager)   |
| Who will need to be involved in the project (Responsible, Accountable, Consulted, Informed)?  |
| Operators,Maintenance,Site supervisor,instrumentation,technical services, OEM vendors,Poly supplier technical expert ,Director of waste services, Lean specialist, Consultant   |
| What activity, risk, issue or opportunity is it trying to resolve or improve (Object & Defect)?   |
| To produce a more consistent flow from the SDMs and across the belts with improved dewatering. Increasing the final product (%ds) to an optimum rate of 6-7.5%. Reduce the operating costs of the equipment and optimise poly usage. Improve automation and increase H&S by reducing manual interventions. Improve OEE. |
| Describe the current state situation - what are the customers seeing?   |
| Inconsistent sludge to belt, with potential to back up in PSTs where thick sludge will cause scraper failure and potential tankering costs.   |
| No structure of pre-planned maintenance on common faults regarding blockages instead it's on a as and when basis  |
| Thick sludge feed onto the belt results in the belt running out of design spec and hinders the transfer pump getting the sludge away.   |
| Uncontrolled poly usage often results in belt blinding hindering dewatering and increasing cost per ton.  |
| Intermittent failure due to rag/fat build up in transfer pumps and rising mains causing discharge failures  |
| Wash water pumps blocking due to FE quality   |
| Transfer pumps not being controlled by VSD  |
| Frequently wouldn't run overnight without intervention (potentially taking advantage of cheaper overnight tariffs).   |
| Poly mixing poor on shear valves  |
| Not confident to operate 2 belts on Primary manually, (never been done before)  |
| <b>Timeline</b>   |
| March - October 2016  |
| <b>Coach</b>  |
| Lean specialist,Consultant  |
| <b>Communication to stakeholders?</b>   |
| Regular updates to Catchment Manager and Head of Waste. Regular contribution to 5 box updates to support steering group meetings  |
| Regular feedback to wider site team via team meetings   |

# What it's like to Work here-28 perceptions



| EMPLOYEE | E  | P  | POSITION |
|----------|----|----|----------|
| 1        | 14 | 18 | Op       |
| 2        | 2  | 5  | Op       |
| 3        | 8  | 10 | Op       |
| 4        | 15 | 13 | Op       |
| 5        | 9  | 13 | Op       |
| 6        | 16 | 13 | MEI      |
| 7        | 5  | 8  | MEI      |
| 8        | 15 | 12 | MEI      |
| 9        | 15 | 12 | KC       |
| 10       | 13 | 11 | KC       |

# Things that Hinder our Progress

|  | Maintainers | Operators | Key Contacts | TOTAL |
|--|-------------|-----------|--------------|-------|
| 1 We have an I operate you fix mentality                             | 33%         | 27%       | 67%          | 42%   |
| 8 Production & Maintenance pull in opposite directions               | 11%         | 0%        | 50%          | 20%   |
| 41 We don't work as a team to improve the quality of our maintenance | 0%          | 7%        | 50%          | 19%   |
| 7 People are reluctant to say what they think                        | 33%         | 47%       | 0%           | 27%   |
| 4 Groups do not get together to work on common problems              | 33%         | 0%        | 50%          | 28%   |
| 10 Skills are picked rather than learnt systematically               | 33%         | 47%       | 67%          | 49%   |
| 39 Our spares stock holding is not as good as it should be           | 89%         | 93%       | 100%         | 94%   |
| 31 We suffer from too many initiatives                               | 56%         | 40%       | 33%          | 43%   |

# Things that Help our Progress

|  | Maintainers | Operators | Key Contacts | TOTAL |
|--|-------------|-----------|--------------|-------|
| 40 We should introduce a CI/TPM Approach                   | 89%         | 87%       | 100%         | 92%   |
| 48 Standard methods are seen as important                  | 78%         | 93%       | 100%         | 91%   |
| 45 The company does take safety seriously                  | 100%        | 87%       | 100%         | 96%   |
| 15 The company operates on new ideas                       | 78%         | 40%       | 33%          | 50%   |
| 43 Unit cost information is made available to me           | 100%        | 87%       | 83%          | 90%   |
| 2 Lines of responsibility & accountability are clear to me | 89%         | 100%      | 100%         | 96%   |
| 9 I am asked my opinion by my boss about the job I do      | 89%         | 80%       | 83%          | 84%   |
| 42 Most of my work is planned                              | 56%         | 87%       | 83%          | 75%   |

Sharing of lessons learnt between Ops on different areas here is minimal

We tend to have Generic Maintenance procedures so don't really challenge the standards put in place

Some people can be quite reluctant about speaking up as you feel you could be marked

Some skills are learned systematically and some are picked up

Few people would welcome further/ more challenge in their job

We do have quite a few initiatives which seem to be flavour of the month but nothing gets the time it needs to be embedded

The biggest issue we have with Spares is the lead-time!!

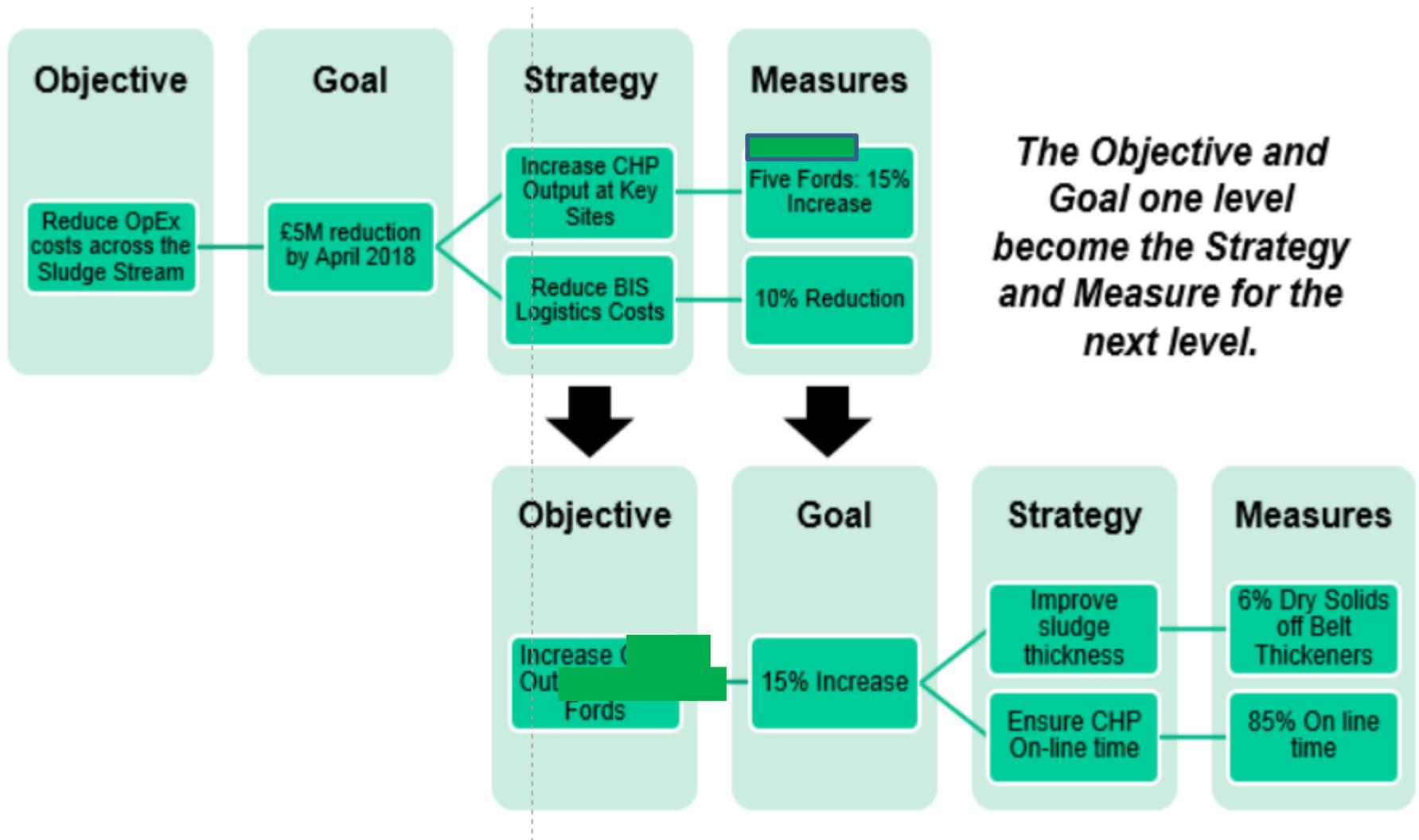
Commitments on our other sites mean we can't always meet and work together to overcome common problems we have arise

Some of us share information on how well or poor our assets are running, but it tends to be in passing and not via any formal process

The company has some new ideas but a lot of the things we do are the same as we always have

I wouldn't say Standard methods aren't important, but sometimes there are better ways of doing things

# The Headline Business Objective



## The detailed 8 Step TPM Process

- Case Study of applying the 8 Equipment Steps to a critical Micro Value Stream
- The high level VS Mapping exercise showed that whilst the Belt Thickener was a critical pinch point in the process flow ,we also needed to embrace the up stream Sludge Feed Pump and the down stream Discharge Pump.

# Our Pilot Project to prove the 8 x Step Process

**Sludge Feed Pump**

**Belt Thickener**

**Discharge Pump**



# 4 Day TPM /Asset Optimisation Practitioners Workshop

| DAY 1  | DAY 2   | DAY 3  | DAY 4   |
|--|---|--|---|
| <ul style="list-style-type: none"> <li>• <b>Introduction to Asset Opt</b><br/>Icebreaker-World class sportsperson<br/>Exercise- Maintenance Assessment</li> <li>• <b>Asset Op PRINCIPLES</b></li> <li>• OEE is simple Flip chart exercise</li> <li>• Exercises - OEE</li> <li>• <b>Asset Op TECHNIQUES AND 11 STEP IMPROVEMENT PLAN</b></li> </ul> | <ul style="list-style-type: none"> <li>• <b>CONDITION CYCLE</b><br/>Exercise - Criticality Assessment (On-the-Job)<br/>4)Criticality Assessment<br/>5a)Condition Appraisal<br/>5b)Refurbishment Plan</li> </ul> | <ul style="list-style-type: none"> <li>• <b>Review of Progress since last session-Team review of activity boards</b></li> <li>• 6) Future Asset Care</li> <li>• <b>PROBLEM PREVENTION CYCLE</b><br/>(On-the-Job)<br/>7)Problem Solving<br/>8)Best Practice Routines</li> </ul> | <ul style="list-style-type: none"> <li>• <b>PREPARE PRESENTATION</b></li> <li>• Dry Run Presentations</li> <li>• <b>SYNDICATE PRESENTATIONS</b></li> <li>• <b>REVIEW AND KEY LEARNING POINTS</b></li> </ul> <p>Next steps<br/><b>PILOTS &amp; 4 STAGE ROLLOUT</b></p> |
| <ul style="list-style-type: none"> <li>• Visit to Pilot and Plan the Plan Equipment Description</li> <li>• <b>MEASUREMENT CYCLE</b><br/>(On-the-Job)<br/>1)History/Records<br/>2)OEE Measures<br/>3)6 Loss Assessment</li> </ul>   | <ul style="list-style-type: none"> <li>• <b>Building Asset Opt Activity Boards</b></li> <li>• Consolidating Measurement and Condition Cycles</li> </ul>   | <p><b>PROBLEM PREVENTION CYCLE CONT..</b></p>  | <p><b>Getting Started SUPPORTING THE PILOTS</b></p> <p>Course Assessment</p>  |

# GBT Gravity Belt Thickener 3-Before



# Look Go and See-Walk the process



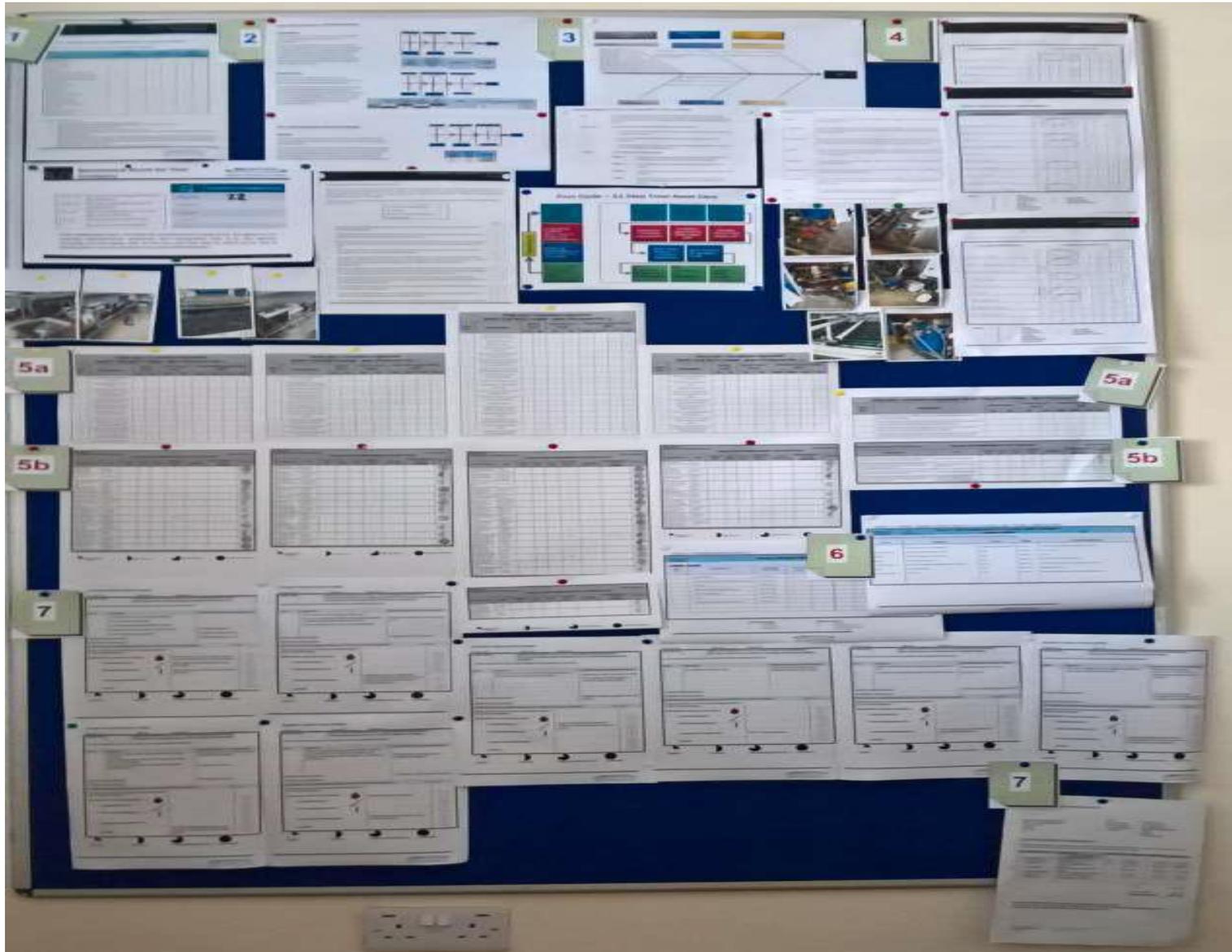
# Polymer feed area



# Building our TPM Activity Board-Day 2 (of 4)



# Our TPM Activity Board-as the key to understanding-Day 4

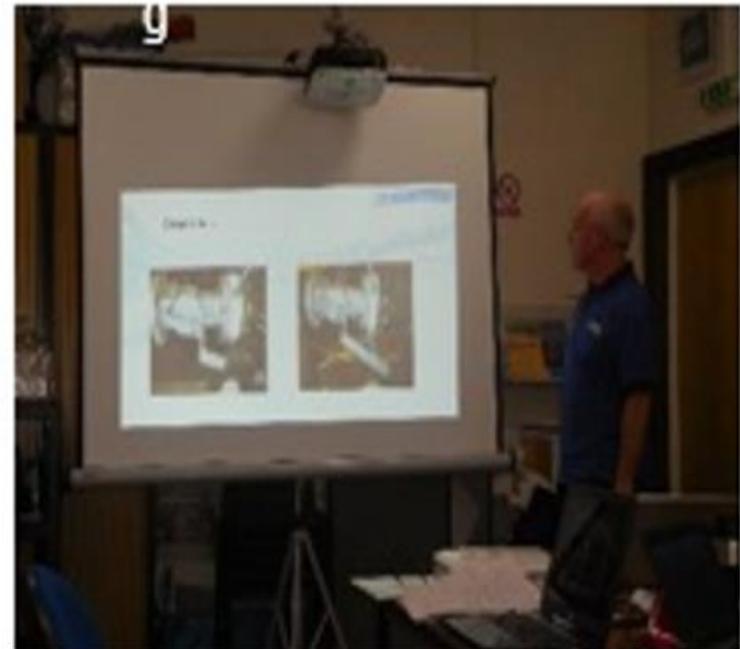


# Understanding how things are meant to work



Understanding flocculent characteristics with different levels of Poly

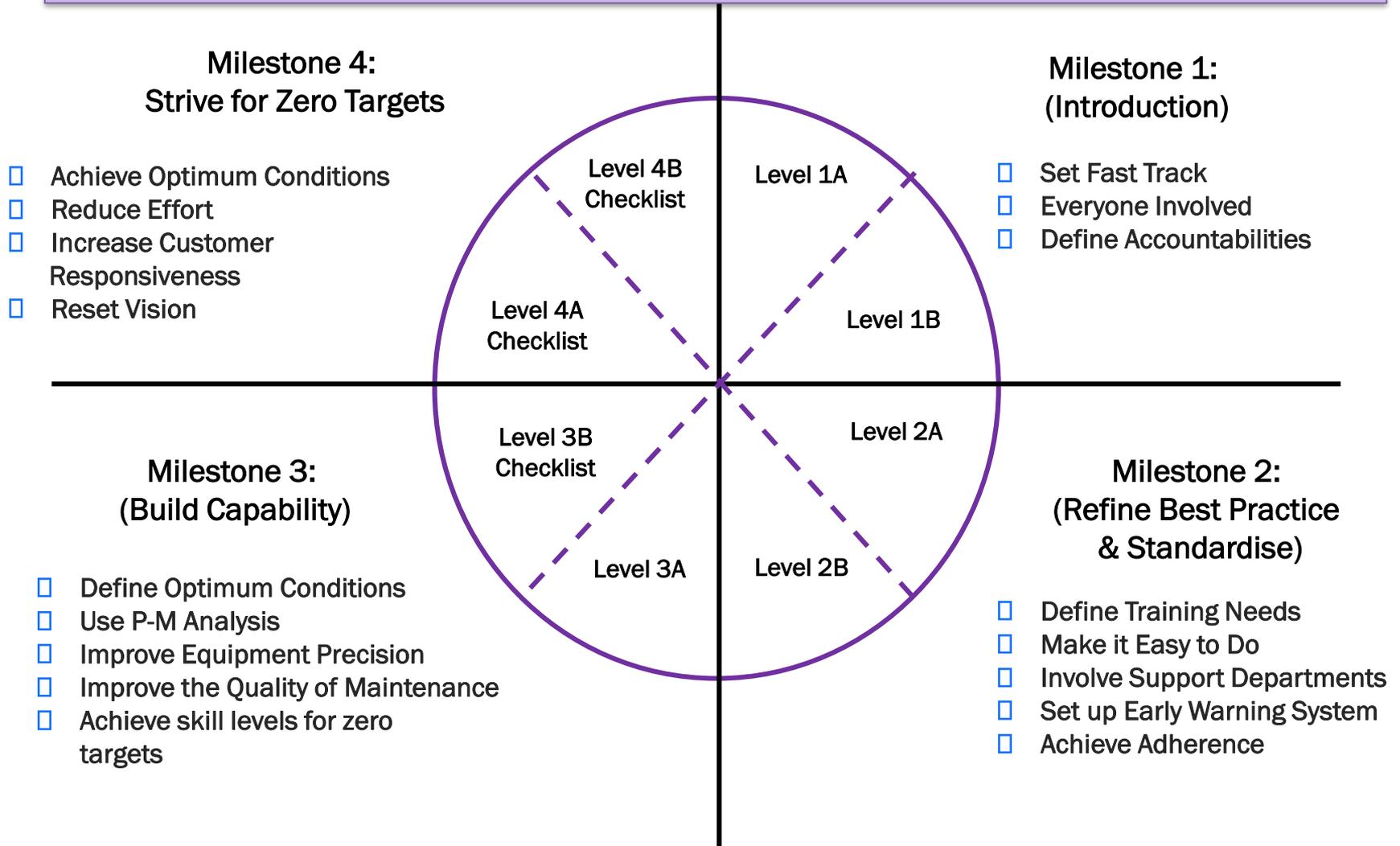
## Understanding operation of shear valves



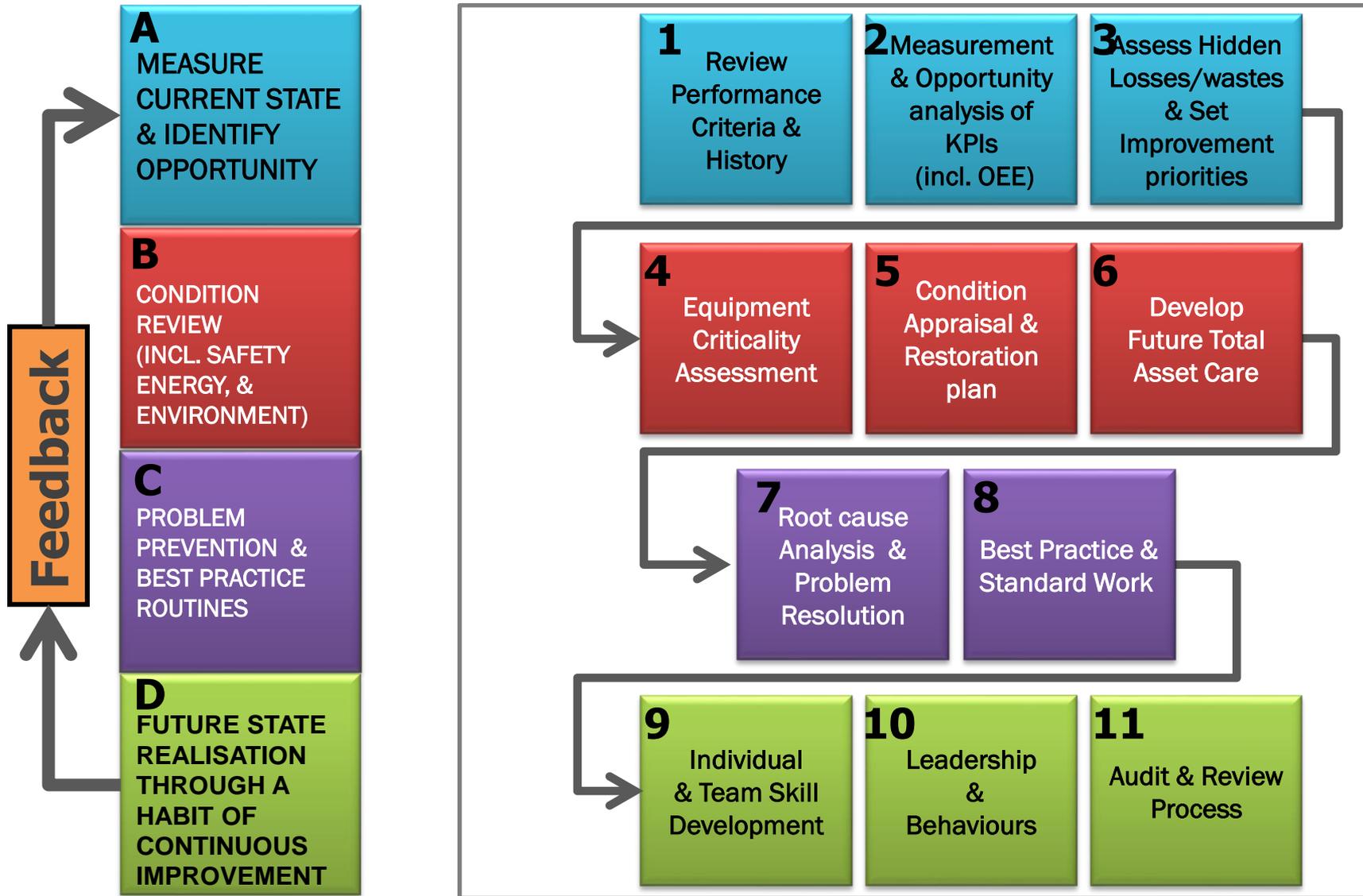


# Needed to also understand where the journey will take us

## Delivering the Production Response through 10 Point Audits / Reviews



# Four Cycle-11 Step TPM



# Step 1 - Sources of Information

- What Sources do we have?
- How Comprehensive are they and...
- How Trustworthy are they?
- List and Rank them 1 to 5, where:-
  - 1 is Poor,
  - 2 is Fair,
  - 3 is Adequate,
  - 4 is Very Good
  - 5 is Excellent

# Example STEP 1 Sources of Information

1 = Poor, 2= Fair , 3= Adequate, 4= Very Good, 5 = Excellent

| SOURCE                     | How Comprehensive ? | How Trustworthy? |
|----------------------------|---------------------|------------------|
| SAP                        | 4                   | 1 to 5           |
| Efficiency Files (AO1only) | 3                   | 3                |
| Kissler Monitor (E14 only) | 4                   | 4 to 5           |
| Operator Log Book          | 3                   | 2                |
| Maintenance Log Book       | 2 to 3              | 2 to 3           |
| Tool History Log           | 3 to 4              | 3 to 4           |
| Materials Handling Sy      | 3                   | 5                |
| Robot History (E14 only)   | 3                   | Rarely Used      |
| OEM Manuals                | 4 to 5              | 2                |
| Operator Knowledge         | 1 to 5              | 1 to 5           |
| Maintainer Knowledge       | 1 to 5              | 1 to 5           |
| M/C History Single Page    | 1                   | 5                |
| SORT-Suspect Parts         | 4                   | 4                |
| Spares Usage               | 5                   | 5                |
| Daily Activity Sheet       | 3 to 4              | 3 to 4           |
| Daily Management Board     | 3                   | 1 to 5           |
| Material Cycle Count       | 4                   | 4                |
| Process Change Management  | 4                   | 3                |

# Step 1 KLP's

- **Brainstorm and Review the number of different sources, their variety, their comprehensiveness and their integrity**
- **Is there scope to subject each source to the ECRS test?**
- **What sources can we-Eliminate or Combine and if not, can we at least Replace with something smarter or at least Simplify ?**
- **Can we extract the OEE metric from these sources or do we need to design and implement a OEE Shift Log sheet ?**

# Step 2- Self Assessment Example

|                            | Availability %   | Performance Rate %   | Quality Rate %  | OEE % |
|----------------------------|--|--|---|-------|
|                            | <ul style="list-style-type: none"> <li><input type="checkbox"/> Breakdowns</li> <li><input type="checkbox"/> Set Ups/ Changeovers</li> </ul> | <ul style="list-style-type: none"> <li><input type="checkbox"/> Running at Reduced Speed</li> <li><input type="checkbox"/> Minor Stops &amp; Idling</li> </ul> | <ul style="list-style-type: none"> <li><input type="checkbox"/> Scrap Rework</li> <li><input type="checkbox"/> Start-up Losses</li> </ul> |       |
| Current 4 Wks Average OEE  | 80   | 90   | 97  | 70    |
| 4 Weeks Best of Best (BoB) | 90 (Wk1)   | 95 (Wk3)   | 98 (Wk1& 4)   | 84    |
| World Class                | 95   | 96   | 99  | 90    |

Difference between Current Average & BoB is  $(14 / 70) \times 100\%$   
**= 20% Real improvement In Productive Capacity**

## Step 2-What is BoB & WC OEE Worth to Us?

If this asset is planned to be manned for 168 Hours per week

At 70 % OEE we only achieve 118 Productive Hrs / week

At **84% OEE** we can achieve **141 Productive Hrs / week**

Yielding a **benefit of 23 productive Hrs / week or 1,150 hrs / Yr**

### Namely

a CHOICE of flexibility at 84% OEE that we do not enjoy  
at 70% OEE !!

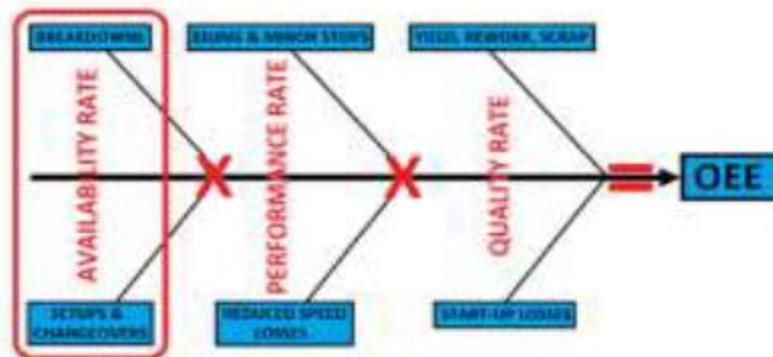
(When we hit WC levels of 90% OEE the benefit is worth  
1,660 extra productive hrs / year)

# Understanding the Availability Issues

## Availability:-

As we know from the 6 Loss Fishbone, Availability looks at Breakdowns, as well as Setups & Changeovers.

Belt Thickeners don't suffer from Setups or Changeovers so the focus on calculating an Availability rate is solely on Breakdowns. Although reliable, they do suffer from time-to-time with breakdowns, so following a team discussion, the simplest way to calculate breakdowns would be by registering the hours the Belt Thickener itself had failed in the last 24 hours.



## Calculation Example:

| Hours Failed in last 24 Hrs | Expected/ Targeted Daily Availability (Hrs) | Availability Sum         | Availability Result |
|-----------------------------|---|--------------------------|---------------------|
| 2                           | 24  | $((24-2)/24) \times 100$ | 91.67%              |

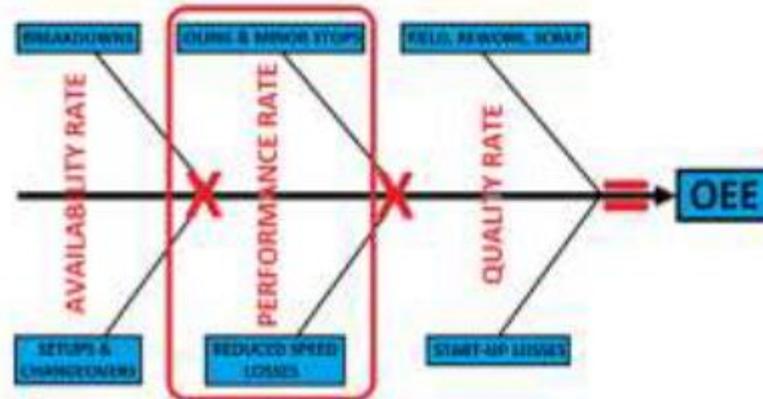
# Understanding the Performance Issues

## Performance:-

To measure Performance was a little more complicated as the Belt Thickeners suffer from both Minor Stops and Running at Reduced Speeds.

To calculate Performance the team look at what the expected processed

Sludge Quantity will be by assessing the Sludge feed rate, typically 8 l/s, against the maximum designed spec. of 15 l/s (Running at Reduced Speed) and the differential in Hours Run between the Sludge Feed Pump and the Belt Thickener (Minor Stops)



## Calculation Example:

|          | Actual Feed Rate | Expected/ Target Feed Rate | Sludge Feed Pump Hours Run | Belt Thickener Hours Run | m3 Sum                                    | m3 Result | Performance Sum             | Performance Result |
|----------|------------------|----------------------------|----------------------------|--------------------------|---|-----------|-----------------------------|--------------------|
| Actual   | 8                |                            | 22                         |                          | $(8 \times 60 \times 60 \times 22)/1000$  | 633.6     | $(633.6 / 1296) \times 100$ | 48.89%             |
| Expected |                  | 15                         |                            | 24                       | $(15 \times 60 \times 60 \times 24)/1000$ | 1296      |                             |                    |

# Understanding the Quality Issues

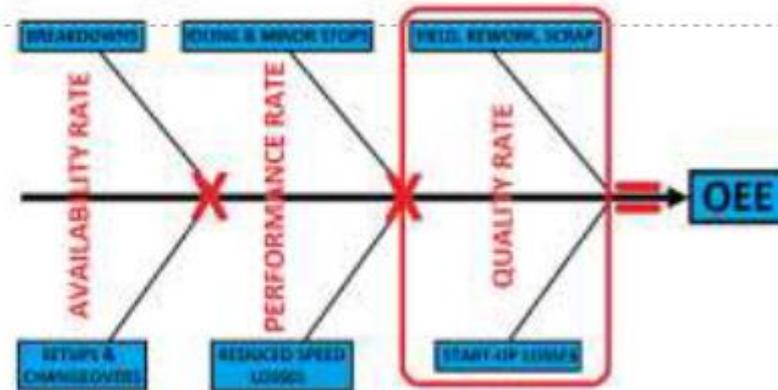
## Quality:-

Finally, by measuring the actual % Dry Solids coming off the Belt Thickener against the target of 6.5%, we are then able to calculate the Quality Rate.

The Belt Thickeners can produce well over the 6.5% Dry Solid target but this can have negative effects on, for example, Digester Health, the Discharge Pumps due to additional strain and the Discharge Pipeline by blocking it up. We therefore mark the Quality Score down, whether it is over or under the desired 6.5% Dry Solids target.

Example:

| % Dry Solids Target | Actual Belt % Dry Solids | Quality |
|---------------------|--------------------------|---------|
| 6.5                 | 3.25                     | 50.00%  |
| 6.5                 | 9.75                     | 50.00%  |



As can be seen in the table, if the % Dry Solids was 3.25% (half the target figure), the score would be 50%. If 9.75% (one and a half times the target) the score would also reflect negatively and result in a 50% score.

# Golf analogy to illustrate Best of Best

| Hole   | Par | 1  | 2  | 3  | 4  |
|--------|-----|----|----|----|----|
| 1      | 5   | 7  | 5  | 6  | 6  |
| 2      | 3   | 5  | 4  | 3  | 3  |
| 3      | 4   | 4  | 7  | 6  | 5  |
| 4      | 5   | 8  | 6  | 7  | 5  |
| 5      | 3   | 5  | 5  | 4  | 6  |
| 6      | 4   | 5  | 4  | 5  | 5  |
| Total: | 24  | 34 | 31 | 31 | 30 |

Average Score = 32

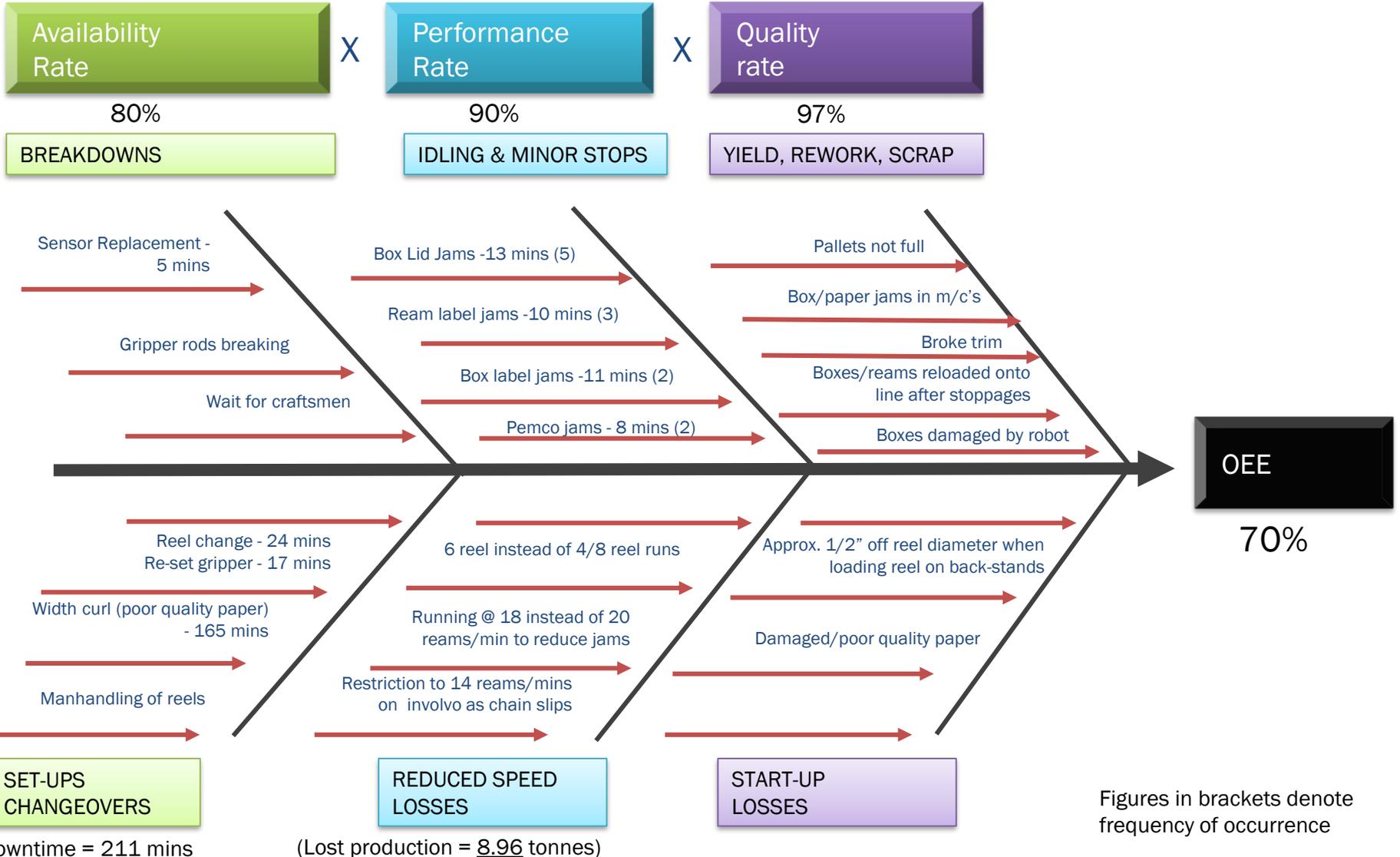
Best of Best Score = 25



## Step 2 KLP's

- Have we calculated a current average OEE?
- What is our interim Best of Best OEE target?
- What is our ultimate WC-OEE ?
- What is the value of additional productive hours per week when our BoB is achieved?
- This potential value will help to make a compelling business case to implement TPM and justify our step 5b) Refurbishment Plan

# Step 3-Fishbone format for Assessing 6 Losses



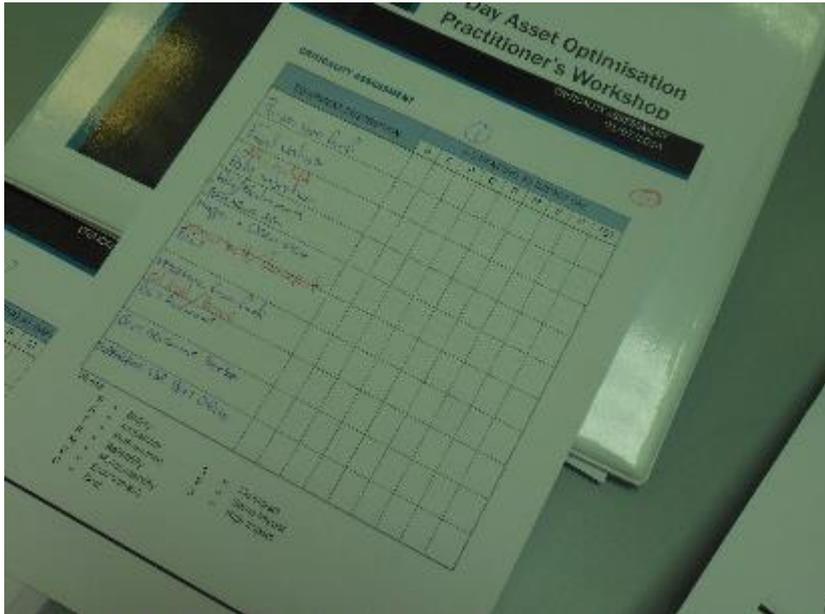
## Step 3 KLP's

- These are the classic 6 x loss reasons and why the current OEE is what it is
- Also differentiating between 'Floor to Floor' Equipment based Losses v's the 'Door to Door' or 'Management Losses'

# Step 4-Criticality assessment- on Pilot equipment



# Step 4-Criticality assessment- on Pilot equipment





# Example of Step 4 Criticality Assessment Output

| EQUIPMENT DESCRIPTION                 | 1-3 RANKING AS IMPACT ON: |   |   |   |   |   |   |   |     |
|---------------------------------------|---------------------------|---|---|---|---|---|---|---|-----|
|                                       | S                         | A | P | Q | R | M | E | C | TOT |
| 1. Hoist                              | 3                         | 3 | 2 | 1 | 1 | 3 | 1 | 3 | 17  |
| 2. Matcon Discharge station           | 2                         | 3 | 3 | 3 | 1 | 3 | 3 | 3 | 21  |
| 3. Vacuum Transfer system             | 1                         | 2 | 2 | 3 | 1 | 1 | 2 | 2 | 14  |
| 4. Hopper & screw feeds               | 1                         | 3 | 3 | 3 | 1 | 1 | 3 | 3 | 18  |
| 5. Stirring Motor x 2                 | 1                         | 3 | 3 | 2 | 1 | 1 | 1 | 3 | 15  |
| 6. Dosing Auger x 2                   | 1                         | 3 | 3 | 3 | 1 | 1 | 2 | 3 | 17  |
| 7. Vibrator                           | 1                         | 3 | 3 | 3 | 1 | 1 | 3 | 2 | 17  |
| 8. Dosing Funnel x 2                  | 1                         | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 21  |
| 9. Aspirator                          | 1                         | 3 | 3 | 3 | 1 | 1 | 3 | 3 | 18  |
| 10. Top Sealing plate                 | 3                         | 3 | 3 | 3 | 1 | 1 | 2 | 3 | 19  |
| 11. Code block (Filling)              | 2                         | 3 | 3 | 3 | 1 | 1 | 1 | 2 | 16  |
| 12. Foil cutting                      | 3                         | 3 | 3 | 3 | 1 | 1 | 2 | 2 | 18  |
| 13. Suction cups/Pick 'n Place        | 1                         | 3 | 3 | 2 | 1 | 1 | 1 | 1 | 13  |
| 14. Toothed transfer belt             | 2                         | 3 | 3 | 3 | 1 | 3 | 1 | 2 | 18  |
| 15. Green Belt transfer               | 3                         | 3 | 3 | 3 | 1 | 3 | 1 | 2 | 19  |
| 16. Collator/Magazine                 | 3                         | 3 | 2 | 1 | 3 | 3 | 1 | 3 | 19  |
| 17. Foil Holder – loading foil holder | 2                         | 3 | 3 | 2 | 1 | 1 | 1 | 2 | 15  |
| 18. Foil Pulling & guiding system     | 1                         | 3 | 3 | 3 | 1 | 1 | 1 | 2 | 15  |
| 19. Foil Perforation                  | 1                         | 3 | 3 | 3 | 1 | 1 | 1 | 2 | 15  |
| 20. Foil bottom seal                  | 3                         | 3 | 3 | 3 | 1 | 1 | 1 | 2 | 17  |
| 21. Foil separator                    | 1                         | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 20  |

Where:

|                     |
|---------------------|
| S = Safety          |
| A = Availability    |
| P = Performance     |
| Q = Quality         |
| R = Reliability     |
| M = Maintainability |
| E = Environment     |
| C = Cost            |

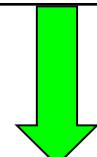
| Rating Scale            |
|-------------------------|
| 1 = No or Little Impact |
| 2 = Significant Impact  |
| 3 = Major Impact        |

| LEGEND  |                    |
|---|--------------------|
|  | A,P,Q over 3       |
|  | Reliability over 3 |
|  | Safety over 3      |
|  | Over 20 total      |
|  | Highest total      |

# Step 4: Criticality Assessment Outputs



| EQUIPMENT DESCRIPTION<br>Packing Line 6 (P6) | 1-3 RANKING AS IMPACT ON: |   |   |   |   |   |   |   |     |
|--|---------------------------|---|---|---|---|---|---|---|-----|
|  | S                         | A | P | Q | R | M | E | C | TOT |
| <b>1. Checkweigher</b>                       | 2                         | 3 | 3 | 3 | 1 | 1 | 1 | 3 | 17  |



## Optimum Checkweigher Conditions

- The checkweigher is calibrated (FLOAC)
- The belts are clean (FLOAC)
- The correct format is entered (FLOAC)
- Load cells are clean (FLOAC)
- Motors are in good condition and bearings are good (FLOAC, PM, condition monitoring)
- All rollers are free and easy to rotate (FLOAC, PM, condition monitoring)

- Safety
- Availability
- Performance
- Quality
- Reliability
- Maintainability
- Environment
- Cost
- 1 = No impact
- 2 = Some impact
- 3 = Major impact

## Step 4 - Criticality Assessment Outputs

- Builds Teamwork between Operators & Maintainers
- Understanding of the Equipment Functionality
- Checklist for Condition Appraisal (Step 5a)
- Focus for Future Total Asset Care (Step 6)
- Highlights Safety & Environmentally Critical Items
- Potential Impact on OEE
- Highlights Weaknesses Regarding:-
  - Ease of Operation
  - Inherent Reliability
  - Ease of Maintenance

## Step 4 KLP's

- The Operators and their Maintenance colleagues become far more '*Equipment Conscious*'
- They now actually *understand* how the equipment works
- Highlights the Impact of Safety, Reliability, Environment and APQ(ie the OEE)
- Focuses on parts that need to be kept in Optimum Condition as part of Steps 6 & 8

# Step 5a)-Condition Appraisal

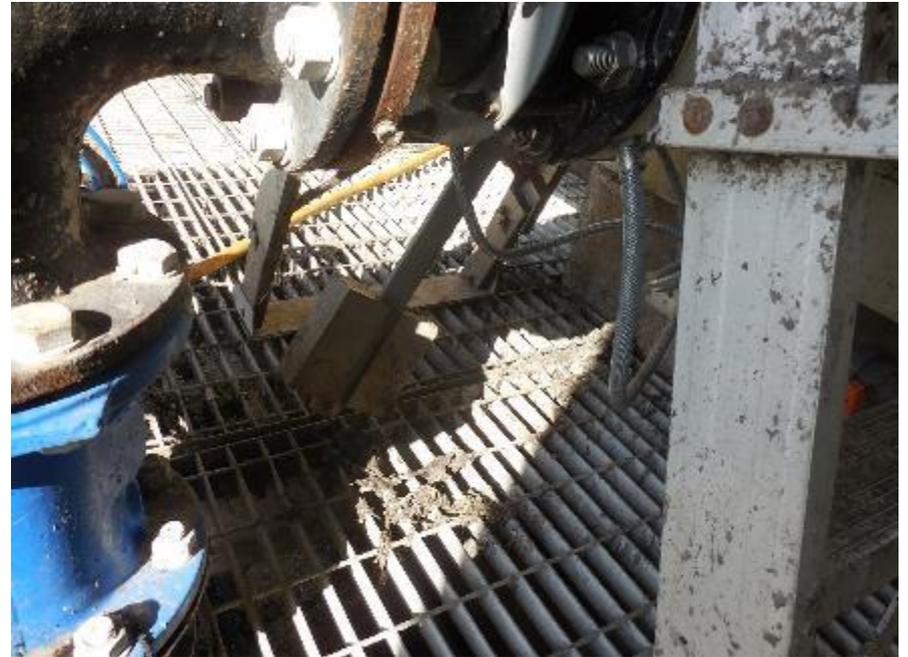
## STEP 5a) 'Spot the Rot'

Go to the machine and systematically inspect every square centimetre for deterioration and refurbishment needs. Look for:

- ▶ Dirty or Neglected equipment (Packaging debris and / or dust particles)
- ▶ Disconnected hoses
- ▶ missing nuts and bolts producing visible instability
- ▶ steam leaks and air leaks
- ▶ Air Filter Drains That Need Cleaning
- ▶ jammed valves
- ▶ hydraulic, lubricating and oil leaks
- ▶ measuring instruments too dirty to read
- ▶ abnormal noises in pumps and compressors

Pay particular attention to Step 4-Critical components. They should be kept in optimum condition.

## Step 5a)-Condition Appraisal- Spot the Rot



# Step 5a)-Condition Appraisal- Spot the Rot



## Step 5a)-Condition Appraisal-Spot the Rot



# Step 5a)-Condition Appraisal-Spot the Rot





## Step 5a)-Condition Appraisal-Spot the Rot



# Step 5a)-Condition Appraisal- Spot the Rot



# Step 5a)-Condition Appraisal-Spot the Rot



# Step 5a)-Condition Appraisal-Spot the Rot



## Step 5a)-Spot the Rot summary

| Asset        | Total No of Issues | Safety Issues | Environment Issues | High OEE Impact | Medium OEE Impact | Low OEE Impact | Cum OEE Impact |
|--------------|--------------------|---------------|--------------------|-----------------|-------------------|----------------|----------------|
| Auto 1       | 30                 | 15            | 26                 | 7               | 4                 | 1              | 12             |
| Auto 2       | 38                 | 15            | 2                  | 5               | 9                 | 10             | 24             |
| Tape         | 24                 | 6             | 0                  | -               | 10                | 2              | 12             |
| Braze        | 57                 | 36            | 11                 | 10              | 2                 | 9              | 21             |
| <b>Total</b> | <b>149</b>         | <b>72</b>     | <b>39</b>          | <b>22</b>       | <b>25</b>         | <b>22</b>      | <b>69</b>      |

### Spot the Rot Summary

Total of 149 issues of which...

- 48% are potential safety issues,
- 26% environmental issues and ....
- 46% perceived as having a potentially negative impact on the OEE

## Step 5a)-KLP's

1. TPM is about positive obsessive attention to detail.
2. Using our God-given senses of Look, Listen, Smell, Feel/Touch, Discuss.
3. Even the smallest thing wrong can develop into a major problem. At best it will stay as it is. At worst it will deteriorate. It certainly won't get better on its own !
4. Use Photographic Evidence as a reminder of 'Before TPM...'
5. Spotting what's wrong is only half of the solution. Correcting the problem with a permanent '100 year fix' solution is the other half.
6. Many small problems have potential safety and/or environmental issues.
7. Some will eventually impact on the OEE
8. In the real TPM "Cleaning is Inspection.... is Spotting Deterioration.... is Catching it before it becomes Catastrophic.... is pride in the workplace.... is a "hassle free" shift.... Resulting in "Pride of Ownership".

## Step 5b) Refurbishment

**The objective of the Refurbishment Programme is to set up a Repair and Replacement Plan, based on the Condition Appraisal (step 5a) )**

**The plan will provide a detailed summary of actions to be coordinated by the team and will include:**

- ☐ Dates and Timescales**
- ☐ Resource (labour, materials, time)**
- ☐ Responsibilities**
- ☐ Control and feedback (Management of Change)**

**To aid Planning and Completion of Refurbishment Tasks, it may be helpful to categorise up to three work packages:**

- ☐ On the Run (Low Cost/Easy to Do/No Outage)**
- ☐ Minor Planned Outage (8 to 24 hours)**
- ☐ Major Planned Outage (involving Redesign/Fabrication).**

# Step 5b) Refurbishment Plan

Section 7- Four Day Workshop  
Workbook Master  
11/08/2014

**STEP 6- REFURBISHMENT ACTION PLAN**

Equipment/Installation: \_\_\_\_\_ Date: \_\_\_\_\_

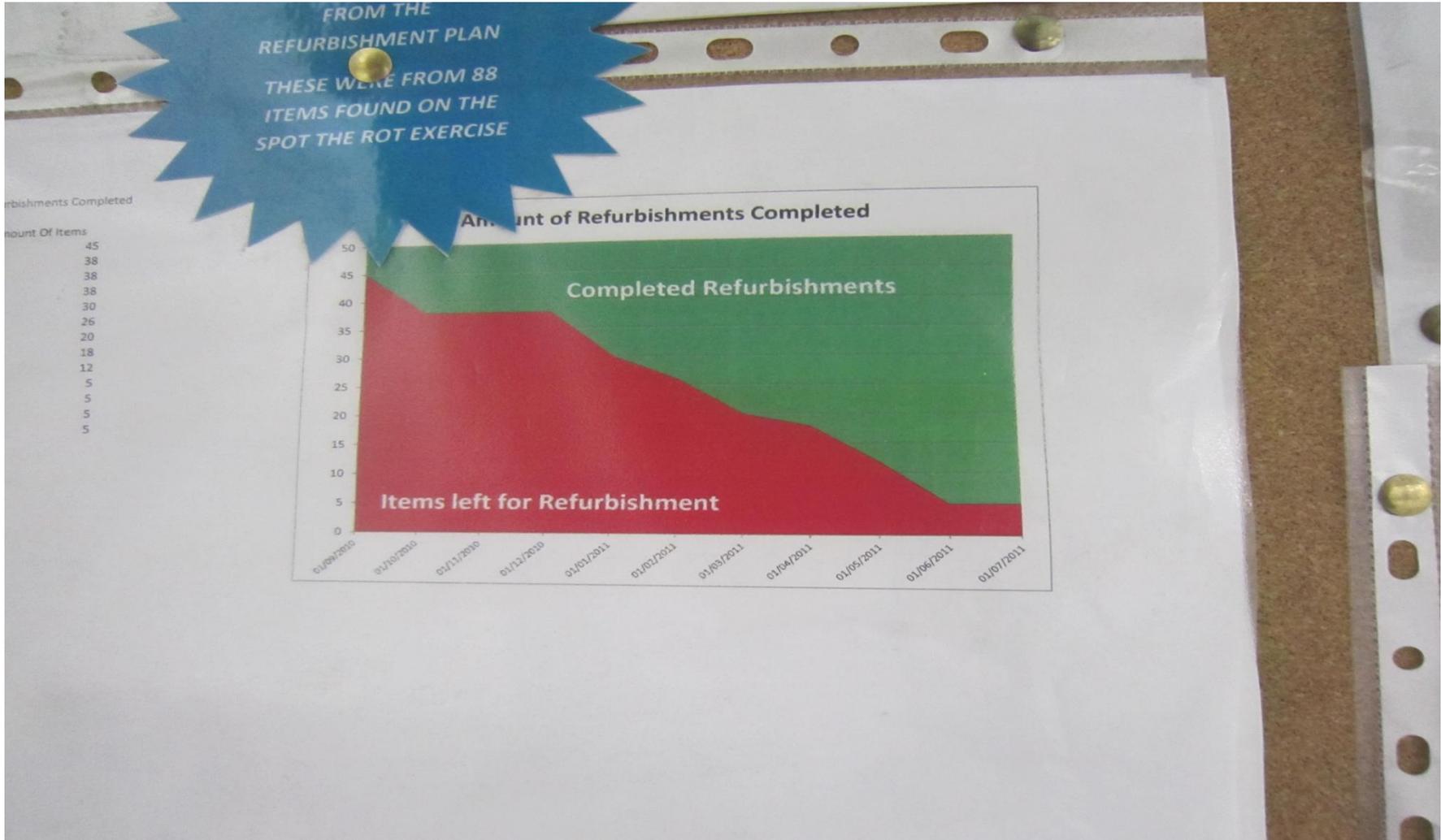
| DESCRIPTION           | TASK                         | LABOUR HRS | MAT COST | TOTAL COST | EXPECTED BENEFIT H/M/L | PLANNED COMPLETION | RESPONSIBILITY & DATE ASSIGNED | STATUS |
|-----------------------|------------------------------|------------|----------|------------|------------------------|--------------------|--------------------------------|--------|
| Roller Shutter Door   | Affix seal to bottom of door |            |          |            | M                      |                    |                                |        |
| General House Keeping | Clean and tidy               | 50         | 127      | 1170       | M                      |                    |                                |        |
| Liquid Poly Spill     | Included in above            |            |          |            |                        |                    |                                |        |
| Corrosion on Bolt     | Replace                      | 1          |          |            |                        |                    |                                |        |
|                       |                              |            |          |            |                        |                    |                                |        |
|                       |                              |            |          |            |                        |                    |                                |        |
|                       |                              |            |          |            |                        |                    |                                |        |
|                       |                              |            |          |            |                        |                    |                                |        |
|                       |                              |            |          |            |                        |                    |                                |        |
|                       |                              |            |          |            |                        |                    |                                |        |

Responsibility Allocated    
  Work Planned    
  Work Completed    
  Confirmed as Effective

20

# Step 5b) Refurbishment Plan Summary Visual Tracker

Plan the Refurbishment, Spares & Manpower



# GBT Gravity Belt Thickener 3-Before



# After restoration & improvements

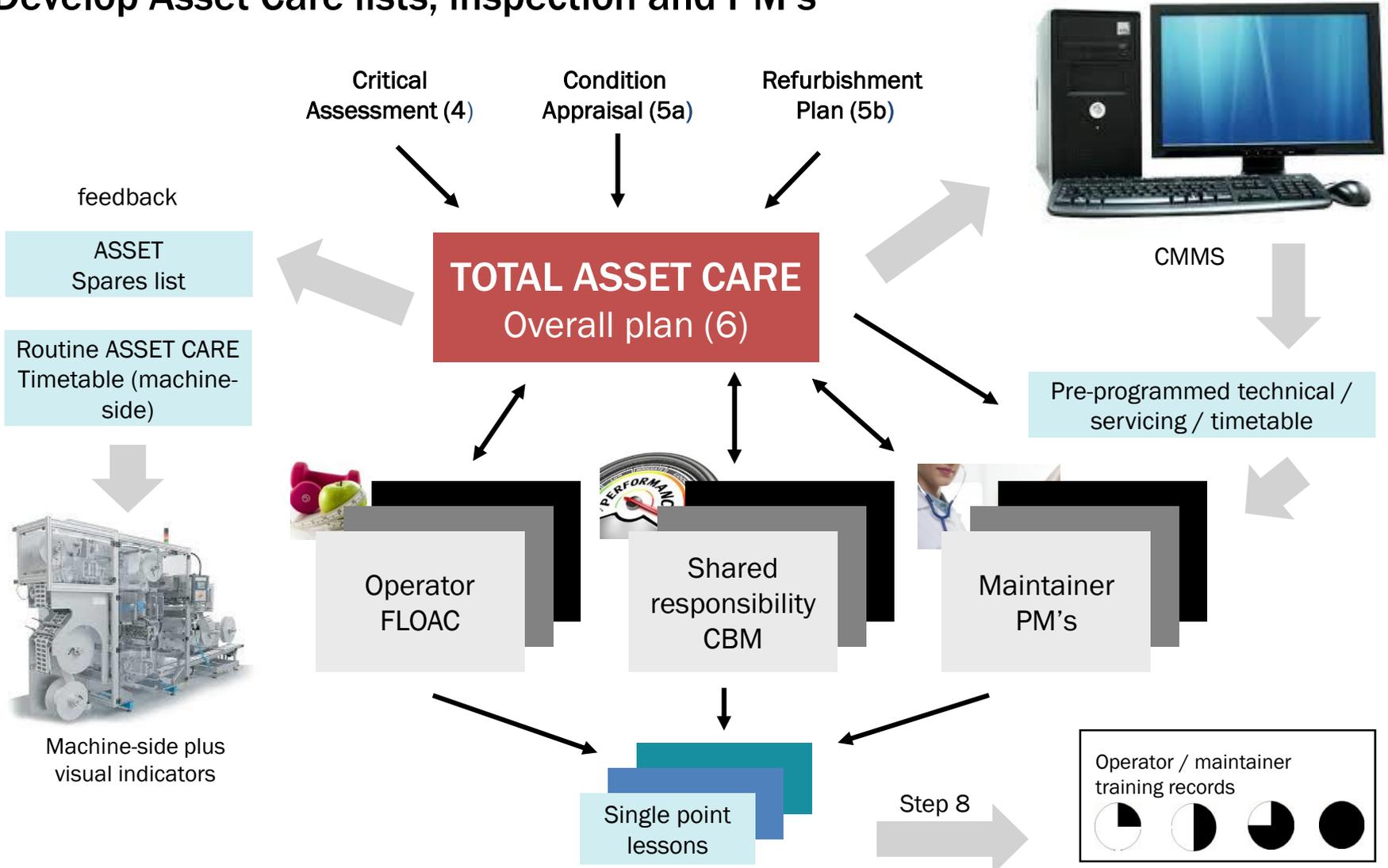


## Step 5b) KLP's

- Restore to 'as new' condition,
- The need for a progress Tracker,
- Now able to justify cost/benefit via OEE's Best of Best additional productive hours

# Step 6-Developing the future Total Asset Care

## Develop Asset Care lists, inspection and PM's



# Step 6 FLOAC Example

## Line Six East Satellite Asset Care

Develop Future  
Total Asset Care

What's This ?

|     |                                |
|-----|--------------------------------|
| E 1 | RESIN SPILLAGES                |
| E 2 | CONEVATOR SUCTION PIPE         |
| E 3 | WATER FLOW INDICATOR           |
| E 4 | WATER FLOW INDICATOR           |
| E 5 | WATER FLOW INDICATOR           |
| E 6 | OIL TEMP IN                    |
| E 7 | OIL TEMP OUT                   |
| E 8 | OIL FLOW INDICATOR             |
| E 9 | OIL FILTER CONDITION INDICATOR |
| E10 | SUPPLY TANK WATER LEVEL        |
| E11 | DRIVE MOTOR AIR LEAKS          |
| E12 | GEAR BOX OIL LEVEL             |
| E13 | GEAR BOX OIL LEAKS             |
| E14 | WATER TEMPERATURE              |
| E15 | OIL PRESSURE OUT               |
| E16 | BARREL COOLING WATER LEVEL     |
| E17 | WATER PIPE LEAKS               |
| E18 | GENERAL CLEANLINESS            |
|     | CHANGE CONEVATOR PADS          |
|     | RETURN USED PACKS TO STORES    |

See next Slide ►

# Make It Easy to do Things Right

## E 3 WATER FLOW INDICATOR

CHECK THAT THE WATER FLOW INDICATOR IS SPINNING

IF IT IS NOT SPINNING, PLEASE RAISE A JOB REQUEST AND RECORD THE JOB REQUEST NUMBER AND DATE ON A RED TAG AND ATTACH THE RED TAG TO THE INDICATOR.

THE ASSET CARE SHEET OF THIS SECTION SHOULD BE FILLED WITH A RED PEN

**FAILURE TO RECTIFY THIS COULD RESULT IN DOWNTIME**

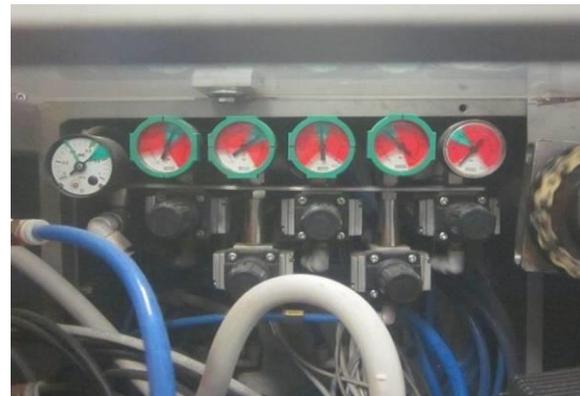
## E 3 WATER FLOW INDICATOR



## Step 6-Front Line Operator Asset Care (FLOAC) Operator as the Nurse



- The operator takes on the role of first line asset care
- Checking the condition of the equipment during operation
- Carrying out checks during the weekly asset care shift windows
- Progressing carrying out change overs on equipment



- The operator carries out more interesting tasks and expands their knowledge

# Step 6-Condition Based Maintenance via the Maintenance Technician



Date: 9/27/2011 4:18 PM

### 810 Vibration Tester Diagnostic Report

Device Serial Number : 1380010  
Machine Setup Name : AH-102  
Measurement Date/Time : 09/05/2011 11:33:08

Drive Train  
1

**Diagnosis**

| Fault description  | Fault severity | Severity Score | Severity Scale |
|--------------------|----------------|----------------|----------------|
| Motor Bearing Wear | Serious        | 66/100         |                |

**Recommendations**

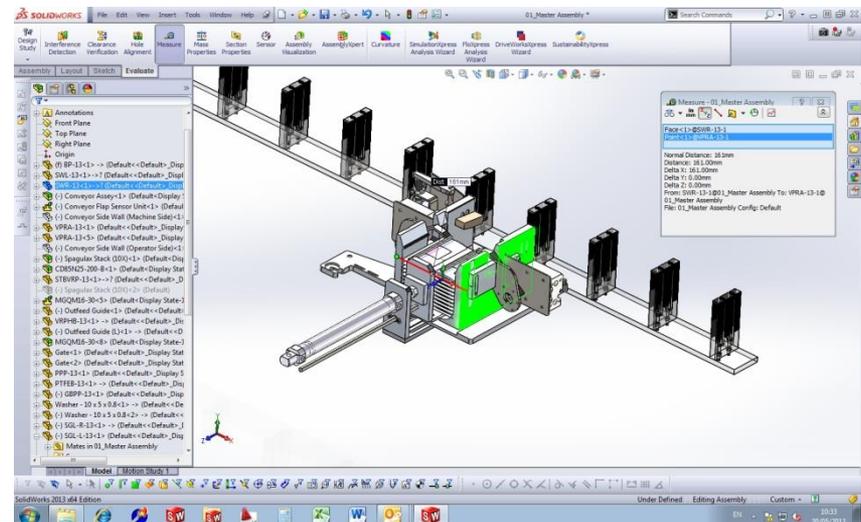
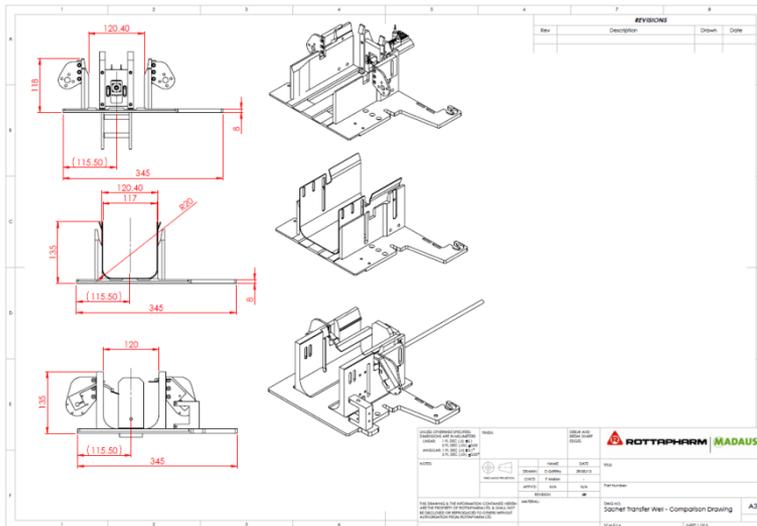
| Recommendations        | Priority | Priority Description |
|------------------------|----------|----------------------|
| Replace Motor Bearings | 3        | Important            |

## Responsibility of the Maintenance Technician

# Step 6-Maintenance Technician as the Engineer (Doctor)



- Technicians spend more time on design and engineering out problems
- Less work is outsourced
- More knowledge and ability is developed in-house
- Technicians feel more motivated and more valued



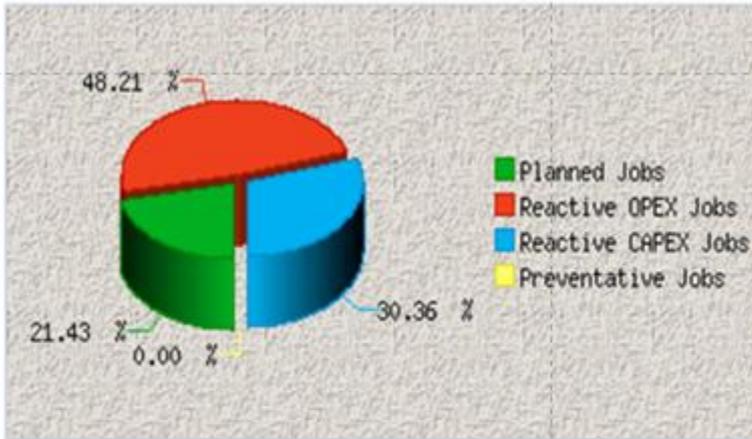
# From Reactive **RED & BLUE** to Proactive **Green over 6 months**

Start

6 months later

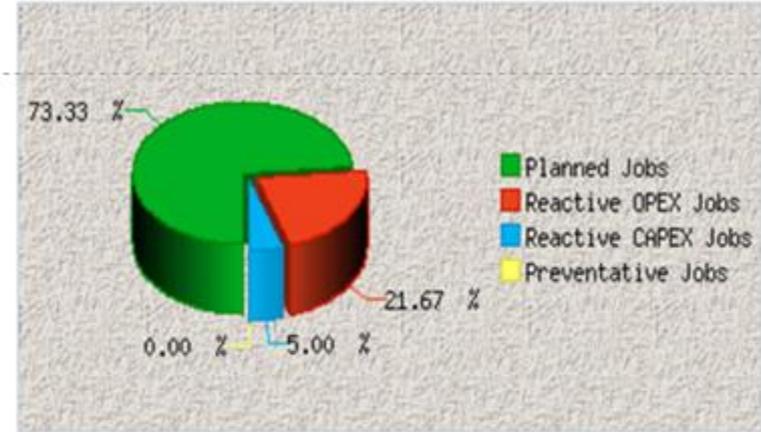
Planned Vs Reactive Vs Preventative Jobs % - MEI

Graph Table



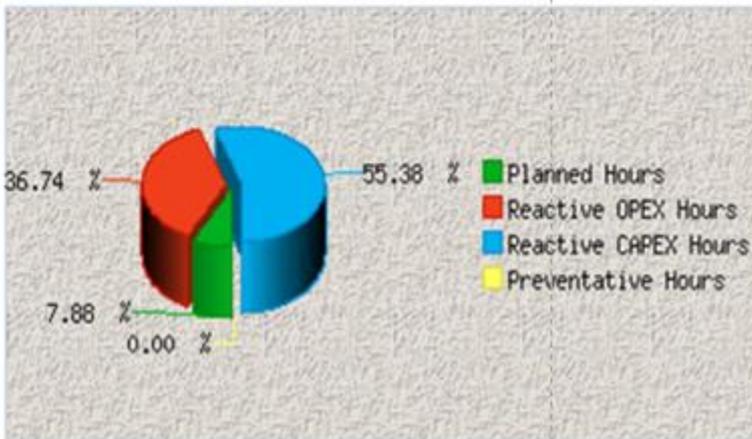
Planned Vs Reactive Vs Preventative Jobs % - MEI

Graph Table



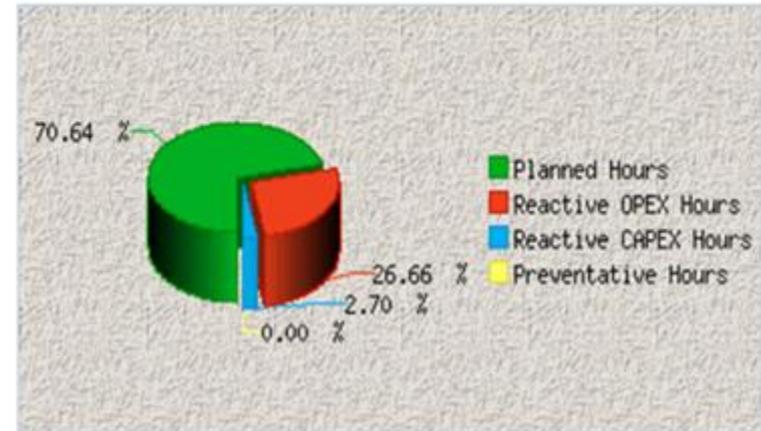
Planned vs Reactive vs Preventative Hours % - MEI

Graph Table



Planned vs Reactive vs Preventative Hours % - MEI

Graph Table



## Step 6 KLP's

- FLOAC's - Use of Visual Indicators ,  
Make it easy to do right, and difficult to do wrong,
- How many minutes (usually less than 10)  
to carry out FLOAC checks.
- Full Step 6 must also include CBM  
& a comprehensive review of the fixed interval PM's

# Step 7

## P-M Analysis - On the Job Reality

P-M Analysis is the Problem Solving Tool used in TPM, which Emphasises the Machine/Human Interface:

**There are:**

The 4 P's

Caused by:

**P**roblems, due to

**P**henomena, which are

**P**hysical, which can be

**P**revented

**Because they are to do with:**

The 5 M's

Involving:

**M**aterials & **M**other nature

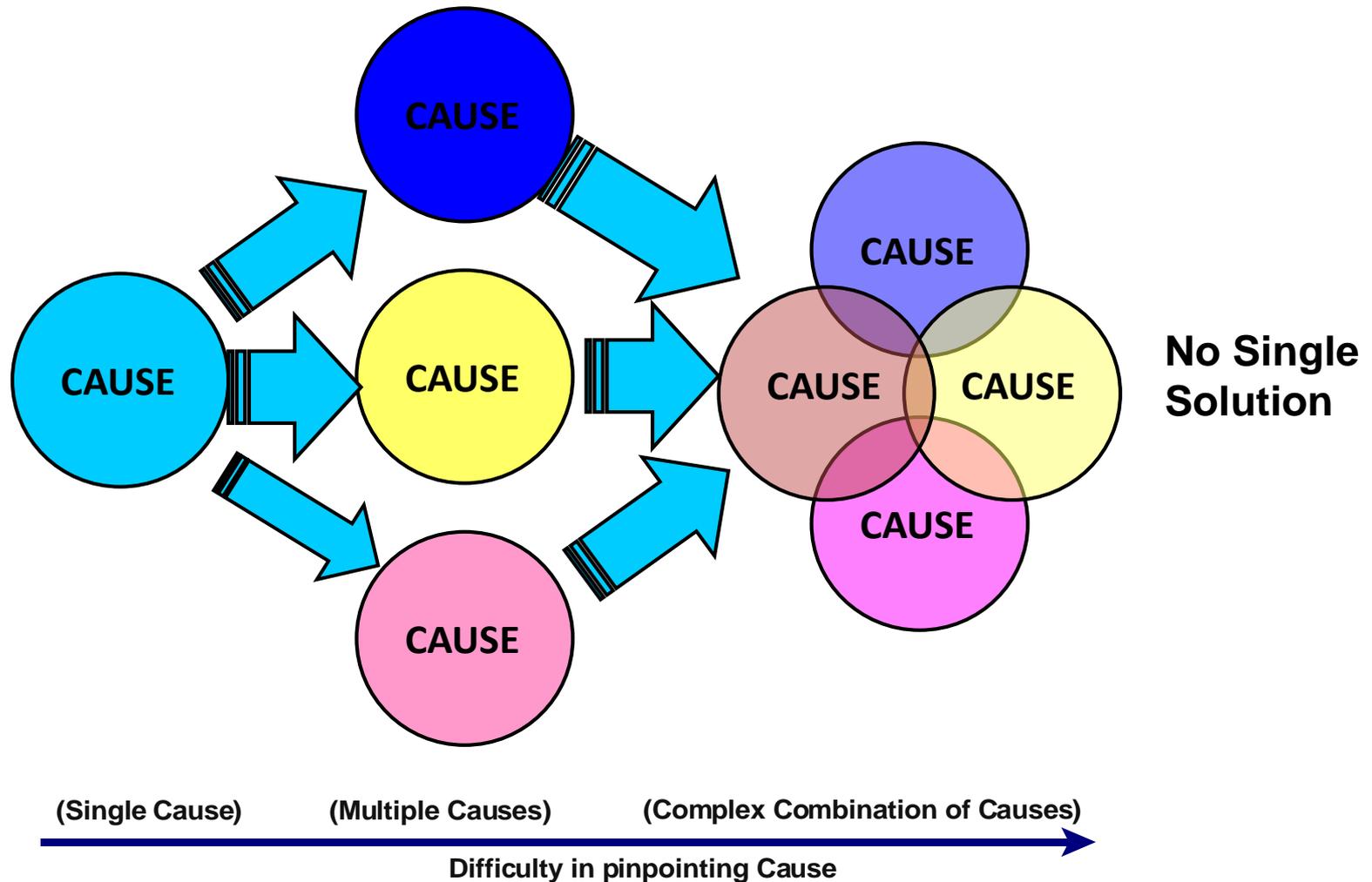
**M**achines

**M**ethods

**M**anpower

.....and We Need a 6<sup>th</sup> **M** Which is Measurement

# Step 7 -Problem Solving Causes Of Chronic Losses



# Step 7 KLP's

- Use of the Event Analysis form to not only solve the problem but to also prevent re-occurrence with the '100 year fix'
- The importance of the P-M mindset of the 4 x P's and 6 x M's
- Strong links back to solve highlighted issues on Step 3 fishbone
- Use of Ask Why? 5 x times or A3, DMAIC and FMEA tools to deliver the 100 year fix mentality

# Step 7-Problem Solving/event analysis



Residue left in Poly containers



Solution - Elevate + on/off tap

# Step 7-Problem Solving/event analysis



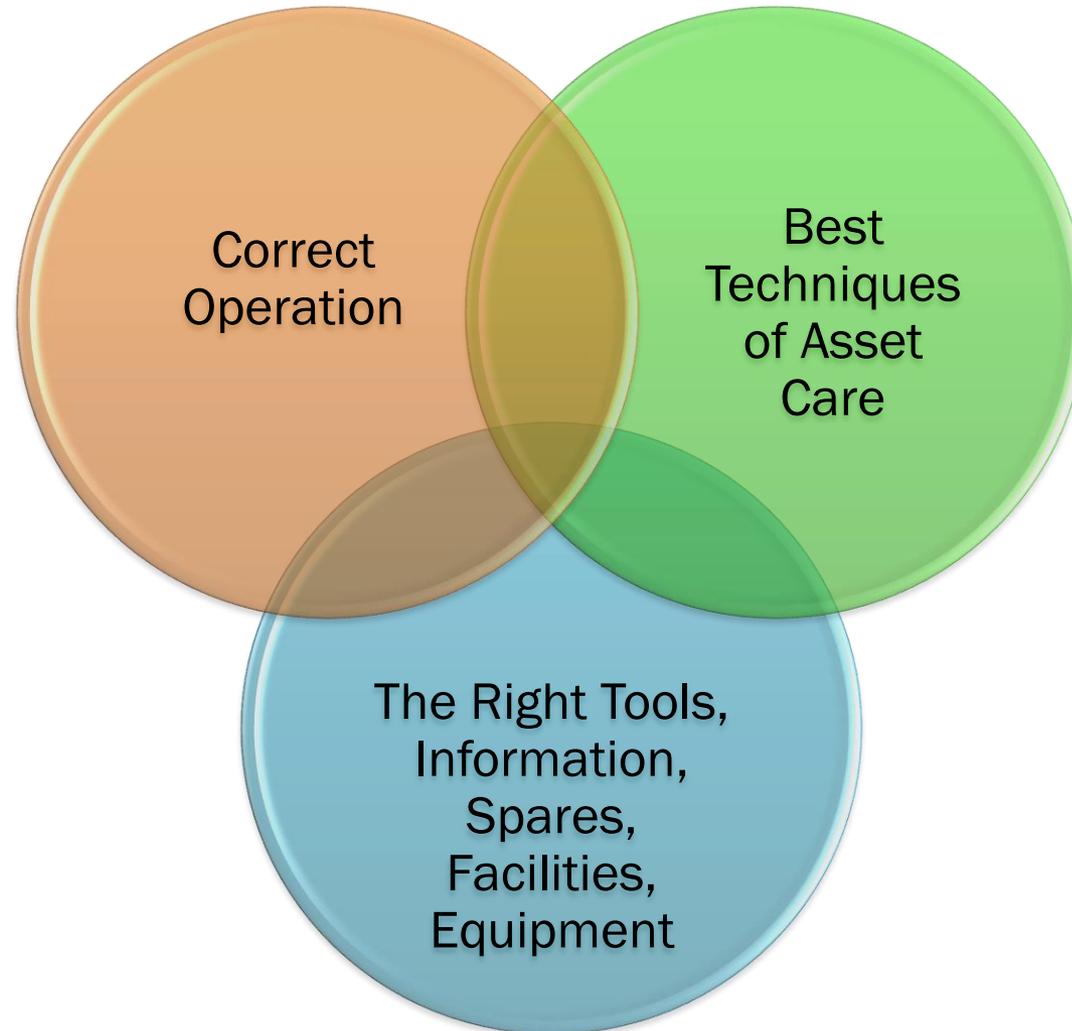
Opportunity to reduce loss in Poly Containers by modifying pallet base to ensure contents flow and empty out

## Step 8 Standard Work-Best Practice Routines

- Agree Best Practice
- Standardise (Train and Assess)
- Practice and Refine (Pass on Lessons Learnt)



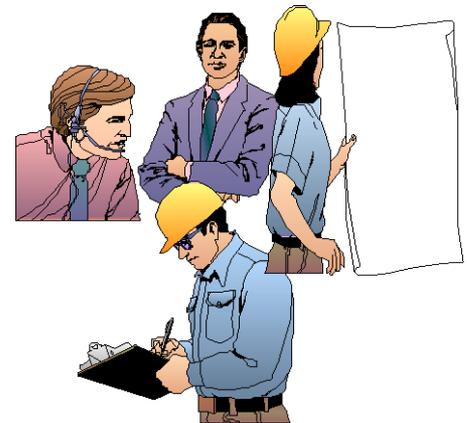
# Step 8 - Best Practice Framework



# Step 8-Single Point Lessons

- Contain content which can be delivered in 10 minutes or less
- Are highly Visual
- Are an Essential aid to communication for Operators, Maintainers, Managers and Support Staff
- Address the Main Stages of the Learning Process:-

|             |                             |
|-------------|-----------------------------|
| Explain     | (Awareness)                 |
| Demonstrate | (Understanding)             |
| Practice    | (Skill Development)         |
| Confirm     | (Competent to Train Others) |



# Step 8: Develop Best Practice Standard Work and SPL's

| JOB BREAKDOWN SHEET   |   |   |
|---|---|---|
| MAJOR STEPS   | KEY POINTS  | REASON FOR KEY POINTS   |
| (WHAT)  | (HOW)   | (WHY)   |
| <p><b>STEP # 1</b><br/><u>Turning On The Grip Verification For The Robot</u></p>  | <p>1) Turn the key to pgm/man mode. Press the power button , then press the GRIP VER. button to enable the green light.</p>   | <p>1) To ensure the robot will not operate if it fails to pick sprue. This ensures the mould won't close on sprue and damage tooling.</p> |
| <p><b>STEP # 5</b><br/><u>Checking The Water Flow In The Machine</u></p>  | <p>1) Check to ensure that the selector box which is located at the rear of the machine is on the correct number to co-operate with the regrind return system.</p>  | <p>1) To ensure the regrind return works correctly.</p>   |
| <p>1) Check and make sure that there's an adequate water flow level in the machine.</p>  | <p>1) To ensure that the water system is operating correctly.</p>   | <p>1) To ensure the regrind return works correctly.</p>   |

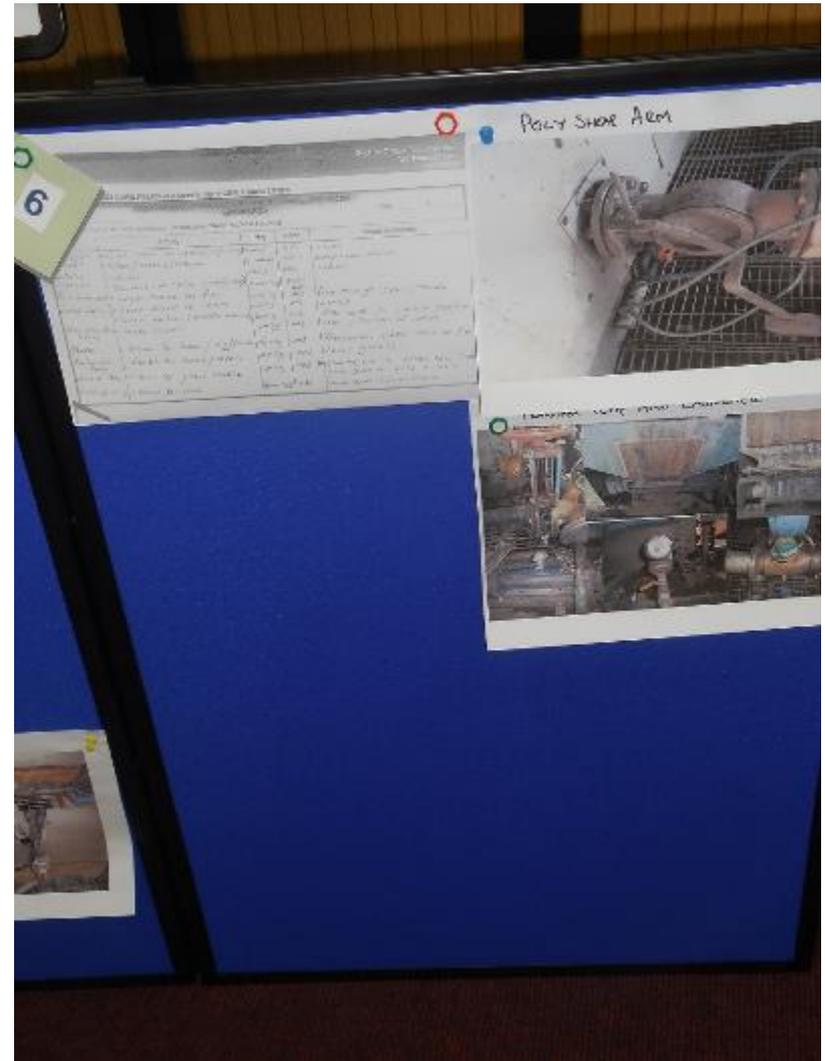
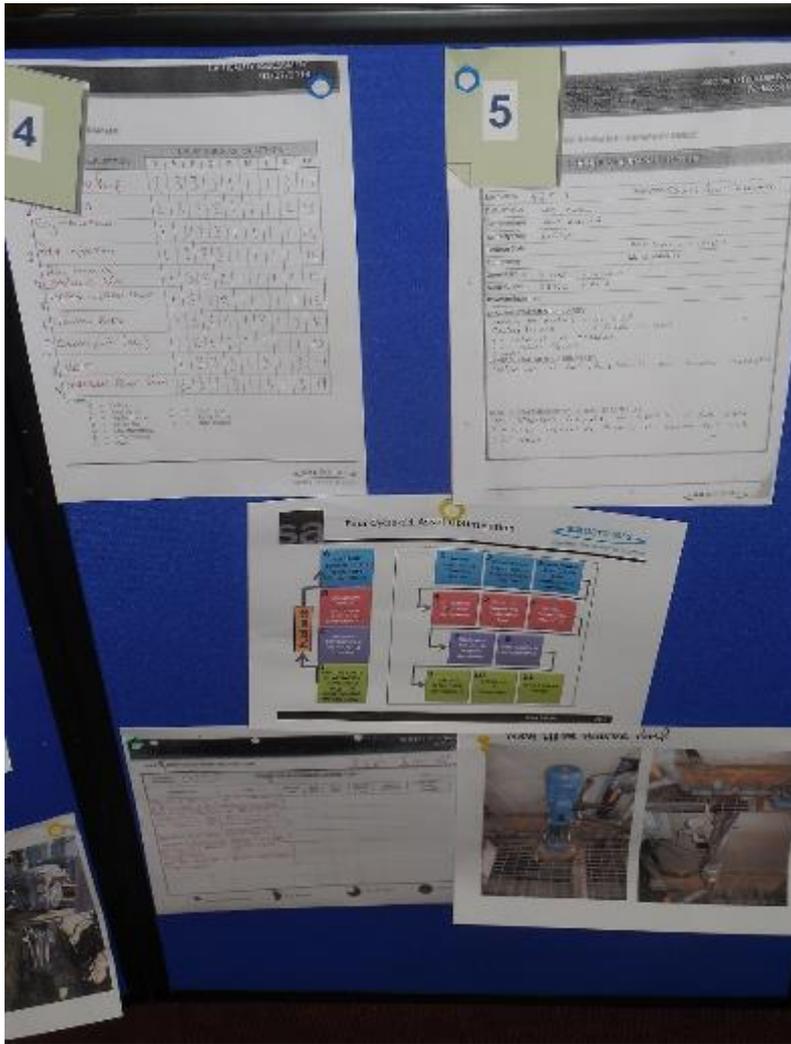
## Step 8 KLP's

- **There is only one Best Way**
- **Use of SPL's & Skills Matrix**
- **Standard Work**

# Building the TPM Activity boards



# Building the Activity boards



# Step 8-Single Point Lessons

**Cog Moors WwTW - 33726**

|                     |  |       |  |  |  |  |
|---------------------|--|-------|--|--|--|--|
| Description of task | To check poly level on the Control panels to see its | BT 01 |  |  |  |  |
| SNRP                | 33726-S3-P0014                                       | Ops   |  |  |  |  |
| Equipment           | Brth Poly systems                                    |       |  |  |  |  |

Ensure equipment is locked out before work is done. Always use correct LOTO for the area you are working in.

**Additional PPE Required**

All company standard PPE / Safe Systems of Work MUST be adhered to at all times.

**Objective of Doing this Task**

To ensure the Poly systems are working for use.

**Task Procedure:**

There are two Polymer systems in use for the Brth Poly Systems at Cog Moors. The checking of PWS uses a local poly system and the checking of primary uses a secondary poly system.

**NOTE:** Care must be taken to and around the poly make up room as poly becomes wet & slippery if it becomes wet.

- Check both control rooms for 'Flick' & alarm lights. If there are no lights present then all lights need to be checked to ensure the poly system is still in use.
- Check the 'poly range' on the powder poly system for a reading. If the display has a 'LOC' reading this could indicate there is a fault with the main tank's electronic unit.

**What to do in the event of abnormality or defect found:**

All defects are to be recorded in the works diary "WCD01" and reported to the Site Ops or the Ops Manager. A completed repair tag should be attached at or near the defect and the roll price be confirmed.

Page 1 of 1

Issue 01  
Apr 2016

## Step 4-Criticality-Supplier involvement



Understanding operation  
of shear valves

Understanding  
flow characteristics  
with different levels of Poly



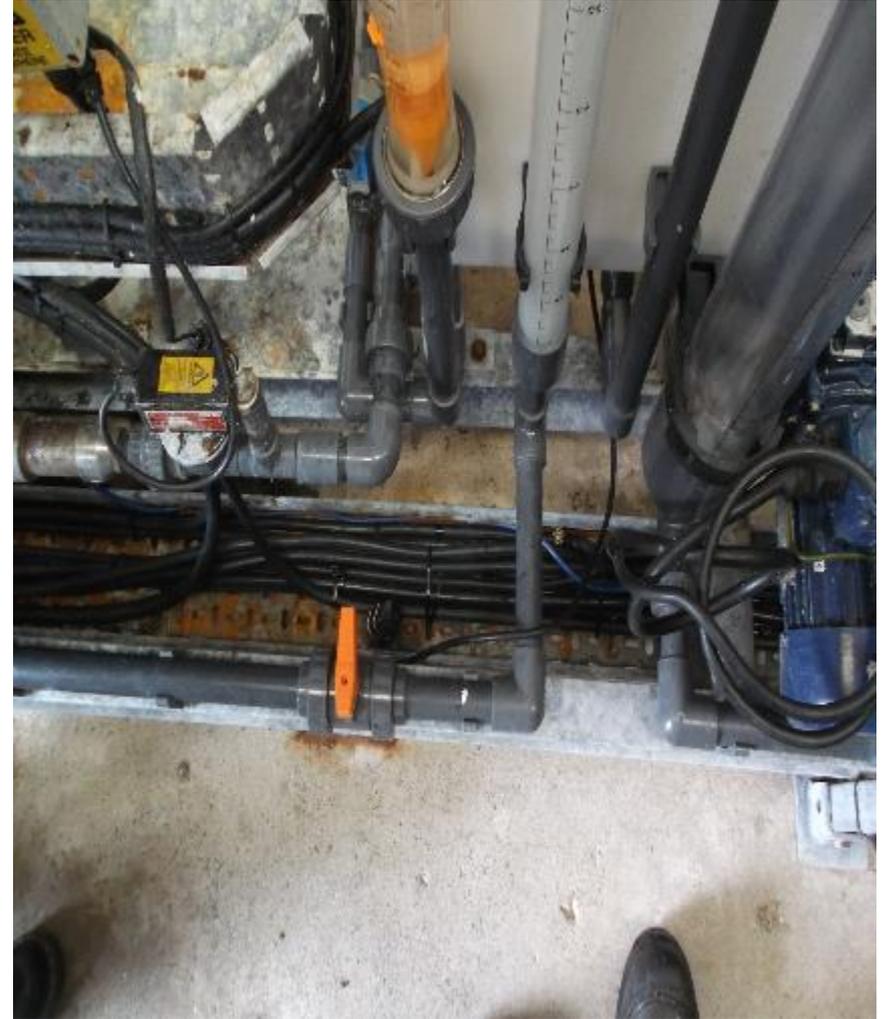
# Polymer feed area-Before



## Cleaned Poly hopper, leaks identified and repaired. After



## Before and after, Cleaned to allow inspection and improved H&S.

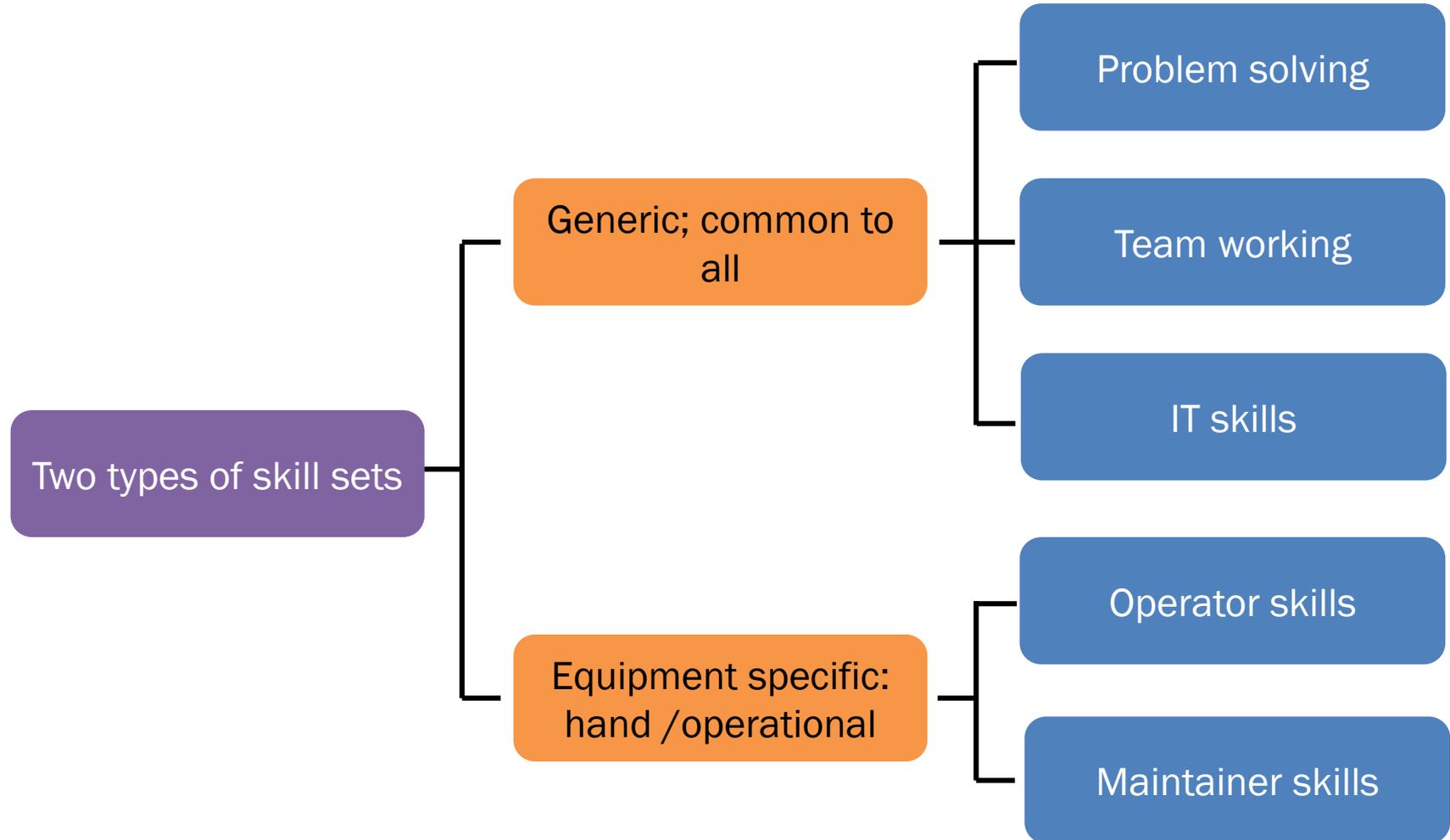


# Session 6-Upskilling and TPM Roles and responsibilities of your Front Line O&M Staff

## Step 9 - As an Operator or Maintainer, I Will Do Something Different If You.....

- ▶ Ask My Opinion about the Best Way.
- ▶ Include it in the Future Ways of Working.
- ▶ Feedback the Result to Me.
- ▶ Train Me and Coach Me.
- ▶ Give Me Dedicated Improvement Time.....
- ▶ ...And It Results in a “Trouble Free” Shift

# Two types of skill sets



# The TPM role of the operator

## 4 x Principles to Follow:

1. The operator predicts a problem before it happens (i.e. tighten station clamp/air leaks etc.) and corrects provided it is within their competence and skill set
2. The operator will carry out all checks and inspections which don't require a technical judgement. Any faults found are fixed by him/her (i.e. worn hoses/loose limit switches) and reported to maintenance if outside their scope.
3. The operator will carry out set-ups and changeovers to the product or process. As a result, he/she is more aware of the equipment functionality process logic sequence, cycle time and quality requirements and implications
4. The operator initially responds to all breakdowns before involving the maintenance technician. Because of their experience working with the equipment, simple faults can be tackled (i.e. parts being mis-located, adjustments, alarms).

**These four aspects give a high level of OWNERSHIP**

# Skill set requirements of the operator

| AREA      | UNDERSTANDING   | SKILL REQUIREMENT  |
|-----------|---|--|
| Operation | <ul style="list-style-type: none"> <li>• Normal/Abnormal Running</li> </ul> | <ul style="list-style-type: none"> <li>• Able To Record / Measure               <ul style="list-style-type: none"> <li>• Statistically</li> <li>• OEE</li> </ul> </li> </ul> |
|           | <ul style="list-style-type: none"> <li>• Asset Care</li> </ul>              | <ul style="list-style-type: none"> <li>• Lubrication</li> </ul>  |
|           | <ul style="list-style-type: none"> <li>• Equipment Based Losses</li> </ul>  | <ul style="list-style-type: none"> <li>• Inspection</li> </ul>   |
|           | <ul style="list-style-type: none"> <li>• Equipment Control</li> </ul>       | <ul style="list-style-type: none"> <li>• Cleaning Standards (5S)</li> </ul>  |
|           |   | <ul style="list-style-type: none"> <li>• C.I. Activities               <ul style="list-style-type: none"> <li>• Asset Care</li> <li>• Problem Solving</li> </ul> </li> </ul> |
|           |   | <ul style="list-style-type: none"> <li>• Team working</li> </ul>   |

# The TPM role of the maintenance technician

## 4 x Principles to Follow:

1. The Maintenance Technician will carry out the Planned Maintenance (PM) Schedules & Programme, where a technical judgement is required.
2. Every job the Technician does is recorded. Analysis is carried out in the TPM activity sessions. The trends can then be used to initiate Continuous Improvement Activities as part of Steps 7&8
3. The Technician trains the Manufacturing Staff to carry out the Front line Operator Asset Care Activities. If the Manufacturing Staff do not do it correctly, it is normally because they have not been shown how to do it or the Standard Work Instructions are inadequate
4. Every Technician, as part of his induction programme, spends time on the line or process making product and this quickly develops empathy with the Manufacturing Staff.

# Skill set of the maintenance technician

| AREA               | UNDERSTANDING  | SKILL REQUIREMENT   |
|--------------------|--|---|
| <b>Maintenance</b> | <ul style="list-style-type: none"> <li>Quality Maintenance Strategy</li> </ul>           | <ul style="list-style-type: none"> <li>Condition Monitoring</li> </ul>                                |
|                    | <ul style="list-style-type: none"> <li>Improving Component Reliability (MTBF)</li> </ul> | <ul style="list-style-type: none"> <li>Reliability Centred Maintenance</li> </ul>                     |
|                    | <ul style="list-style-type: none"> <li>Reducing Mean Time To Repair (MTTR)</li> </ul>    | <ul style="list-style-type: none"> <li>Preventative Maintenance and quality of maintenance</li> </ul> |
|                    | <ul style="list-style-type: none"> <li>Operator Asset Care</li> </ul>                    | <ul style="list-style-type: none"> <li>Failure Analysis (FTA, FMEA)</li> </ul>                        |
|                    |  | <ul style="list-style-type: none"> <li>Conditions For Zero Breakdowns</li> </ul>                      |
|                    |  | <ul style="list-style-type: none"> <li>P-M Analysis</li> </ul>  |
|                    |  | <ul style="list-style-type: none"> <li>Breakdown Analysis</li> </ul>                                  |
|                    |  | <ul style="list-style-type: none"> <li>Machine Components (Functional Analysis)</li> </ul>            |
|                    | <ul style="list-style-type: none"> <li>Visual Controls (including 5S)</li> </ul>         |   |

# Skills assessment. Where are we now ?

## Operator Skill Requirement

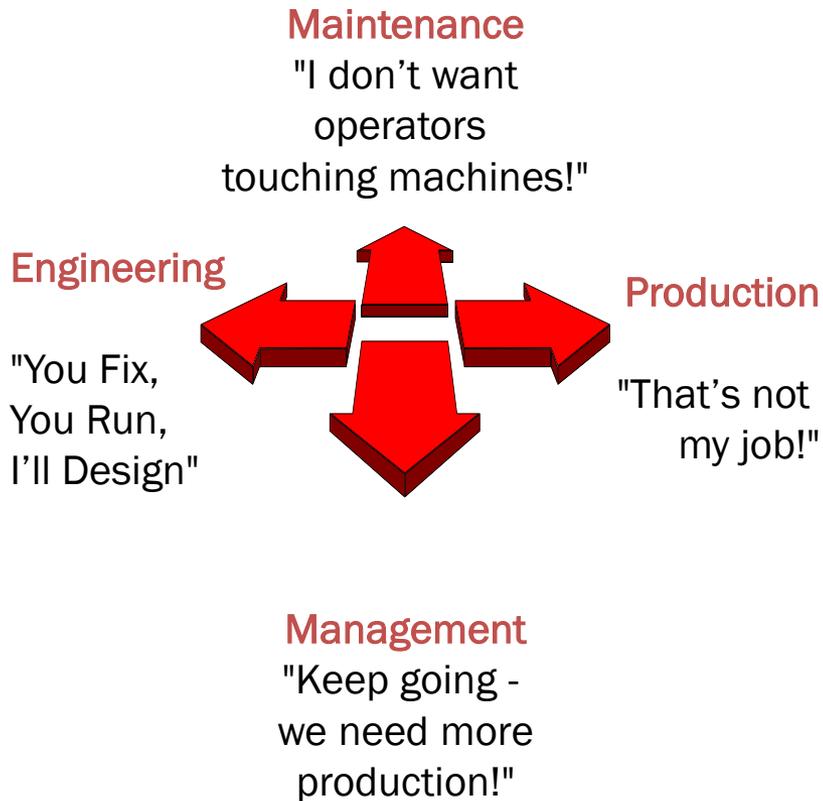
- Ability to detect abnormalities
- Able to understand
  - OEE
  - Quality
- Level checks
- Routine line inspection
- Cleaning standards (5S)
- C.I. Activities
  - Front line asset care
  - Action teams
- Team-based working
- Trending and Visual Mgt

## Maintainer Skill Requirement

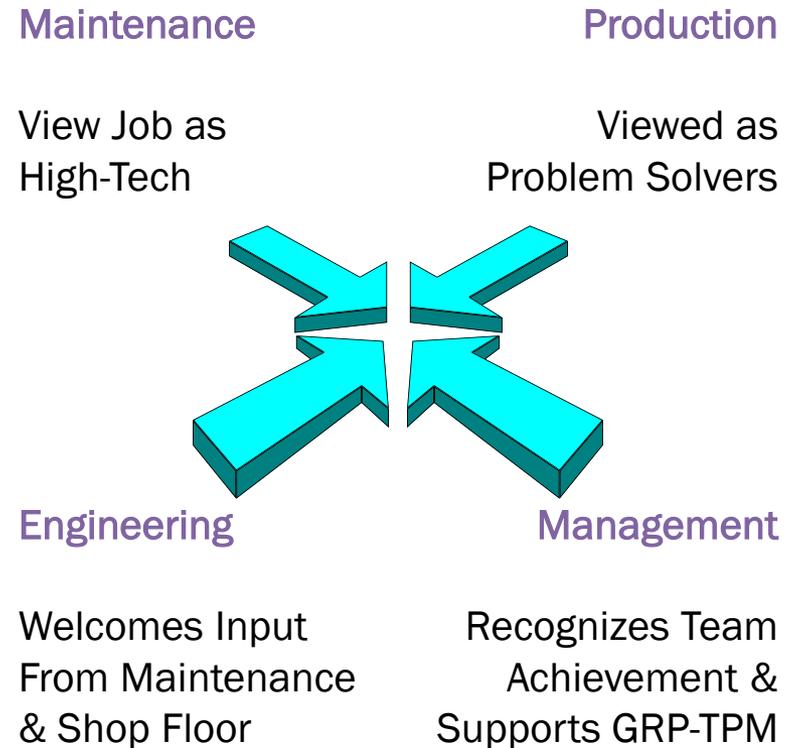
- Condition monitoring
- Criticality assessment
- Refurbishment
- Planned maintenance
- Failure analysis (FMEA)
- Conditions for zero breakdowns
- A3 problem solving
- Breakdown / event analysis
- Machine components (functional analysis)
- Visual management and trending

# Changes in attitude required when Operator Care is introduced

## Traditional Site Beliefs



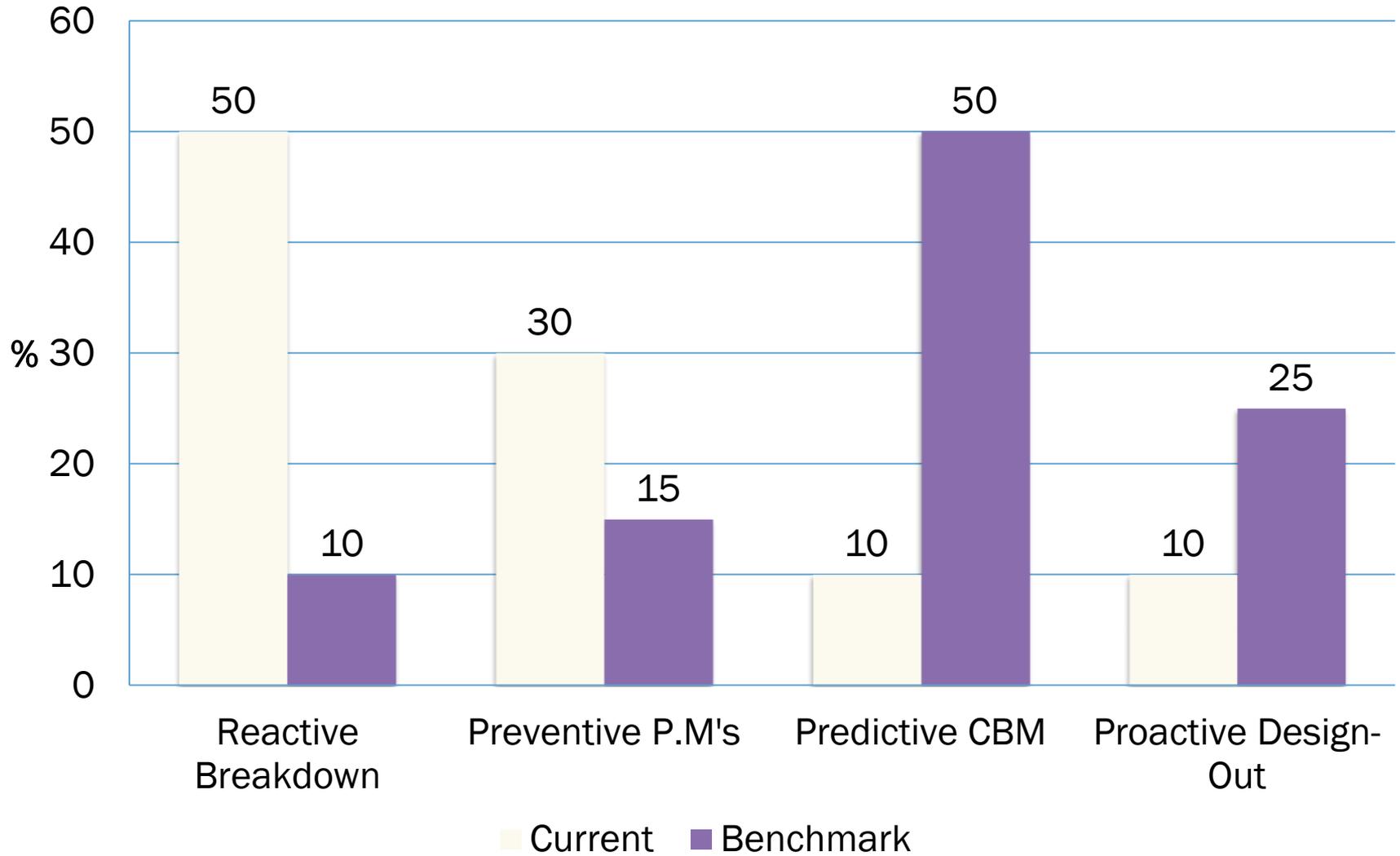
## New Operator Care thinking



# Front line operator care process - summary

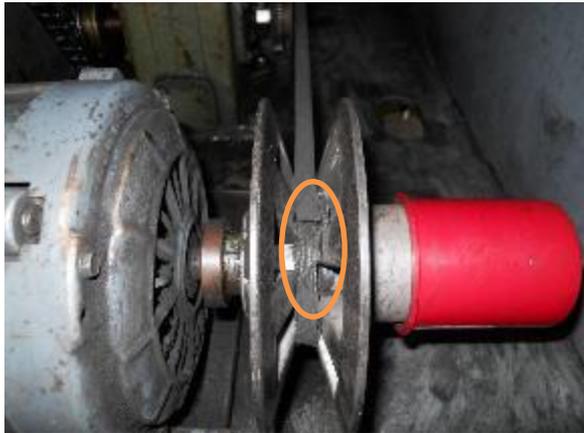
- Operators are taught how machines work
- Systematically mapping and tagging of faults by operators and maintenance engineers
- Understanding the causes of tagged faults and eliminating them by improved knowledge, A3 problem solving and standards
- Maintaining standards by cleaning, lubricating and inspection
- Elimination of “hard to access”
- Constantly reducing the time to clean, lubricate and inspect

# Current vs. (3 yr) benchmark maintenance time allocation



# Equipment assessment and inspection

- ▶ Clean Equipment and Work Areas to “Like New” Condition
- ▶ Perform Detailed Inspections to Identify and Correct all Equipment Problems
- ▶ Create Inspection Tasks or Design Out the Failure Modes, Maintain New Standard
- ▶ Implement Visual Controls and Improve Maintainability



**Imminent Belt Failures**



**Hydraulic Line Wearing in Contact With Rotating Shaft**



**Unprotected Wires**

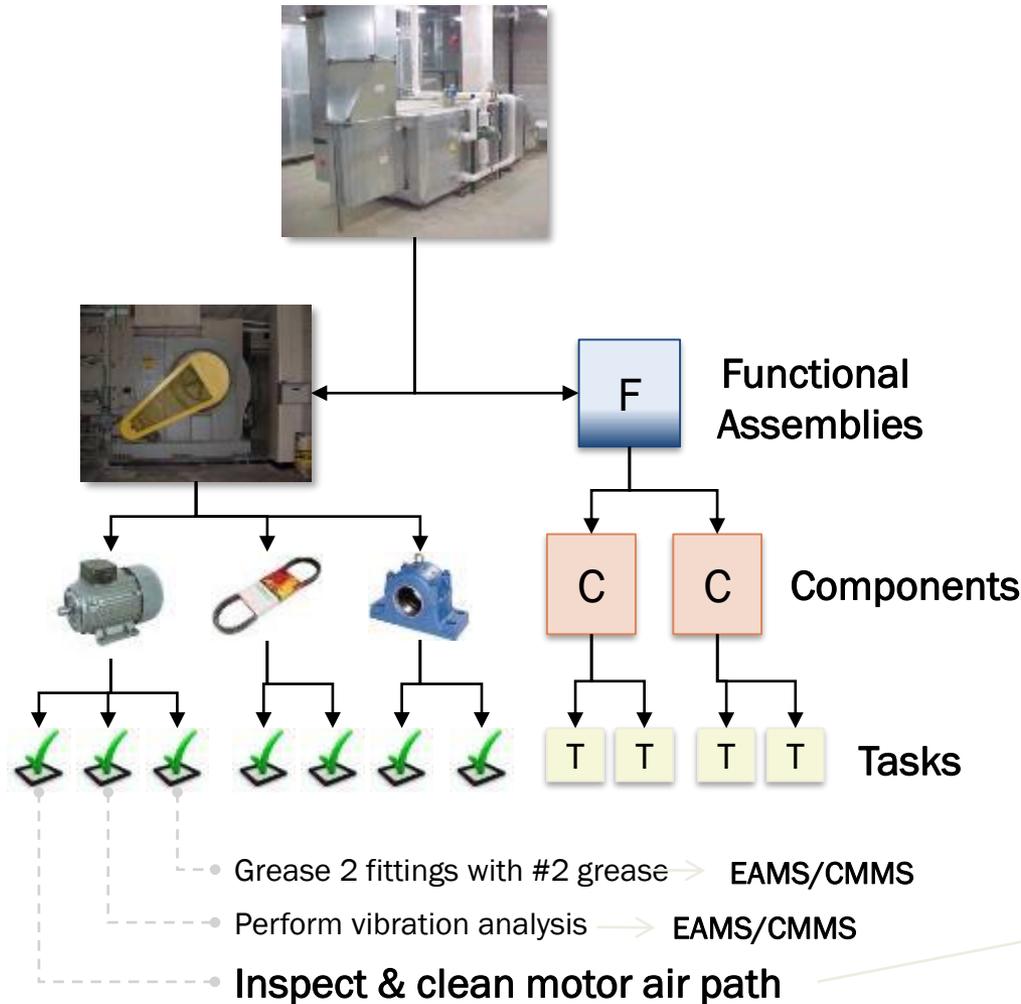


**Electrical Cable In Contact With Rotating Gear**



# PM Optimisation

PMO = The Right PM Work, Operator Care, Fewer Breakdowns



Askeaton IRE Packaging 5467 Ed KZC

---

**Hydraulic Unit > Motor > Visually inspect motor condition**  
A. Ok / B. Dirty / C. Hot / D. Noisy



**Safety:**  
No safety or PPE required to perform inspection

**Tools:**  
Flow template

**Parts:**  
No parts required

**Task Duration:**  
2.00

---

**Inspection Details**

1. Locate motor on rear of unit
2. Visually inspect motor air path
3. Is air path or exterior built up w/ debris?
4. If dirty, hot or noisy, notify maintenance

**Comments / Notes:**

Global Reliability Program

# Asset Life Cycle Management Philosophy- Align with future asset care plan

## TPM AS A HOLISTIC LIFE CYCLE APPROACH



People

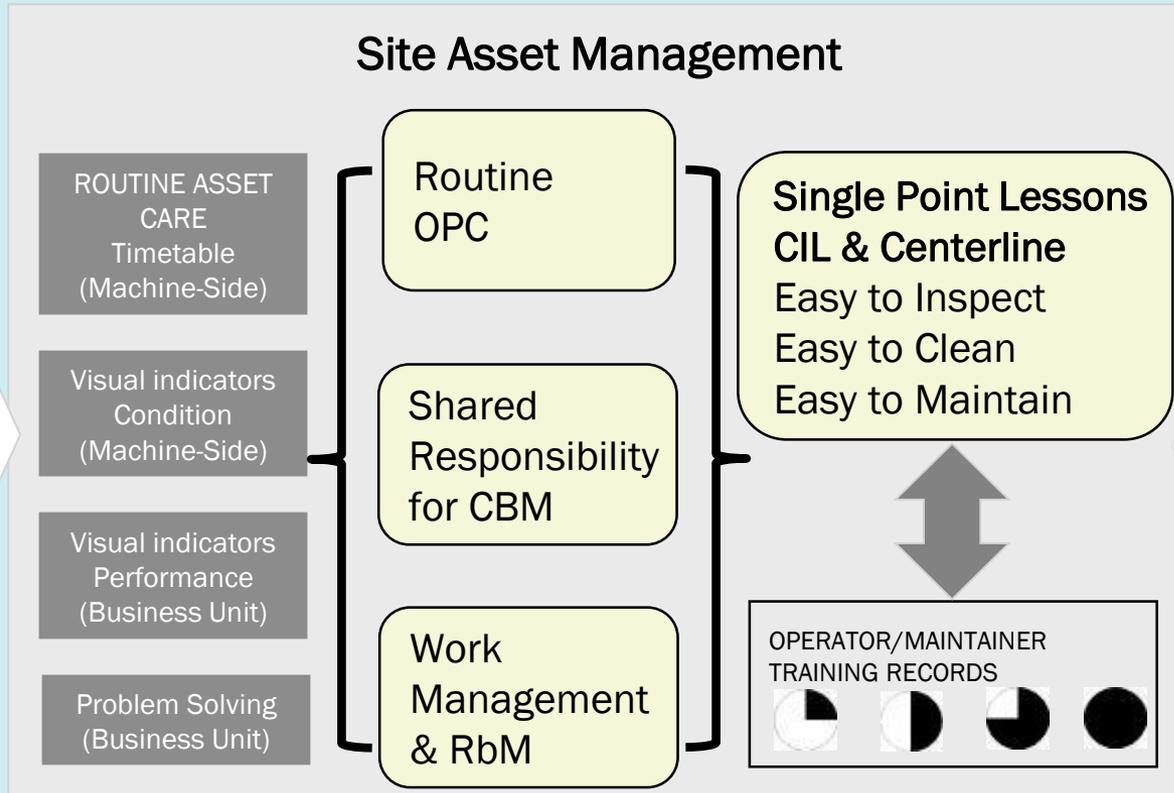
Equipment Assessment

Condition Appraisal

Refurbishment Plan

Agreed Standards

Design



CMMS/EAMS

ASSET  
Equipment & Spares  
Lists

ASSET  
Preventive &  
Condition-based  
Inspections

ASSET  
Work Management-  
Identify, Plan, &  
Schedule

ASSET  
Performance  
Management &  
Standard Reports

## Asset Life Cycle Management System

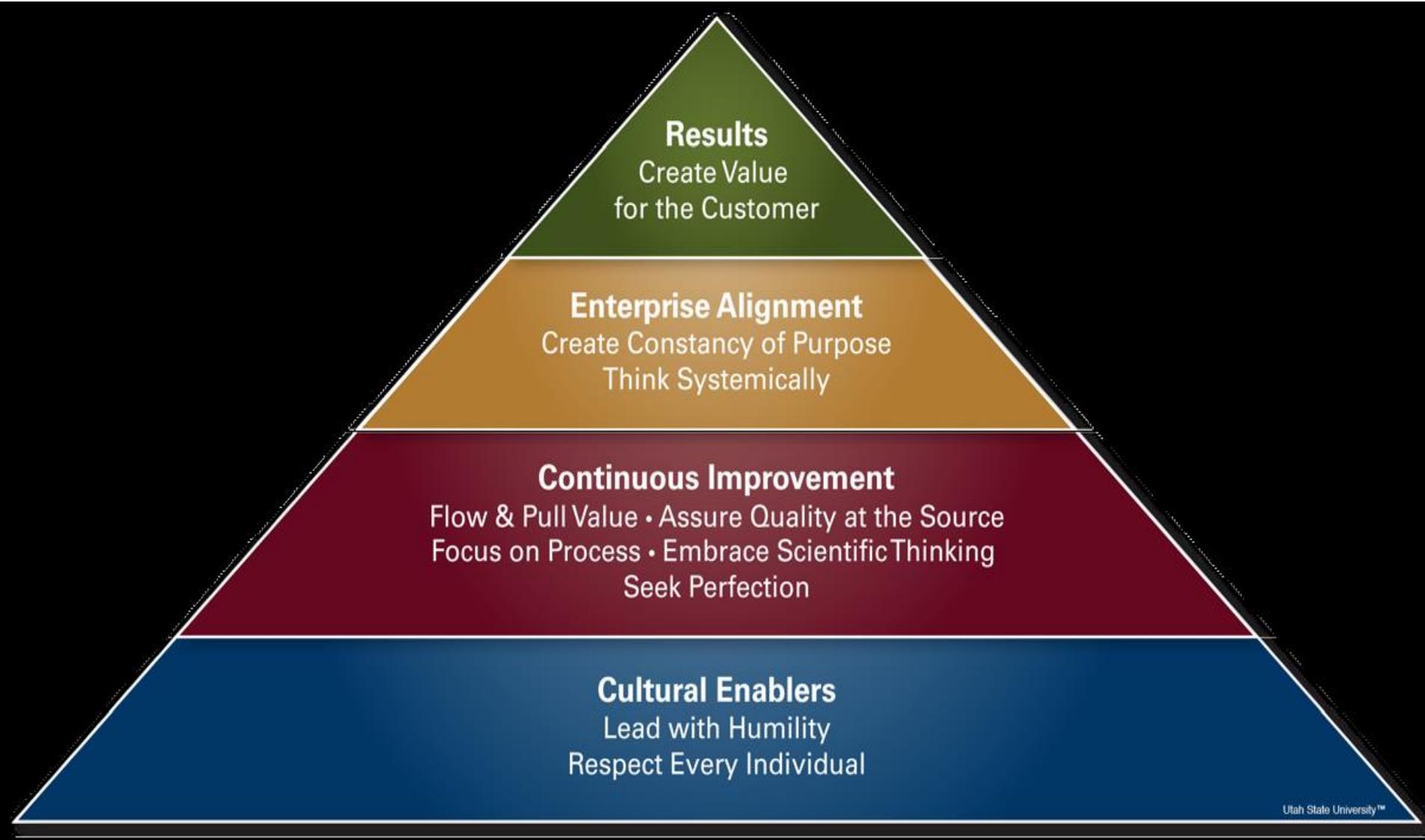
# The link with human senses

|                          | Sight  | Touch  | Hear  | Smell  | (Taste)   |
|--------------------------|--|--|---|--|---|
|                          |   |  |  |   |  |
| Vibration                |   |   |  |  |   |
| Leaking                  |   |  |   |   |  |
| Over Heating             |  |  |   |  |   |
| 4 <sup>th</sup> Reason ? |  |  |   |  |   |

# The link with human senses

|                 | Sight   | Touch  | Hear  | Smell   | (Taste)   |
|-----------------|---|--|---|---|---|
|                 |    |  |    |    |  |
| Vibration       |    |   |    |   |   |
| Leaking         |    |  |   |    |  |
| Over Heating    |   |  |   |   |   |
| They go BANG !! |  |  |  |  |   |

# The Shingo Model™



# The Ten Shingo (behavioural) Principles /Attributes

- Respect every individual
- Lead with humility
- Flow and pull value
- Assure quality at the source
- Seek perfection
- Focus on process
- Embrace scientific thinking
- Think systematically
- Create constancy of purpose
- Create value to the customer

# Think big-Seek Perfection

“The greatest *danger* for most of us is not that our aim is *TOO HIGH* and we *MISS IT*, but that it is *TOO LOW* and we *REACH IT.*”

Michelangelo c.1450

# Interpretation of Michelangelo

“If we **STRIVE for PERFECTION** we might not achieve it, but at least we will **MAKE SIGNIFICANT PROGRESS.**”

ANON 2019

# APPENDIX A-Workshop Exercises

# Exercises

- We will also work through 2 x syndicate group exercises and see how those KLP's might impact your future management of Operations & Maintenance-
- Whether you are the Asset Owner or Service Provider.

# World Class Maintenance Delivery

(1 of 2)



| Traditional Maintenance Delivery |   |   | World Class Maintenance Delivery |  |
|----------------------------------|---|---|----------------------------------|--|
| 1                                | 2   | 3 | 4                                | 5  |
| 1.0                              | React to and fix problems as they occur   |   | <input type="checkbox"/>         | Work is preventive based and planned   |
| 2.0                              | Accept facts as they occur  |   | <input type="checkbox"/>         | Problems are anticipated and dealt with <u>before</u> failure  |
| 3.0                              | Fatalist and status quo mentality   |   | <input type="checkbox"/>         | Futurist so that we have the skills to take on change and new technology   |
| 4.0                              | Busy achieving 'our' plan with no input from the other party and no integration with the production planning            |   | <input type="checkbox"/>         | Both parties must support the business plan and adjust accordingly to suit with flexibility and agility  |
| 5.0                              | Wrong objectives, geared to activities and maintaining the status quo rather than needs with clear performance tracking |   | <input type="checkbox"/>         | The word ' <i>Maintenance</i> ' suggests status quo, change it to ' <i>Asset Performance</i> ' so that both are focused on improvement (a reason to exist) |
| 6.0                              | Limited use of visual colour indicators (things which make the work easier to do)                                       |   | <input type="checkbox"/>         | Appropriate use of visual and colour indicators for patrol /front line running inspections.  |
| 7.0                              | Work is prescribed, issued on job cards, hence no ownership for quality of work done                                    |   | <input type="checkbox"/>         | Work is developed by the team and is therefore, owned by the team with resultant quality work  |
| 8.0                              | Information has little integrity and people have little access to it  |   | <input type="checkbox"/>         | High quality information with good access to encourage 'ownership'   |

# World Class Maintenance Delivery (2 of 2)



| Traditional Maintenance Delivery |   |   | World Class Maintenance Delivery  |   |
|----------------------------------|---|---|---|---|
| 1                                | 2   | 3 | 4   | 5 |
| 9.0                              | Rigid structure does not allow flexibility  |   | ☐ Versatile and flexible team, multi-disciplined  |   |
| 10.0                             | Functional skills are not shared and there is no integration with the local Asset 'Owner'               |   | ☐ Common goals which are value / benefit driven   |   |
| 11.0                             | Poor housekeeping, our workshops are a mess   |   | ☐ 5S in our own workshops – We lead by example  |   |
| 12.0                             | Backlog is used as a negative management tool and rarely reduces because of reaction                    |   | ☐ Proactive in our attitudes to achieve the common goals, work is planned and delivered with the 'internal customer'                      |   |
| 13.0                             | There is no control, overtime orientated means less work gets done during normal hours                  |   | ☐ Process is managed and team is self motivated, behaviours are developed to match the role and drive the right behaviours                |   |
| 14.0                             | Over-manned for the status quo, unproductive  |   | ☐ Resources are optimised and skills balanced to match the work level to continuously improve   |   |
| 15.0                             | Purely Revenue Budget driven- tip of the iceberg only, Perceived as efficient but totally in-effective. |   | ☐ Costs are activity based so that the whole cost can be managed – including lost opportunity. Efficiency optimised through effectiveness |   |

## Rate each of the above 15x Statements and total your score out of 75 Maximum

- 1 = Poor, No Evidence, No Plans to Improve.
- 2 = Fair, Little Evidence, Great Deal of Scope, Limited Plans to Improve.
- 3 = Adequate, Some Evidence but Still Much Scope  
Solid Plans
- 4 = Very Good, Almost There, Solid Evidence and Track Record.
- 5 = Excellent, Achieved World Class.

# Enter Your Score here.....

| Statement Number | Your Score | Statement Number    | Your Score |
|------------------|------------|---------------------|------------|
| 1                |            | 9                   |            |
| 2                |            | 10                  |            |
| 3                |            | 11                  |            |
| 4                |            | 12                  |            |
| 5                |            | 13                  |            |
| 6                |            | 14                  |            |
| 7                |            | 15                  |            |
| 8                |            | <b><i>TOTAL</i></b> |            |

# Add up your score:

- 15 to 29      We have a major opportunity for improvement
- 30 to 44      We have significant scope for improvement
- 45 to 59      We are doing well, but can still gain some benefits
- 60 to 74      We are almost World Class
- 75              We are the World's Best!!!

| Score    | Number of Delegates |
|----------|---------------------|
| 15 to 29 |                     |
| 30 to 44 |                     |
| 45 to 59 |                     |
| 60 to 74 |                     |
| 75       |                     |

Joint Partnership Agreements need to address each of these 15 x fundamental reasons for the gaps in our existing Maintenance Philosophy & Strategy and recognises that our relationship with our Operations & Maintenance Service Supplier OR the Asset Owner Customer is the key, and the way in which that relationship is integrated and supported is vital to deliver true value to your Business-whether you are the Supplier or the Customer

# Drivers and Stoppers Exercise

| Business Drivers | Potential Impact of O&M.<br>'Partnership' |                 |           |             |   |   |   |
|------------------|---|-----------------|-----------|-------------|---|---|---|
|                  |   |                 |           |             |   |   |   |
|                  |   |                 |           |             |   |   |   |
|                  |   |                 |           |             |   |   |   |
|                  |   |                 |           |             |   |   |   |
|                  |   |                 |           |             |   |   |   |
|                  |   |                 |           |             |   |   |   |
|                  |   |                 |           |             |   |   |   |
|                  |   |                 |           |             |   |   |   |
|                  |   |                 |           |             |   |   |   |
| 0 = None         | 1 = Some                                  | 2 = significant | 3 = Major | Total Score | / | = | % |

# What Will Stop These New Ways of Working from “taking hold” ?

| Stoppers | Countermeasures |
|----------|-----------------|
|          |                 |
|          |                 |
|          |                 |
|          |                 |
|          |                 |
|          |                 |
|          |                 |
|          |                 |
|          |                 |

# Senior Management Team Workshop

| Business Drivers        | Potential Impact of O&M –Team A |
|-------------------------|---------------------------------|
| Joint Profitability     | 3                               |
| Meet Customer Demand    | 3                               |
| Quality with Compliance | 2                               |
| Safety                  | 3                               |
| Enhanced Reputation     | 3                               |
| Cost Competitiveness    | 3                               |
| Increase Market Share   | 3                               |
| Reduce Inventory        | 2                               |
| Increased Efficiency    | 3                               |
|                         | <b>25</b>                       |

Total Score 25 / 27 = 93%

| Business Drivers                | Potential Impact of O&M –Team B |
|---------------------------------|---------------------------------|
| Reduced Unit Cost of Production | 3                               |
| Increased Quality               | 3                               |
| Meet Deliveries on Time         | 2                               |
| Increased Outputs               | 3                               |
| Improved Safety record          | 2                               |
| Minimise Inventory Levels       | 2                               |
| Minimise Lead Times             | 2                               |
| Increased Competitiveness       | 3                               |
|                                 |                                 |
|                                 | <b>20</b>                       |

Total Score 20 / 24 = 83%

0 = None 1 = Some 2 = Significant 3 = Major

# What Will Inhibit These New Ways of Working ?

| Team A ----Stoppers                     | Team A----Countermeasures   |
|---|---|
| Lack of Acceptance & Buy-in             | <ul style="list-style-type: none"> <li>•Engagement thro' Education</li> <li>•Building Teams</li> </ul>  |
| Fear of Change                          | <ul style="list-style-type: none"> <li>•Reassurance &amp; Involvement from Start-Up</li> </ul>  |
| Cost & People Resources                 | <ul style="list-style-type: none"> <li>•Investment. Make Resources available. Planning. Restructuring</li> </ul>  |
| Unrealistic Expectations                | <ul style="list-style-type: none"> <li>•Milestone Recognition</li> <li>•Education, Training &amp; coaching</li> <li>•Recognition for every Improvement (Big and small)</li> </ul> |
| Poor Communication/ Objective alignment | <ul style="list-style-type: none"> <li>•Ongoing Communication</li> </ul>  |
| Loss of Momentum                        | <ul style="list-style-type: none"> <li>•Put Governance Structure in place-Regular Partnership Reviews</li> </ul>  |

| Team B---Stoppers                              | Team B----Countermeasures   |
|--|---|
| People's Attitude / Understanding / Old Habits | <ul style="list-style-type: none"> <li>•Relevant Training</li> </ul>                                |
| Fear of Change / New Roles                     | <ul style="list-style-type: none"> <li>• Communication Plan &amp; Cascade</li> </ul>                |
| Benefit not immediately Apparent               | <ul style="list-style-type: none"> <li>•Planning of Work / Publicise Results</li> </ul>             |
| Poor Teamwork-Them and Us                      | <ul style="list-style-type: none"> <li>•Improve Understanding thro' coaching</li> </ul>             |
| Lack of Perseverance / follow through          | <ul style="list-style-type: none"> <li>•Persist through Review and Action+ Pillar Champs</li> </ul> |
| Lack of Support / commitment from Management   | <ul style="list-style-type: none"> <li>•Provide necessary Support / resources/ Budget</li> </ul>    |