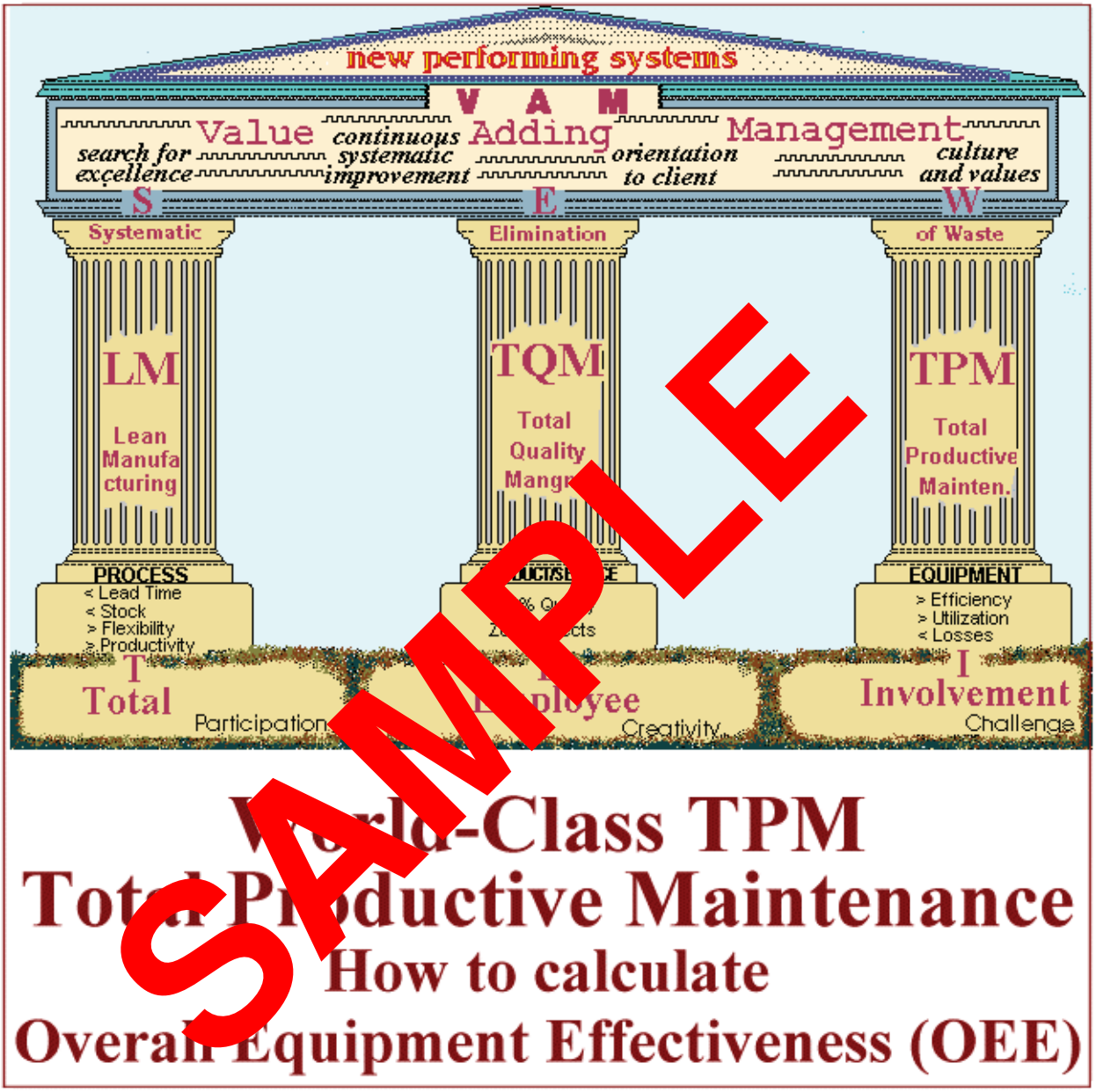
To download this Ebook sample, please visit …

**http://www.FeedForward.com.au/TPM_Tool_OEE_calculation.htm**




# World-Class TPM
# How to calculate Overall Equipment Effectiveness (OEE)

**BY**
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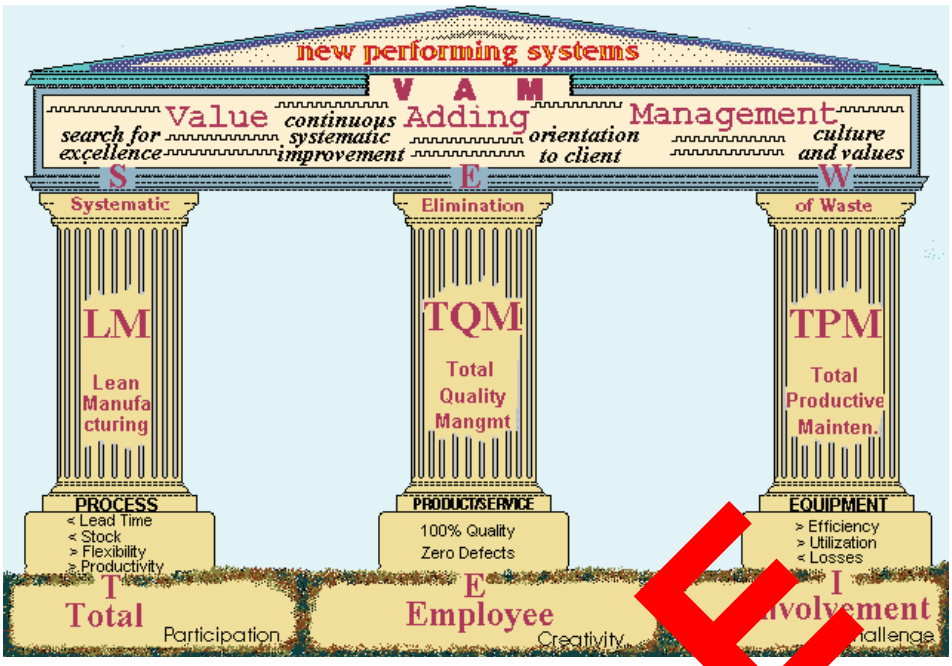



In the ideal productive process, equipment should be operating at 100% capacity 100% of the time.

TPM is a powerful discipline leading, in a process of continuous, systematic improvement, towards the ideal, with 0 downtime, 0 defects and 0 safety problems.

"Traditional" TPM (as created by Nakajima) is a set of participative programs designed to increase equipment effectiveness (productivity - quality - safety) and aiming at various goals:

- elimination of the 6 big losses, in order to maximise equipment effectiveness
- restoration of equipment to optimal operating conditions
- elimination of accelerated deterioration
- autonomous maintenance activities to maintain basic equipment conditions
- increase in efficiency and cost-effectiveness of maintenance function
- maintainability improvement and development of a maintenance system for the equipment life
- maintenance prevention
- total involvement of people from all depts. that plan, design, use or maintain equipment - involvement of top management
- increase of operation and maintenance skills
- max. safety and environment conservation/pollution control
- and others



In this course we shall deal only in part with the first goal (elimination of the 6 big losses, in order to maximise equipment effectiveness).
Before going into that, let's point out that TPM has developed over the years, and today's TPM is somewhat different from the original concept.

For Class A of machinery, this coefficient is the perfect way of reflecting the impact of speed losses: if a machine goes slower than its ideal or design speed, the time it takes to process one unit of product is longer so its *actual cycle time* is longer.

For instance, if the same machine above has an *ideal cycle time* of 0,8 seconds whereas its *actual cycle time* is 1 second, its *operating speed coefficient* would be 0,8 (0,8/1).

NB: This coefficient is normally not expressed as a % (but it would be the same).

An now we can introduce another component of OEE, the

### ➢ PERFORMANCE RATE

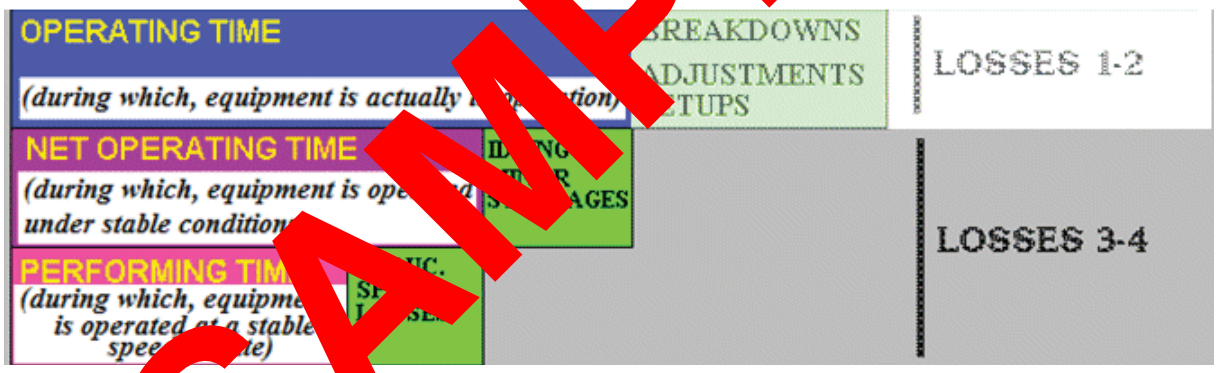
This is another primary component of OEE.

By definition:

**PERFORMANCE RATE = NET OPERATING RATE x OPERATING SPEED COEFFICIENT x 100**

This rate reflects the impact of ***losses3 and 4*** (***idling/minor stoppages*** and ***speed losses***) on the overall effectiveness of a piece of equipment in a given time, and as such refers to the PERFORMING TIME.

If you remember the definition of Performing Time




you will see immediately the relationship between *Performing Time* and *Operating Time*: the impact of ***idling and minor stoppages losses*** is taken into consideration by the *Net Operating Rate* – the impact of ***speed losses*** is reflected by the *Operating Speed Coefficient*. The overall impact gives origin to the *Performing Rate*.

Now, if you remember

$$\text{NET OPERATING RATE} = \frac{\text{OUTPUT x ACTUAL CYCLE TIME}}{\text{OPERATING TIME}} \times 100$$

and

$$\text{OPERATING SPEED COEFFICIENT} = \frac{\text{IDEAL CYCLE TIME}}{\text{ACTUAL CYCLE TIME}}$$

# OVERALL EQUIPMENT EFFECTIVENESS
# CALCULATION SHEET

***(manufacturing equipment –Class A machinery )***

EXAMPLE: MACHINE XXXXXX - One Day = 8 Hrs

| | | | |
|---|---|---|---|
| a | Available Time (8 Hrs x 60') | 480 | min |
| b | Scheduled maintenance 15' - Scheduled Production break 15' | 30 | min |
| c | Active Time (= a-b = 480' - 30') | 450 | min |
| d1 | Recorded Breakdown Time 20' | 20 | min |
| d2 | Production Change-Over: internal c/o time 30' | 30 | min |
| d | Major Stoppage Losses (= d1+d2) | 50 | min |
| e | Operating Time (= c-d = 450' - 50') | 400 | min |
| f | Operativity Rate (= 100 x e/c = 100 x 400/450) | 88,9 | % |
| g | Net Input: 558 pcs Re-work: 10 pcs Gross Input | 568 | pcs |
| h | Gross Output (includes rework) (= g) | 568 | pcs |
| i1 | Start-up Defects: 8 pcs | 8 | pcs |
| i2 | Trial Runs Defects: 4 pcs | 4 | pcs |
| i3 | Process Defects: 10 pcs (then re-worked). Unreworkable: | 0 | pcs |
| i | Total Defective Output (= i1+i2+i3 = 8 + 4 + 0) | 12 | pcs |
| l | Acceptable Output (= h-i = 568 - 12) | 556 | pcs |
| m1 | Number of Minor Stoppages: unknown | | - |
| m2 | Average duration of Minor Stoppages: unknown | | min |
| m3 | Idling Time: unknown | | min |
| m | Minor Stoppages/Idling Losses (= m1xm2+m3): unknown | | min |
| n | Net Operating Time (= n): unknown | | min |
| o | Actual Cycle Time | 0,7 | min |
| p | Net Operating Rate (= 100 x h x o/e = 100 x 568 x 0,7/400) | 99,4 | % |
| q | Ideal (Theoretical, Design or Optimal) Cycle Time | 0,5 | min |
| r | Operating Speed Coefficient (= q/o = 0,5/0,7) | 0,714 | - |
| s | Performance Rate (= p x r = 99,4 x 0,714) | 70,1 | % |
| t | Quality Rate (= 100 x l/h = 100 x 556/568) | 97,9 | % |
| u | Overall Equipment Effectiveness<br>(= 100 x f/100 x s/100 x t/100 = 100 x 88,9/100 x 70,1/100 x 97,9/100) | 61,0 | % |



All clear?
Yes: carry on and do an exercise on your own
No: start all over again

# EXERCISE 1

## OVERALL EQUIPMENT EFFECTIVENESS

In a normal productive day (8 hrs), following data were recorded for an automatic processing line:

Planned maintenance 30'

2 Breakdowns in the morning of 20' each

1 Breakdown in the afternoon which also affected quality and lasted 50' overall.

The line was reset during the afternoon for a change-over in production. The overall internal c/o time amounted to 20'.

Both product A (before change-over) and B (after change-over) were produced at a rate of 4 pcs per minute, the corresponding Actual Cycle Time resulting in 0,25'.

The Line was actually designed to produce 5 pcs/min of those products (both A and B).

A total of 950 pieces A were processed.

6 defective pieces were produced during the A process, all rejects.

A total of 410 pieces B were processed.

4 defective pieces were produced during normal processes and 2 defective pieces during trial-runs after a technical intervention to fix that quality problem - all to be considered rejects.

Calculate the OEE of the Processing Line for that day.

Clear enough?
I trust you will try your best to do this exercise on your own before looking at its solution (at the end of this course manual)!

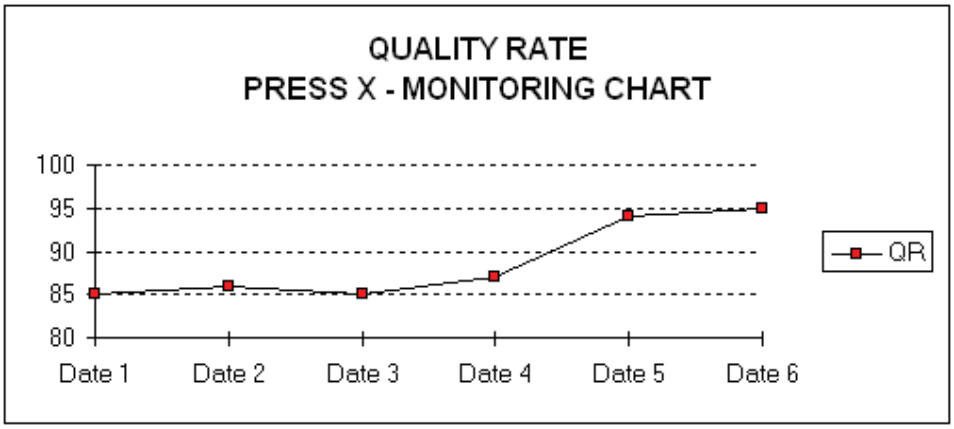
Very well. Now we can start examining our step-by-step approach for

**MACHINERY CLASS I (most Continuous Processing and some Construction Equipment)**

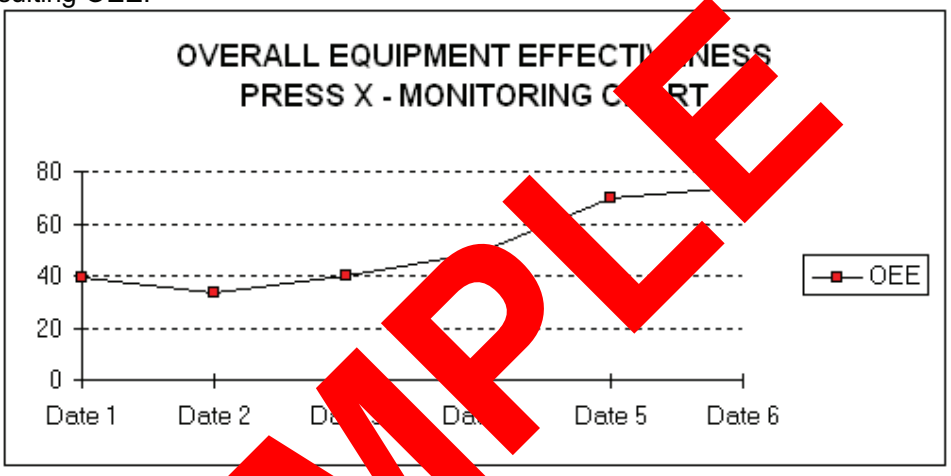
For the sake of completeness, I shall go through an identical step-by-step approach as for Class A Machinery.

Once more, the, let's identify all components of the OEE Index - we call these components ***rates***.

And QR:




And the resulting OEE:






In this way, graphs talk even mo

- If the period co hese 4 aphs was 6 months
- Where each Rat nd s averaged for the month
- And in parallel to alysis we launched improvement and corrective actions,

we can defin ee good tcomes following our efforts: all rates (OR – PR – QR) have improved and OEE h impro We e doing well.

Whenever we eed it:

- we can g to each month's graphs and data in the chart
- we can analyse deeper individual data in any individual day or shift to understand causes of poor performance or reasons of good performance
- we can even dig-in through Operators or Supervisors daily reports to investigate occurrences that happened months earlier and make correlations.
- and so on….

## MY PHILOSOPHY, MY VISION, MY MISSION

I believe in Value and Lean.

I believe that in many decades of industrialisation we have somehow lost a key word and a key concept: value - value that Enterprises offer to Clients - value generated by productive processes - value produced by managers and employees in their daily confrontation with reality - value produced by plant, equipment, machines, and technology - value brought in by suppliers - value inherent in people know-how - value generated by continuous improvement.....

Today, World Class Performers are re-discovering the vital importance of this key concept, and build enterprises engineered to produce pure, abundant value. World Class Performers are Enterprises that build their competitiveness on the value parameter: their processes are waste-less, and under continuous improvement - their people understand value, and are extremely critical about the way they produce it - their plant and their technology are managed to generate extremely high levels of output value - customers' satisfaction is their primary target, and they achieve it by offering customers an ever increasing level of value - suppliers and sub-suppliers, clients and clients of clients become integral part of a "value-chain" ending only at end-user level - their vision, their mission, their strategies, their targets, their industrial culture, their corporate communication, their organisational structure..... are all focusing on this very, primary concept: value.

I believe that, in a rapidly changing world, featuring globalisation and vanishing borders, all Enterprises, of any size, must and can, today, perform as the "top of the class" by adopting Lean Value Adding Management discipline as their guiding light.

My philosophy rotates around the key concept of value, and my training and consulting services are structured to enable Small and Medium size Enterprises to achieve higher levels of performance by re-discovering "value" as key parameter for competitiveness and success.

I believe in Integration.

I believe that as specialisation has been the key feature of this century's industry, integration is going to be the key feature of years 2000's industry.

Industry has been built around the concept of "specialisation" from well over a century: processes, products, services, jobs, machine functions, etc. shaped to a high degree of specialisation. Associated to specialisation, however, there is another feature which is "fragmentation": fragmentation of processes, of work, of operations, of activities, of tasks.....

I believe that specialisation and fragmentation are enemies number one when aiming at high levels of performance. I believe that only integration is the path to excellence and real industrial performance.

Integration is associated with flexibility, adaptability, government and control of change: all important features in our industrial world of today and tomorrow. Integration is associated with overall view, overall control, and overall, holistic approach to performance: for too long many Enterprises, especially of small and medium size, have tried to achieve competitiveness and performance by embracing the "fashion" management discipline of the time, be it Quality Assurance, Total Quality Management, Zero Defects, Productivity Improvement, Process Improvement and Management.... or effective Management techniques, or Leadership techniques, or a Continuous Improvement approach, or Management by Objectives..... and even One-Minute Management, trusting they had come across the truth and the recipe to success, to discover eventually, in many cases, that the improvement in performance was not real, or consistent, or stable.....

I believe that real improvement in performance can only be obtained with an integrated approach, focusing on the key concept of "value" as guiding light, and powered by the use of a number of appropriate disciplines "in consociation" and simultaneous deployment: like to say that targeting at quality improvement without considering simultaneously the productivity aspect is not getting to real improvement, and it has never generated real improvement, because quality and productivity are always the two sides of the same medal - and vice-versa - like to say that focusing on process improvement or process re-engineering without considering simultaneously the primary importance of getting employees highly involved and without the simultaneous deployment of adequate technology-performance techniques can only bring very marginal results - like to say that going for a Kaizen style of continuous improvement without knowing priorities and targets that in certain instances only adequate Benchmarking can provide may fail, as it has failed - and so on: there are many more examples of possible failures due to lack of integration or to excessive focus on an individual, specialised technique.....

Only an integrated view (".....see the tree, not the leaves....." or, referring to my New Performing Systems architectural structure, ".....see the temple, not only the pillars....") can produce valid, high level results.